Fort Bragg Wastewater Collection System Master Plan

City of Fort Bragg

August 1, 2026

Contents

EXECUTIVE SUMMARY 1

ES.1 Background 1
ES.2 Key Master Plan Components 1
ES.3 Capital Improvement Program (CIP) 2
ES.4 Capital Plan Funding 6
ES.5 System Hydraulic Analysis 6
ES.6 Condition Assessments 7
ES.7 Geotechnical, Environmental, and Climate Risk and Resilience 7

CHAPTER 1 Introduction 1-1

1.1 Master Plan Purpose & Goals 1-1
1.2 Wastewater Collection System 1-2
1.3 Report Organization 1-3

CHAPTER 2 Data Collection and Hydraulic Modeling 2-1

2.1 Existing Model Development 2-1
2.2 Manhole Field Survey 2-10
2.3 Flow Monitoring 2-12

CHAPTER 3 Existing and Future Capacity Analysis 3-1

3.1 Introduction 3-1
3.2 Infiltration & Inflow (I&I) Analysis 3-1
3.3 Hydraulic Model Calibration 3-3
3.4 Existing and Future Capacity Analysis 3-6

CHAPTER 4 Risk Assessment 4-1

4.1 Risk Assessment Framework 4-1
4.2 Data Preparation 4-3
4.3 Summary of Findings and Recommendations 4-4
4.4 Applying the Risk Model 4-10

CHAPTER 5 Condition Assessment 5-1

5.1 Introduction 5-1
5.2 Lift Stations 5-1
5.3 Force Mains 5-1
5.4 Gravity Mains 5-3

CHAPTER 6 Geotechnical Desktop Assessment 6-1

6.1 Geologic Assessment and Hazards 6-1

6.2 Summary of Wastewater Collection System 6-1
6.3 Areas of Concern for the Rehabilitation of the Wastewater Collection Facilities 6-2
6.4 Recommended Further Action 6-5

CHAPTER 7 Climate Risk 7-1

7.1 Climate Resilience Assessment 7-1
7.2 Recommended Resilience Strategies 7-2

CHAPTER 8 Capital Improvement Program 8-1

8.1 Introduction 8-1
8.2 Ten-Year Capital Plan Overview 8-1
8.3 Planning Criteria 8-15
8.4 Prioritization strategy 8-16
8.5 Cost Estimating 8-16
8.6 Preliminary Engineering Reports 8-18
8.7 Condition Assessment Program 8-19

CHAPTER 9 Funding Opportunities 9-1

9.1 Overview 9-1
9.2 Water Infrastructure Finance and Innovation Act 9-2
9.3 U.S. Department of Housing and Urban Development Community Development Block Grants 9-3
9.4 Economic Development Administration Public Works and Economic Adjustment Assistance Programs 9-3
9.5 U.S. Department of Agriculture Water and Waste Disposal Loans and Grant Program 9-4
9.6 Congressional Earmarks 9-4
9.7 State Revolving Funds 9-5
9.8 USACE Section 219 Environmental Infrastructure Program 9-8
9.9 Climate Bond (Proposition 4) 9-8
9.10 Funding Recommendations 9-10

CHAPTER 10 Conclusions and Recommendations 10-1

Tables

Table ES-1: 10-Year Capital Improvement Plan 2

Table 2-1. GIS Feature Class to Hydraulic Model Element 2-2

Table 2-2. Data Source and Possible Errors 2-8

Table 2-3. Sewer Lift Station Information 2-10

Table 2-4. List of Monitoring Locations, Total ADWF, and Area 2-12

Table 3-1. Total Basin Area and Hourly Flow (GPM) 3-5

Table 3-2. Monitored Basin RTS 3-7

Table 3-3. Sewer Duty Factors (GPD/Acre) per Land Use Type 3-7

Table 3-4. Preliminary Proposed CIP Projects for Existing, Near Term, and Build-Out (10-Year Storm) 3-17

Table 4-1. Total Risk – LoF and CoF Weighting 4-1

Table 4-2. Likelihood of Failure Factors, Data Sources, and Weights 4-2

Table 4-3. Consequence of Failure Factors Data Sources and Weights 4-3

Table 5-1. Condition Rating Methodology 5-2

Table 5-2. Summary of Lift Station Improvements 5-4

Table 5-3. Lift Station Replacement Costs by Timeframe 5-4

Table 5-4. Summary of Lift Station Improvements 5-5

Table 5-5. Decision Support Framework 5-5

Table 5-6. Gravity Main Repair Recommendations 5-7

Table 8-1: 0-5 Year Capital Projects 8-3

Table 8-2. 6-10 Year Capital Projects 8-6

Table 8-3. >10 Year Capital Projects 8-11

Table 9-1. Interest Rates Effective April 1, 2025 9-4

Table 9-2. CWSRF Interest Rates 9-5

Table 9-3. CWSRF Disadvantaged Community Citeria 9-6

Table 9-4. CWSRF Principal Forgiveness Criteria 9-6

Table 9-5. CWSRF Schedule 9-6

Table 9-6. Climate Bond Funding 9-9

Table 9-7. Potential Funding and Project Eligibility Matrix 9-11

Table 9-8. Available Funding Summary 9-11

Figures

Figure ES-1: 10-Year Capital Plan Projects 5
Figure 1.1 - Wastewater Collection System Map 1-2
Figure 2-1. Fort Bragg Sewer Network 2-5
Figure 2-2. Fort Bragg Sewer Core Network 2-7
Figure 2-3. Data Quality 2-9
Figure 2-4. Junctions Surveyed with Invert Elevation 2-11
Figure 2-5. Map of Flow Monitoring Sites and Node Sewershed Area 2-13
Figure 3-1. RTK Unit Hydrograph Method 3-2
Figure 3-2. Possible FM-04 Sanitary and Storm Sewer Cross-Connections 3-3
Figure 3-3. Fort Bragg Node Sewershed Area 3-4
Figure 3-4. Weekday Monitoring Basin Diurnal Patterns 3-6
Figure 3-5. City’s Future Land Use Categories 3-9
Figure 3-6. City's Proposed Rezoning Plan 3-10
Figure 3-7. GP Mill Site Illustrative Land Use Plan 3-11
Figure 3-8. Future Development Lots 3-12
Figure 3-9. Existing Max d/D and Flooding (10-Year Storm) 3-15
Figure 3-10. Proposed CIP Projects For Existing, Near Term, and Build-Out (10-Year Storm) 3-23
Figure 4-1. Wastewater Collection System Risk Formula 4-5
Figure 4-2. Cumulative Length Compared to Total Risk 4-6
Figure 4-3. Total Risk 4-7
Figure 4-4. Likelihood of Failure 4-8
Figure 4-5. Consequence of Failure 4-9
Figure 5-1. Force Mains 5-1
Figure 5-2. Elm Street Lift Station Force Main 5-3
Figure 6-1. Cypress St. Perched Water 6-4
Figure 8-1. - 0-5 Yr Capital Projects 8-5
Figure 8-2. 6-10 yr Capital Projects 8-10
Figure 8-3. >10 Yr Capital Projects 8-13

Appendices

Appendix A. Manhole Survey A-1
Appendix B. Flow Monitoring B-1
Appendix C. Model Calibration Results C-1
Appendix D. Risk Factors & Weighting D-1
Appendix E. CCTV Inspection Plan E-1
Appendix F. CCTV Results F-1
Appendix G. Lift Station Visual Assessment Report G-1
Appendix H. Climate Resilience H-1
Appendix I. Desktop Geotechnical Assessment I-1
Appendix J. Preliminary Engineering Reports J-1
Appendix K. CIP Projects K-1

ACRONYMS AND ABBREVIATIONS

AACEI	Association for Advancement of Cost Engineering International
AC	Asbestos Cement
ACP	Asbestos Cement Pipe
ACS	American Community Survey
ADWF	Average Dry Weather Flow
APN	Assessors Parcel Number
BI	Base Infiltration
BWP	Base Wastewater Production
CAD	Computer-Aided Design
CCI	Construction Cost Index
CCTV	Closed-Circuit Television
CDBG	Community Development Block Grant
CDF	Controlled Low-Density Fill
CIP	Capital Improvement Program
CIPP	Cast-In-Place Pipe
City	The City of Fort Bragg
CIWQS	California Integrated Water Quality System
CMP	Corrugated Metal Pipe
CMU	Concrete Masonry Unit
CNRA	California Natural Resources Agency
CoF	Consequence of Failure
CRA	Climate Resilience Assessment
CSMP	Wastewater Collection System Master Plan
CWSRF	Clean Water State Revolving Funds
DAC	Disadvantaged Community
DTSC	Department of Toxic Substances Control
DWF	Dry Weather Flow
DWSRF	Drinking Water State Revolving Funds
EDA	Economic Development Administration
ENR	Engineering News-Record
EPA	Environmental Protection Agency
ERDIP	Earthquake Resistant Ductile Iron Pipe
ESRI	Environmental Systems Research Institute
EVRUL	Evaluated Remaining Useful Life
FFY	Federal Fiscal Year
FOG	Fats, Oils, and Grease
FRP	Fiber Reinforced Plastic
FRPM	Fiberglass-Reinforced Plastic Mortar
GIS	Geographic Information System
GP	Georgia-Pacific
GPD	Gallons per Day

GPM	Gallons per Minute
GPR	Green Project Reserve Funding
HDPE	High-Density Polyethylene
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
I&I	Inflow and Infiltration
IIJA	Infrastructure Investment and Jobs Act
IUP	Intended Use Plan
LiDAR	Light Detection and Ranging
JOL	Joint Offset, Large
JOM	Joint Offset, Medium
LoF	Likelihood of Failure
LOI	Letters of Interest
LS	Sewer Lift Station
MCC	Motor Control Center
MGD	Million Gallons per Gay
MHI	Median Household Income
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NOFA	Notice of Funding Availability
NTNC	Non-Transient, Non-Community
OMRR&R	Operation, Maintenance, Repair, Rehabilitation and Replacement
OPC	Opinions of Probable Cost
OUL	Original Useful Life
PACP	Pipeline Assessment Certification Program
PPA	Project Partnership Agreement
PVC	Polyvinyl Chloride Pipe
RDII	Rainfall Derived Inflow and Infiltration
RPM	Fiberglass-Reinforced Plastic Mortar
RTK	R value of the basin unit hydrograph
RTS	Return-to-Sewer
RUL	Remaining Useful Life
SCADA	Supervisory Control and Data Acquisition
SDAC	Small Disadvantaged Community
SRF	State Revolving Funds
SSO	Sewer System Overflow
SWMM	Storm Water Management Model
SWRCB	California State Water Resources Control Board
UN	Utility Network
UPS	Un-interruptible Power Supply
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey

V&A	V&A Consulting Engineers
VC	Vitrified Clay
VCP	Vitrified Clay Pipe
WIFIA	Water Infrastructure Finance and Innovation Act
WRDA	Water Resources Development Act
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

ES.1 Background

The City of Fort Bragg (City) wastewater collection system includes 31 miles of gravity pipeline, 3 miles of force main pipeline, and 6 lift stations. The collection system delivers wastewater to the City's 4.9 million gallon per day (MGD) wastewater treatment plant. The oldest facilities were constructed in the 1960s and are approximately 65 years old or older, while newer sections are estimated to be 20 years old or newer. Approximately 4.5 miles of gravity pipeline (14.5%) has been rehabilitated with slip liners or cast-in-place pipe (CIPP). The City's gravity mains range from 6" to 30" in diameter, and are of various materials, with the majority being vitrified clay pipe (VCP) as well as some asbestos cement (AC), poly vinyl chloride (PVC), corrugated metal pipe (CMP), and others. The City's major force mains are constructed of Techite (fiberglass-reinforced plastic mortar - RPM) pipe, apart from the new Pudding Creek force main, which is high-density polyethylene (HDPE).

The City's wastewater collection system currently operates successfully with adequate capacity. However, the system is aging and exhibits evidence of age-related deterioration in some areas, including groundwater infiltration, corrosion, and structural compromise. Additional factors such as population growth, land use, and climate change will also challenge the system over time. The City anticipates a need to plan for overall system renewal, and investment in resilience and expansion.

The focus of this Wastewater Collection System Master Plan (CSMP) is to develop and document a transparent, data-driven, and repeatable capital planning process for the City's wastewater collection system. The CSMP identifies and prioritizes capital projects to promote collection system resilience, with adequate collection facilities to meet current and future demand. The City-owned and operated Wastewater Treatment Plant is not included in this planning effort, as it has undergone an extensive rehabilitation and upgrade in 2020.

Key capital planning factors include:

- Evaluating system hydraulic performance for anticipated operating conditions
- Studying the impact of re-zoning and development of the City's industrial areas on available capacity
- Identifying strategies to prioritize system investment to maintain system resilience in response to anticipated climate, seismic, and environmental threats.

ES.2 Key Master Plan Components

The key components in this master plan are incorporated into the following chapters:

- Chapter 2 – Data Collection & Modeling
    - Flow Study
    - Manhole Survey
- Chapter 3 – Capacity Analysis
- Chapter 4 – Risk Analysis
- Chapter 5 – Condition Assessment
    - Lift Station Condition Survey

  - Force Mains
  - CCTV Inspection
- Chapter 6 – Desktop Geotechnical Assessment
- Chapter 7 – Climate Risks
- Chapter 8 – Capital Plan
- Chapter 9 – Funding Opportunities

The most significant components of this plan are summarized below.

ES.3 Capital Improvement Program (CIP)

CHAPTER 8 contains the detailed 10-year capital improvement plan for the wastewater collection system. Projects included represent priority capacity, operational, and asset renewal improvements need to meet existing and future demands, facilitate system operations, and keep the current system performing at expected levels of service.

The 10-Year Capital Improvement Plan projects are summarized in

Table ES-1 and are graphically shown on the map in Figure ES-1. The table groups the projects based on priority, identifying those projects expected to be completed in the next five years and those expected to be completed between years six and ten. To support the City's alignment with applicable funding, two project cost estimates are included for some applicable capital projects. The Escalated Existing Project Cost shows the costs to address current deficiencies only. The Escalated Buildout Project Cost shows project cost to address current and future anticipated capacity deficiencies if full buildout scenarios are realized. Each project is categorized by the key driver: Capacity, Asset Renewal, Build-out, or Other as described below. Projects discussed in the text are referenced by their CIP ID.

Table ES-1: 10-Year Capital Improvement Plan

Priority	CIP ID	Project Name	Category	Total Pipe Length (ft)	Time Frame	Escalated Existing Project Cost[1]	Escalated Buildout Project Cost[1]
2	F-01	Elm Street Force Main CIPP Lining	Asset Renewal	2,293	0-5 yrs	$1,053,000	
1	P-01	Chief Celeri Dr Sewer Main Replacement[2]	Capacity	1,882	0-5 yrs	$2,853,000	
3	P-02	WWTP Inflow Sewer Main Replacement[2]	Capacity	2,305	0-5 yrs	$6,103,000	
4	P-03	E Alder St Sewer Main Replacement	Capacity	797	0-5 yrs	$892,000	

[1] 0-5 year costs escalated to 2027 dollars, 6-10 year costs escalated to 2032 dollars

[2] See project sheets, Appendix J.

Priority	CIP ID	Project Name	Category	Total Pipe Length (ft)	Time Frame	Escalated Existing Project Cost[1]	Escalated Buildout Project Cost[1]
8	P-06	E Oak St Sewer Main Replacement III	Capacity	989	0-5 yrs	$377,000	
6	P-10	S Franklin St Sewer Main Replacement	Capacity	633	0-5 yrs	$351,000	
7	P-11	S Harrison St Sewer Main Replacement	Capacity	662	0-5 yrs	$291,000	
5	P-16	E Oak St Sewer Main Replacement IV[2]	Capacity	1,971	0-5 yrs	$724,000	$866,000
9	P-34	North Fort Bragg Sewer Main Extension	Build-out	1,970	0-5 yrs	-	$471,000
10	P-35	GP Mill Sewer Main Extension I (Noyo Center)	Build-out	1,074	0-5 yrs	-	$471,000
11	R-01	CCTV Condition Inspection	Asset Renewal	-	0-5 yrs	$500,000	
12	R-02	Lift Station Rehabilitation	Asset Renewal	-	0-5 yrs	$442,000	
13	R-03	0-5 yr CIPP Lining Projects	Asset Renewal	-	0-5 yrs	$500,000	
14	O-01	Capital Plan Update	Other	-	0-5 yrs	$110,000	
				0-5 Year Subtotal:		***$14,196,000***	***$15,280,000***
30	P-04	E Oak St Sewer Main Replacement I	Capacity	316	6-10 yrs	$112,000	
15	P-05	E Oak St Sewer Main Replacement II	Capacity	2,893	6-10 yrs	$1,399,000	
35	P-07	N Franklin St Sewer Main Replacement	Capacity	472	6-10 yrs	$286,000	
31	P-08	E Chestnut St Sewer Main Replacement	Capacity	703	6-10 yrs	$359,000	
40	P-09	Hazel St Sewer Main Replacement	Capacity	357	6-10 yrs	$230,000	
38	P-12	S Main St Sewer Main Replacement II	Capacity	66	6-10 yrs	$432,000	
16	P-13	Cedar St Replacement I	Capacity	2,171	6-10 yrs	$961,000	$1,224,000
34	P-14	Cedar St Replacement II	Capacity	399	6-10 yrs	$145,000	
23	P-15	Dennison Ln Sewer Main Replacement	Capacity	656	6-10 yrs	$239,000	$526,000
37	P-17	E Fir St Sewer Main Replacement	Capacity	1,140	6-10 yrs	$686,000	$1,951,000
17	P-18	E Laurel St Sewer Main Replacement	Capacity	783	6-10 yrs	$399,000	$504,000

Priority	CIP ID	Project Name	Category	Total Pipe Length (ft)	Time Frame	Escalated Existing Project Cost[1]	Escalated Buildout Project Cost[1]
36	P-19	E Pine St Sewer Main Replacement	Capacity	745	6-10 yrs	$380,000	$971,000
27	P-20	E Redwood Ave Sewer Main Replacement	Capacity	703	6-10 yrs	$359,000	$452,000
32	P-21	N Harold St Sewer Main Replacement	Capacity	433	6-10 yrs	$221,000	$279,000
39	P-22	N Main St Sewer Main Replacement	Capacity	1829	6-10 yrs	$1,176,000	$3,605,000
22	P-23	N McPherson St Sewer Main Replacement	Capacity	908	6-10 yrs	$429,000	$1,068,000
21	P-24	N Sanderson Way Sewer Main Replacement	Capacity	647	6-10 yrs	$330,000	$416,000
33	P-25	N Whipple St Sewer Main Replacement	Capacity	439	6-10 yrs	$224,000	$282,000
18	P-26	E Chestnut St Sewer Main Replacement II	Capacity	3,617	6-10 yrs	$1,567,000	$1,725,000
26	P-27	Minnesota Ave Sewer Main Replacement	Capacity	700	6-10 yrs	$246,000	
25	P-28	S Sanderson Way Sewer Main Replacement	Capacity	613	6-10 yrs	$216,000	
19	P-29	Maple St Sewer Main Replacement	Capacity	180	6-10 yrs	$66,000	
29	P-30	Park St Sewer Main Replacement	Capacity	250	6-10 yrs	$91,000	
20	P-31	South Harold St Sewer Main Replacement	Capacity	902	6-10 yrs	$364,000	
28	P-32	Cypress St Sewer Main Replacement	Capacity	674	6-10 yrs	$245,000	
24	P-33	Georgia-Pacific-Haul Rd Sewer Main Replacement	Capacity	874	6-10 yrs	$326,000	
41	P-36	S Main St Sewer Main Extension	Build-Out	2334	6-10 yrs		$647,000
42	R-04	CCTV Condition Inspection	Asset Renewal	-	6-10 yrs	$634,000	
43	R-05	6-10 yr CIPP Lining Projects	Asset Renewal	-	6-10 yrs	$761,000	
44	O-02	Capital Plan Update	Other	-	6-10 yrs	$127,000	
					6-10 Year Subtotal:	***$13,010,000***	***$19,689,000***
					10-Year Total:	***$27,206,000***	***$34,969,000***

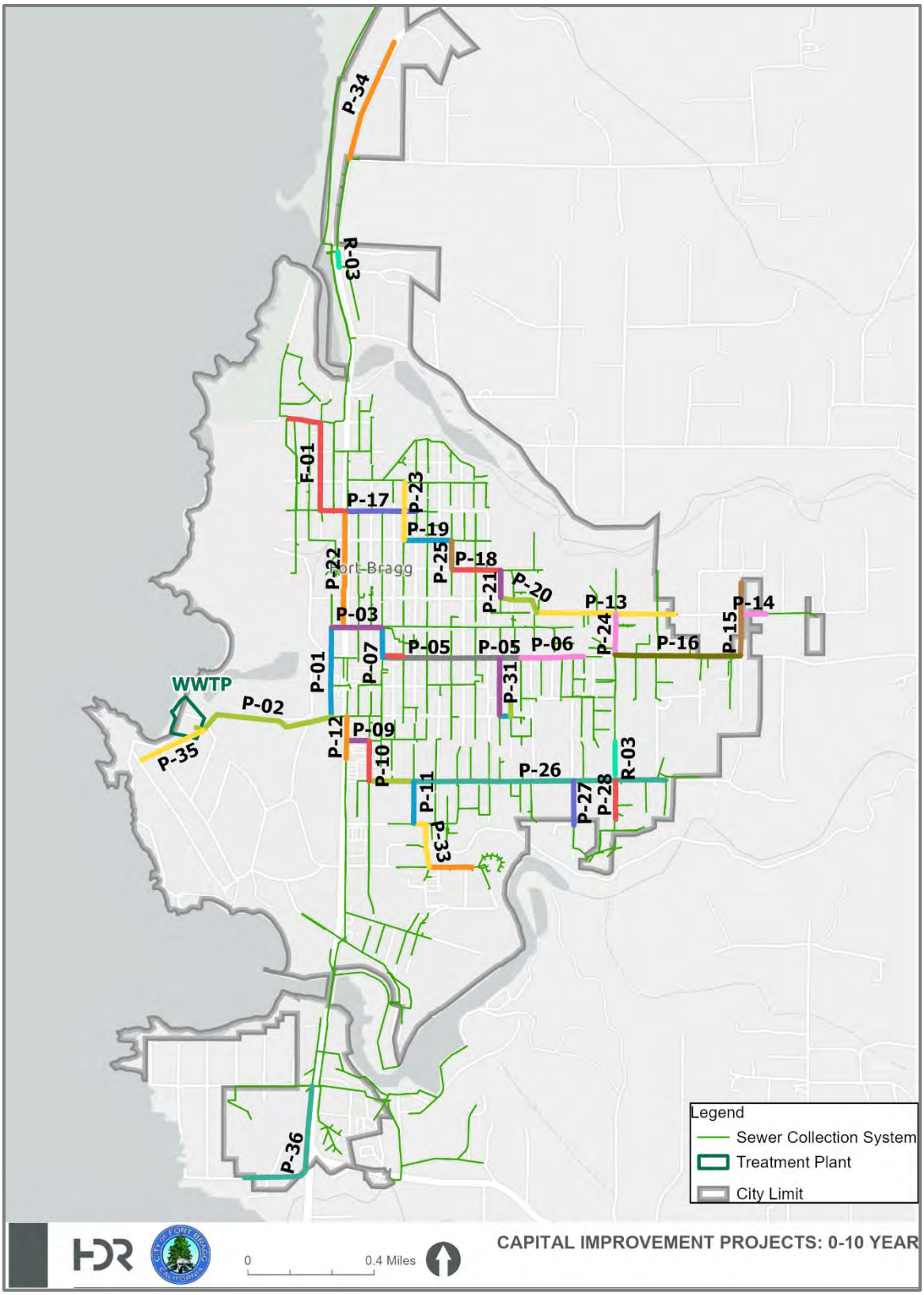


Figure ES-1: 10-Year Capital Plan Projects

Capacity-related capital projects were identified by evaluating current system flows, projected near-term capacity needs (over the next 10 years), and expected capacity needs at buildout, which includes potential development of the Georgia-Pacific (GP) Mill site, development of seven undeveloped lots within the City, the North Fort Bragg Sewer Main Extension, and future annexation areas (See Figure 4.7).

Build-Out - Projects intended to accommodate future potential development and associated system build-out beyond current capacity needs. These projects include installation of new pipelines or upsizing of existing infrastructure to support planned growth and projected peak flows under key design storm conditions.

Asset renewal projects include replacement and rehabilitation of existing infrastructure to keep the current system operating as expected. These include projects for known existing system renewal requirements, such as the Elm Street Force Main rehabilitation project (F-01), projects for rehabilitation of the lift stations (R-02), and placeholders for gravity main rehabilitation projects identified through the condition assessment program (R-03, R-04).

Other capital projects include a condition assessment program and periodic updates to the capital plan every 5 years. The condition assessment program will be used to identify rehabilitation projects suitable for the placeholder asset renewal projects and to prioritize those projects in the capital plan.

ES.4 Capital Plan Funding

CHAPTER 9, Funding Opportunities, provides a summary of grants and funding options from state and federal sources that may be considered for funding projects. Each funding program has specific requirements surrounding permits and project timelines. Each program's process, timeline, and requirements should be reviewed within the context of the City's overall goals, financial considerations, project timelines, and debt financing policies.

It is important to note that funding levels and eligibility requirements are prone to yearly changes. This Master Plan report provides initial funding guidance, but updated funding availability and program requirements should be reviewed before developing an application. Long-term, rate and capital facility charge increases may be needed to recover the costs for projects that do not closely align with grant funding opportunities.

ES.5 System Hydraulic Analysis

A hydraulic model of the City's wastewater collection system was developed from the City's Geographic Information System (GIS) database and is discussed in CHAPTER 3, Existing and Future Capacity Analysis. To calibrate and validate the model, an 8 week flow study was performed during the winter of 2024, where flows in the system were monitored at 7 locations. The model was calibrated and validated using this flow data and used to characterize the system's current performance and its expected performance under future buildout conditions. Capital projects were developed to remediate potential performance deficiencies under these scenarios.

A significant finding of the flow study and hydraulic model development is that the City's system experiences significant inflow & infiltration (I&I) in some areas of the collection system. Causes of this I&I could be cross-connection with the stormwater system, illicit connections to the collection system, and groundwater infiltration through cracks, displaced joints, or other pipe defects. This I&I

increases flow in the system and requires increased conveyance and treatment capacity. The recommended condition assessment program should focus on identifying I&I sources and prioritization of capital projects to address these deficiencies.

ES.6 Condition Assessments

Condition assessments conducted as part of this master plan are discussed in detail in CHAPTER 5, Condition Assessment. Three types of assessments were completed:

Lift Stations – A visual condition assessment was conducted at the City's six lift stations. Most components of the lift stations were assessed to be in fair to good condition with exceptions noted in Section 5.2.2. Individual rehabilitation recommendations over the next 10 years were developed in conjunction with city staff and are provided in Table 5-4. For the Capital Improvement Plan, all the recommended improvements that were identified to be contracted out have been aggregated into a single project, R-02.

Force Mains – A desktop evaluation for the City's 6 force mains was performed based on pipeline age, criticality, and pipe material. The City's 2 smaller force mains (Noyo Point and Noyo heights) have lower criticality, are newer, and are constructed of more resilient materials, so do not warrant rehabilitation in the 10-year CIP time horizon. The City's 4 major force mains (Elm Steet, North Noyo, South Noyo, and Pudding Creek) were originally constructed of Techite pipe. As this material ages, it has been found to fail catastrophically and without warning. Fortunately, the City has or is currently addressing rehabilitation of this pipe type for all these major lines except the Elm Street Lift Station force main. Project F-01 is included in the Capital Improvement Plan to address the Elm Street force main issue within the next 5 years.

Gravity Mains – A limited closed-circuit television (CCTV) survey was conducted as part of this master planning effort. Approximately 4% of the system was inspected, focusing on portions of the system that was suspected to be in poor condition and/or potentially contributing to I&I observed in the flow study. A decision support framework was developed and applied to the results of the CCTV inspection. CIPP lining projects identified from the results of the CCTV inspection are included in project R-03.

ES.7 Geotechnical, Environmental, and Climate Risk and Resilience

The City's infrastructure faces more challenges than just meeting fire flow and aging. The wastewater collection system also faces geotechnical, environmental, and climate risks. The evaluation of these risks and recommendations are provided in CHAPTER 6, Geotechnical Desktop Assessment and CHAPTER 7, Climate Risk.

Geotechnical risks are related to the topography and geology of a geographic area. The City is located on a seismically active, uplifted coastal terrace and faces key geotechnical risks such as:

- **Seismic Risk** – although there are no fault lines crossing the City's service area, differential movement, especially at bridge crossings, may pose risks to the wastewater collection system. Mitigation strategies may include use of articulating joints or earthquake resistant ductile iron pipe (ERDIP) for highly critical infrastructure.

- **Densification** – Significant settlement due to soil spreading or groundwater fluctuation could damage the system.
- **Landslides & Bluff Erosion** – Differential settlement or pipe displacement due to landslides pose a risk to the collection system.
- **Soil Corrosivity** – Terrace deposits are acidic (corrosive) and become more so towards the coast.

Environmental Risks are risks stemming from natural hazards or contamination that can directly impact the system or require specific infrastructure. Key environmental risks include:

- **Flooding/Extreme Weather Events** - The City is susceptible to flooding and severe winter storms, especially the lift stations that are located near sea level.
- **Wildfire** – Significant fires have occurred in Northern California in the last few years, and wildfire can disrupt power supplies and monitoring systems which can interrupt lift station function.
- **Chemically Impacted Sites** – Several chemically impacted sites are located within the City of Fort Bragg. Many of these sites are identified as having been remediated to meet standards set forward by regulatory agencies. It should be noted that there may be residual chemically impacted soils that may require special testing and handling to determine material reuse or disposal during construction projects. The Department of Toxic Substances Control (DTSC) GeoTracker website should be referenced during future system upgrades or rehabilitation projects.

Climate Risks are risks driven by long-term changes in climate patterns that may increase the frequency or severity of environmental risks. Key climate change impacts include:

- **Hotter Temperatures** – Hotter weather adds demand and stress to the City's utility systems and can exacerbate wildfire threat to infrastructure. Remote facilities may be vulnerable to wildfire.
- **Variability in Precipitation** – More intense weather events may increase landslide risk and erosion and may increase peak flows into the collection system due to infiltration and inundation.
- **Sea-Level Rise** – Sea-level rise can increase risk of landslides and erosion, and increased saltwater intrusion can shorten the lifespan of pipes and equipment. It also increases the likelihood of inundation of infrastructure, resulting in flooding lift stations in low-lying areas and surface water inflow into the collection system.

CHAPTER 1 INTRODUCTION

1.1 Master Plan Purpose & Goals

This 2026 Wastewater Collection System Master Plan (CSMP) develops and documents a transparent, data-driven, and repeatable capital planning process to provide the City of Fort Bragg (City) with a master plan and 10-year capital improvement plan that identifies and prioritizes improvements and other planning actions for the wastewater collection system. This plan establishes a basis of understanding of the City's wastewater collection system needs, developing and documenting a transparent, data-driven, and repeatable capital planning process While the system currently performs adequately, the City recognizes the system is aging and will need to adapt for the future, taking into account community growth, system reliability, and a changing environment. The CSMP will help the City identify and prioritize these needs so that they can be proactively addressed before they become emergencies. Projects that are defined from these efforts will be used for the basis of annual capital planning in the coming years. The CSMP will identify and prioritize capital projects to promote wastewater collection system resilience, with adequate collection facilities to meet current and future demand. In the development of the CSMP, the City weighed available budget with many factors, including aging infrastructure, technological advances, community growth, and seismic, environmental, and climate risk.

Key planning factors include:

- Evaluating system hydraulic performance for anticipated operating conditions
- Studying the impact of re-zoning and development of the City's industrial areas
- Identifying strategies to prioritize system investment to maintain system resilience in response to anticipated climate, seismic, and environmental threats.

The master plan provides defensible justification, supporting data, a transparent process, and assesses impacts to the City if the projects are not completed. This will provide the City with a balanced view to compare these needed wastewater collection system projects with other, more visible civil projects to support budget approval.

1.2 Wastewater Collection System

It is important to understand the boundaries of what is addressed in the CSMP. The CSMP includes the collection system infrastructure upstream from the inlet structure to the wastewater treatment plant (WWTP) and assesses the current state of - and primary threats to - the use and integrity of the City-owned wastewater collection system assets, which includes 31 miles of gravity main, 3 miles of force main pipelines, and 6 pump stations. (Figure 1.1). The City-owned and operated Wastewater Treatment Plant is not included in this planning effort, as it has undergone an extensive rehabilitation and upgrade in 2020.

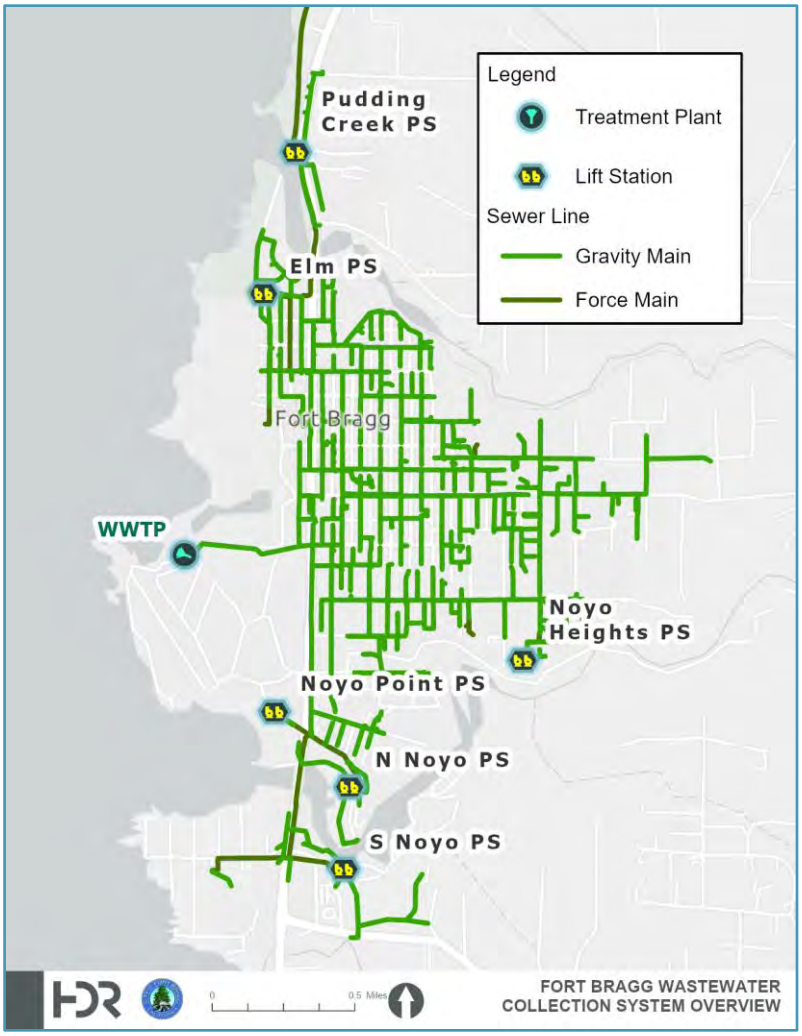


Figure 1.1 - Wastewater Collection System Map

The oldest facilities were constructed in the 1960s and are approximately 65 years old or older, while newer sections are estimated to be 20 years old or newer. The major pump stations were installed in the early 1970's.

The collection system delivers wastewater to the City's 4.9 million gallon per day (MGD) wastewater treatment plant. The system generally flows from east to west. The gravity main system is composed of pipes from 4 inches to 30 inches in diameter. Pipe materials include vitrified clay (VC), asbestos-cement (AC), polyvinyl chloride (PVC), Techite, and corrugated metal (CMP).

The system has 6 pump stations to collect wastewater at low points and pump it to higher locations to be conveyed on to the treatment plant by gravity. Force mains serving the pump stations range from 3" to 14". Three of the four major force mains (Elm Street, North & South Noyo force mains) are Techite pipe, and the fourth (Pudding Creek force main) is high-density polyethylene (HDPE). The two smaller force mains (Noyo Heights and Noyo Point) are steel and PVC respectively.

The entire system flows into a 30" CMP line leading across the GP Mill site to the headworks of the wastewater treatment plant on the costal bluff on the west edge of the City.

1.3 Report Organization

The following sections are provided in the CSMP, and describe the major activities of this master planning effort:

- CHAPTER 1 Introduction – Describes the CSMP purpose and goals, provides an overview of the wastewater collection system, and describes the report organization.
- CHAPTER 2 Data Collection and Hydraulic Modeling – Discusses development of the hydraulic model from existing geographic information system (GIS) information, survey of selected manholes for updates to the model, and the flow monitoring study used for model calibration and validation.
- CHAPTER 3 Existing and Future Capacity Analysis – Presents the infiltration & inflow analysis, hydraulic model calibration/validation, projected future build out development areas, and a capacity analysis for existing conditions and future build-out wastewater flow conditions.
- CHAPTER 4 Risk Assessment – Discusses development of a risk model to prioritize system condition assessment and aid in capital project prioritization.
- CHAPTER 5 Condition Assessment – Describes the condition assessment activities undertaken as part of the master planning process and presents their results. This chapter also develops an ongoing condition assessment framework to systematically identify corrective actions based on pipe condition.
- CHAPTER 6 Geotechnical Desktop Assessment – Analyzes the current and future geotechnical risks associated with the wastewater collection system.
- CHAPTER 7 Climate Risk – Assesses system risk and resilience associated with present and future climate environments and recommends resilience strategies.
- CHAPTER 8 Capital Improvement Program – Presents the recommended capital projects and the 10-year CIP.
- CHAPTER 9 Funding Opportunities – Discusses potential funding opportunities to implement the CIP.
- CHAPTER 10 Conclusions and Recommendations – Summarizes the recommendations, conclusions, and findings of the master planning effort.

CHAPTER 2 DATA COLLECTION AND HYDRAULIC MODELING

This chapter documents HDR's development of a hydraulic model for the City's wastewater collection system. This effort consisted of a GIS review and data gap analysis to develop an model of the existing collection system. HDR also collected and reviewed customer water meter data, historical water use and production, and wastewater treatment plant (WWTP) influent data to support development of the wastewater model. This data was used to calculate expected flows in the collection system.

2.1 Existing Model Development

HDR developed a wastewater system GIS database based upon the computer-aided design (CAD) drawing of Fort Bragg's utility systems, provided by the City and dated September 2022. HDR created the model according to the GIS data, provided suggested edits, and identified data gaps to the City to make the GIS compliant with U.S. Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) 5. The data gap analysis and recommended actions outlined in this report were used to ultimately support an AquaTwin Sewer wastewater system model.

2.1.1 CAD Drawing Review

The CAD Drawing provided by the City contained lines and points to represent wastewater lines and manholes from several sources like as-built drawings. The lines and points were labelled with additional information such as diameter, direction of flow, manhole number, depth of manhole, rim elevation, and invert elevation. This information was derived from several as-built drawings available to the City. Upon review of the CAD drawing, it was observed that the available pipe diameter and rim and invert elevation information could be used to populate additional attributes in the GIS database. This additional information was then be used to create the AquaTwin wastewater system model.

During the review of the CAD drawing, it was also observed that some rim and invert elevations were missing, which would create a data gap in the AquaTwin model. It was also noted that the full comprehensive wastewater network has a large number of wastewater lines and manholes which, if modeled, would result in an unnecessarily complex and inefficient hydraulic model.

The available wastewater lines and manholes were skeletonized to a "core network" for more efficient processing without losing accuracy. The "core network" included pipes 10-inches or greater in diameter, smaller lines required to achieve full connectivity within the model, and additional areas specified by the City. After the CAD drawing review was completed, there were still several manholes on the core network that were missing rim and invert elevations. Since data on those manholes was necessary for the core network wastewater system model to be representative and accurate, HDR worked with the City to fill this data gap.

2.1.2 GIS Integration

HDR determined which GIS feature classes would support which hydraulic modeling facility types. Wastewater system facility types include the following three (3) distinct model elements:

- Conduit – represent wastewater force and gravity mains.
- Junctions – required at the end point of every pipe, at reducers, tees, crosses, and manholes.
- Pumps – represent individual pumps within a lift station.
- Storage – represents wet wells for lift stations.

Table 2-1 lists the feature classes HDR recommended for modeling and their corresponding hydraulic model element.

Table 2-1. GIS Feature Class to Hydraulic Model Element

City's GIS Feature Class	AquaTwin Hydraulic Model Element
SewerLine	Conduit
SewerJunction	Junction
SewerDevice	Junction

It should be noted that Minor Service Lines and Service Points are not required to be modeled. Flows typically are loaded to the nearest junction node; adding an additional pipeline for each service in the collection system would create unnecessary overhead in the model. Fittings are only necessary at Major Service Line junctions where a manhole is not present.

2.1.3 Description of Attributes

The AquaTwin Import Center allows attributes maintained within the GIS database to be "mapped" and imported into the model. For example, pipeline diameter, material, and age can be synchronized with the model if these fields are available within GIS. Attribute data refined during the hydraulic model development process was incorporated back into the City GIS.

2.1.3.1 Asset ID

One key component to GIS integration is a unique identifier for data integration. Asset identifiers must be unique across all hydraulic model elements (i.e. if a junction has an ID of 1, no other element can have an ID of 1). A review of the City GIS data reveals all feature classes currently have a unique identifier in field named AssetID, which is generated automatically by the Environmental Systems Research Institute (ESRI) Utility Network. The City's GIS data also includes an AssetType field where an element's feature class type is specified (i.e. whether a conduit is a gravity main pipe or a force main). These feature classes determine flow behavior in the model and support hydraulic model integration.

2.1.3.2 Model Attribute

Not every facility within the GIS database gets modeled. Therefore, HDR recommended that a "Model" attribute be added to every feature class with a coded value domain that can return a "Y/N" value. Examples of facilities that would have a "N" value include privately owned features, abandoned features, proposed features, removed features, to be abandoned features, or hydraulically insignificant features that would create unnecessary overhead in the model.

The goal is to have a more efficient but accurate model by simplifying the structure of the collection system. This was done by modeling pipes with a diameter of 10 inches or larger then manually

adding back any smaller pipes to ensure a fully connected core network. The flow contribution of other pipes not modeled is accounted for by adding proportional flow to the simplified diameter.

Features within the core network had the Model field as “Y”, and everything outside the core network had the Model field as “N”. This approach helped reduce the number of wastewater lines and manholes in the model and made it less prone to errors, thus ultimately reducing the data gap. It should be noted that smaller pipes and manholes that indicate Model field as “N” will not be ignored, instead the flow through those structures will simply be loaded to the next major manhole and pipe, thus reducing the need to find accurate slopes, diameter, and elevation for those smaller less relevant structures. This process is discussed in more detail in 2.1.4.2.

2.1.3.3 Data Quality

A data quality attribute was recommended to identify the source of junction attributes (i.e. invert and rim elevation) necessary for the hydraulic model. HDR added a “Data Quality” attribute where these sources may be recorded. The Data Quality field primarily relies on the availability of invert and rim elevation of junctions. HDR examined the CAD drawing to identify any data gaps that would require supplementing with field measurements. HDR filled some of these data gaps by using light detection and ranging (LiDAR) data and interpolation. Rim and invert elevations determined this way are less reliable than those acquired from the CAD drawing and so would be candidates for a field survey. The results of the data gap analysis are further described in 2.1.4 GIS Network and Data Gaps.

2.1.3.4 Survey

A survey attribute was assigned to note whether a junction is recommended to be surveyed, with the possible values as “Y” or “N”. In an ideal scenario, to get the most accurate data, any invert or rim elevation that does not have a strong data quality would be surveyed. However, surveying is costly, and thus, in many instances interpolations can be made to obtain the rim and invert elevation of a junction with missing data. For example, if the immediate upstream and downstream junctions have data available, then a uniform slope can be assumed for the pipe, and the rim and invert elevations can be interpolated. When appropriate, this approach avoids the cost of a field survey. HDR used the data quality attribute and best engineering judgement to recommend the junctions to be surveyed.

In summary, fields from the wastewater model to be added into the GIS database for streamlined integration are summarized below. Suggested data types are shown in parenthesis:

1. Junction:
    a. AssetID (String)
    b. AssetType (String)
    c. InvElev (Double)
    d. RimElev (Double)
    e. Model (String)
    f. DataQuality (String)
    g. Survey (String)
2. Conduit:
    a. AssetID (String)
    b. AssetType (String)
    c. Diameter (Integer)

   d. UpElev (Double) - is equal to invert elevation of upstream junction
   e. DownElev (Double) - is equal to invert elevation of downstream junction
   f. Model (String)
3. Pump:
   a. AssetID (String)
   b. Design Flow (Double)
   c. Design Head (Double)
   d. Model (String)

2.1.4 GIS Network and Data Gaps

A review of the current wastewater system GIS and CAD drawing was performed to determine gaps in necessary attribute data. The main areas of concern with the GIS are missing rim and invert elevation data for junctions, which are necessary for the model. This review examined only the active conduits and junctions in the system owned by the agency.

2.1.4.1 Asset ID

Figure 2-1 shows the complete wastewater network currently available in the GIS database, along with a total count of junctions. In summary, a total of 936 junctions which includes 457 manholes, 378 fittings, and 101 cleanouts are available in the GIS.

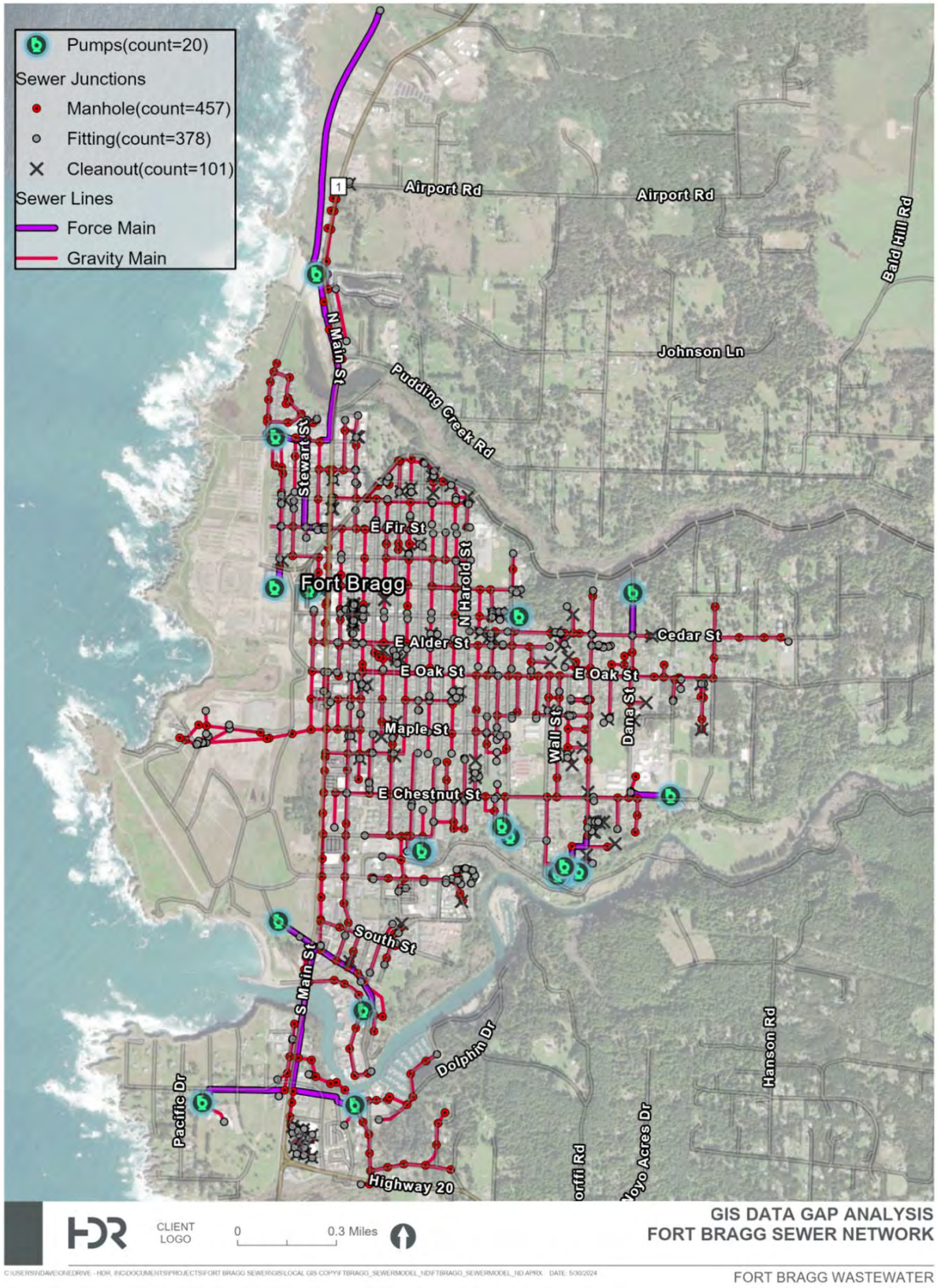


Figure 2-1. Fort Bragg Sewer Network

2.1.4.2 Model

The current GIS database includes a comprehensive inventory of all wastewater lines and junctions (Figure 2-1). Locating accurate data for all structures is a labor and cost intensive procedure. It also makes the model more intricate and complex, which is prone to errors. Thus, HDR created a “core network” to identify the structures that should be modelled. All structures can be maintained in the GIS database, but the AquaTwin wastewater model can be simplified by adding the field called model assigning Yes (Y) or No (N) values to each structure and then only the structures with Model = Y can be used for modeling and locating detailed information like rim and invert elevation.

Documented logic to assign Model = Y:

1. For pumps, select all pumps to be modeled and assign Model = Y. The pumps to be modelled were coordinated with the City staff. Private pumps are generally left out as Model = N.
2. Next for pipes, assume all wastewater lines as Model = N.
3. Select all force mains and assign Model = Y.
4. From the gravity mains, select all pipes with diameter greater than or equal to 10 inch and assign Model = Y.
5. Inevitably there will be a few smaller pipes that are needed to ensure connectivity. Manually trace these lines, select, and assign Model = Y.
6. Ensure that the lines provide reasonable coverage for the City so that flows from all areas can be accounted for. If necessary, select the wastewater lines that need to be included and extended to provide spatial coverage and assign Model = Y.
7. Ensure that all pumps that need to be modeled are connected. Select necessary wastewater lines to ensure connection to pumps and assign Model = Y.
8. Finally for junctions, all manholes and fittings that fall on the core pipeline network can be selected and assigned Model = Y.
9. Exception: After completing this process, a manual data cleaning process was performed to analyze whether junctions were needed to be surveyed. In some cases, a small fraction of pipes and junctions were updated to Model = N due to lack of clean data. This does not affect the integrity of the model.

Figure 2-2 shows a map of the existing wastewater system GIS and shows the core network that is included in the AquaTwin model (Model = Y). After the data gap analysis was conducted, the City requested a few additional lines of interest to be added to the core network. These lines were added to the model so the City can observe the behavior of these specific pipes and are highlighted in Figure 2-2.

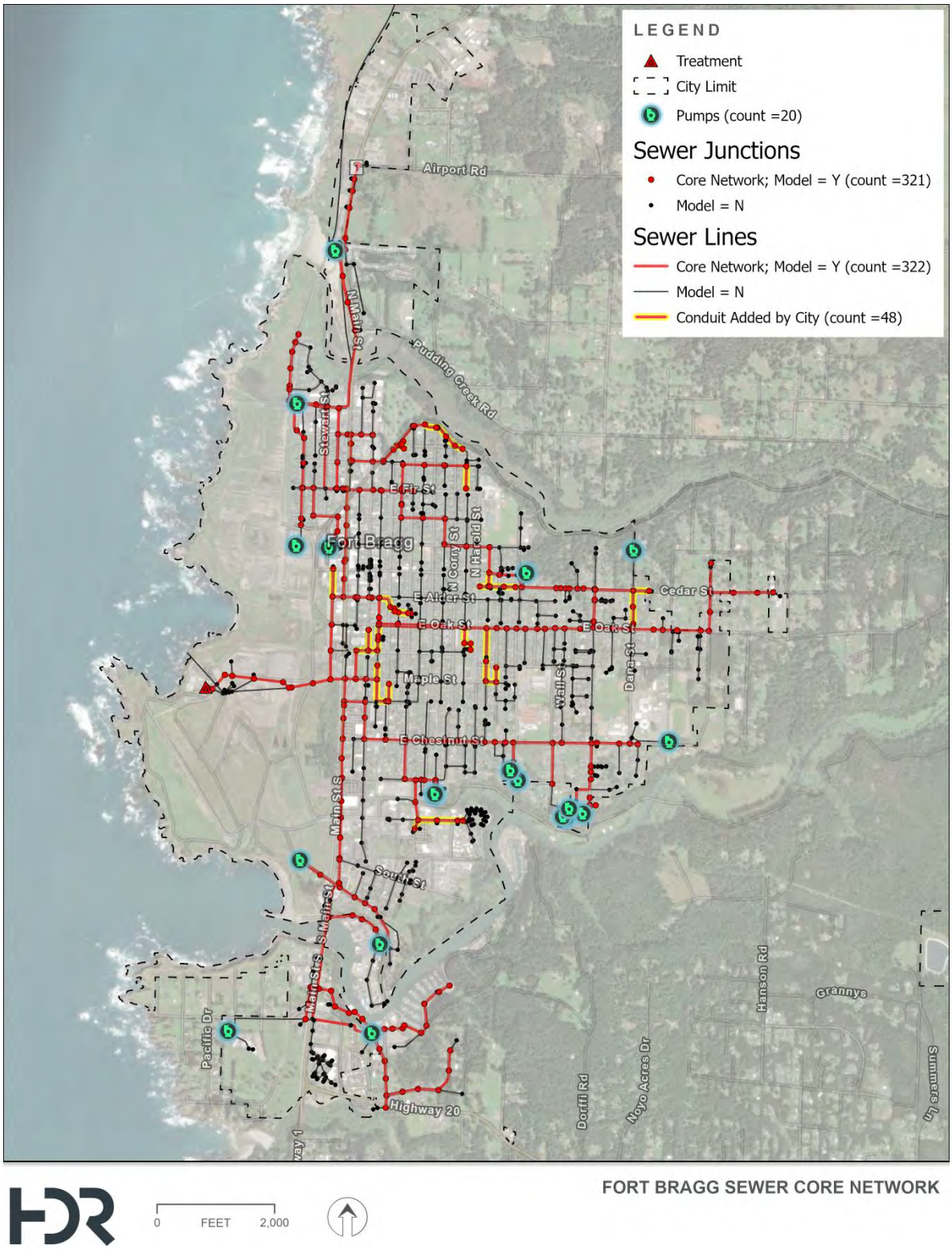


Figure 2-2. Fort Bragg Sewer Core Network

2.1.4.3 Data Quality

All wastewater junctions within the core network were compared against the CAD drawing, and the data for rim elevation and invert elevation was populated. The CAD drawing listed invert elevation, rim elevation, and invert depth for some of the primary manholes in the network. However, several manholes lacked comprehensive data. HDR used LiDAR to fill those data gaps. Following scenarios exist for data availability:

- Rim from CAD = Rim was noted on CAD Drawing
- Rim from LiDAR = Rim was estimated from LiDAR
- Invert from CAD = Invert was noted on CAD Drawing
- Invert from CAD Depth = Rim minus depth noted on CAD Drawing. (Rim could either be noted on CAD or estimated from LiDAR)
- Invert interpolated = Invert was interpolated by assuming uniform slope.

Since both Rim and Invert elevations are needed, possible data quality combinations are:

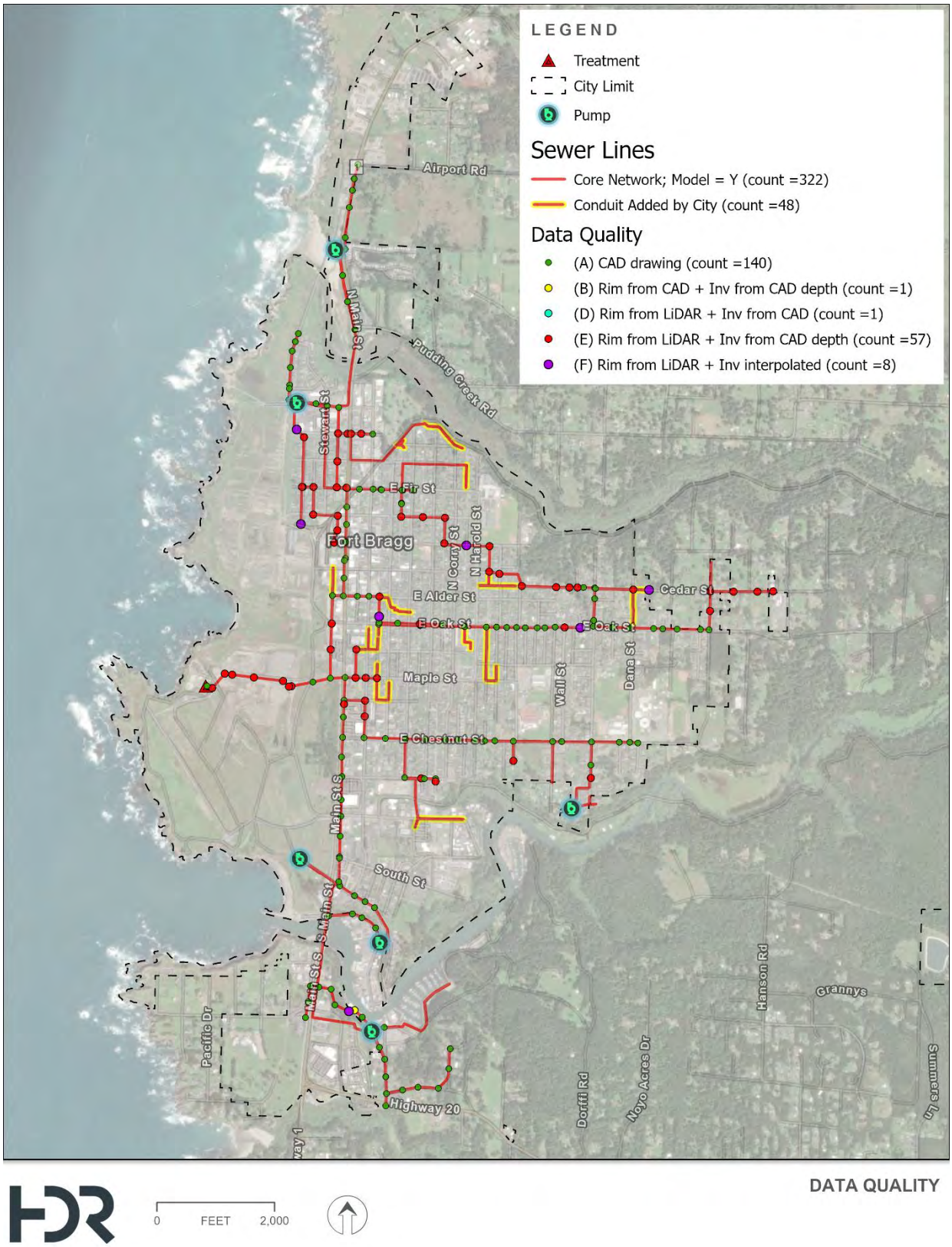
(A) CAD drawing = Rim from CAD + Invert from CAD
(B) Rim from CAD + Invert from CAD depth
(C) Rim from CAD + Invert interpolated
(D) Rim from LiDAR + Invert from CAD
(E) Rim from LiDAR + Invert from CAD depth
(F) Rim from LiDAR + Invert interpolated

It is important to keep in mind the accuracy level of each data source and resulting data quality. For example, an element flagged with data quality (A) can potentially be the most accurate because it was listed on CAD drawing, but the data on the CAD drawing itself was sourced from as-built drawings and was manually typed into the CAD drawing and could contain hand typing errors and may use an unknown datum. The possible exceptions or cautions for each data source are listed in Table 2-2.

Table 2-2. Data Source and Possible Errors

Data Source	Possible Errors
CAD Drawing	Typing errors, unknown datums, as-built drawings could be dated.
CAD Depth	It is unknown if depth was measured from ground surface or rim.
Interpolation	Assumes uniform slope of pipe.
LiDAR	Rim elevation is almost never same ground elevation shown in LiDAR.

Figure 2-3 shows a summary of junctions by data quality. A total of 140 manholes have valid data available which is data quality (A). Data quality was not determined for the additional lines requested by the City as they were included after the data gap analysis was conducted.



DATA QUALITY

Figure 2-3. Data Quality

2.1.4.4 Lift Stations And Force Mains

Sewer lift station (LS) data was provided by the City and shown in Table 2-3. The City confirmed that each LS employs two pumps, which doubles the capacity of the station. Wet well storage volumes were assumed to equal 6 hours of flow at capacity at each LS, for minimum storage for modeling purposes. It was assumed that wet wells were 15 ft deep below surface.

Table 2-3. Sewer Lift Station Information

Sewer Lift Stations		Pumping Rate	Surface Elev.	Invert Elevation	Capacity	Wet Well Volume
Station #	**Station Name**	**GPM**	**FT**	**FT**	**GPM**	**Gal**
1	Pudding Creek	465	21.27	6.27	930	334,800
2	Elm Street	800	55.88	40.88	1600	576,000
3	South Noyo	460	11.82	-3.18	920	331,200
4	North Noyo	353	14.31	-0.69	706	254,160
5	Noyo Point	45	97.02	82.02	90	32,400
6	Sanderson/Noyo Heights	190	143.54	128.54	380	136,800

2.2 Manhole Field Survey

HDR provided the City with a selection of junctions to survey to fill the data gap identified regarding invert data. HDR contracted Mendocino Surveyors, Inc. to survey a total of 201 junctions. Of these surveyed junctions, 179 had a recorded invert that was used to update the model. The remaining junctions were missing invert data due to the manhole being inaccessible or being paved over, etc. Figure 2-4 shows the 179 surveyed junctions with available invert data. The detailed survey results can be found in Appendix A - Manhole Survey.

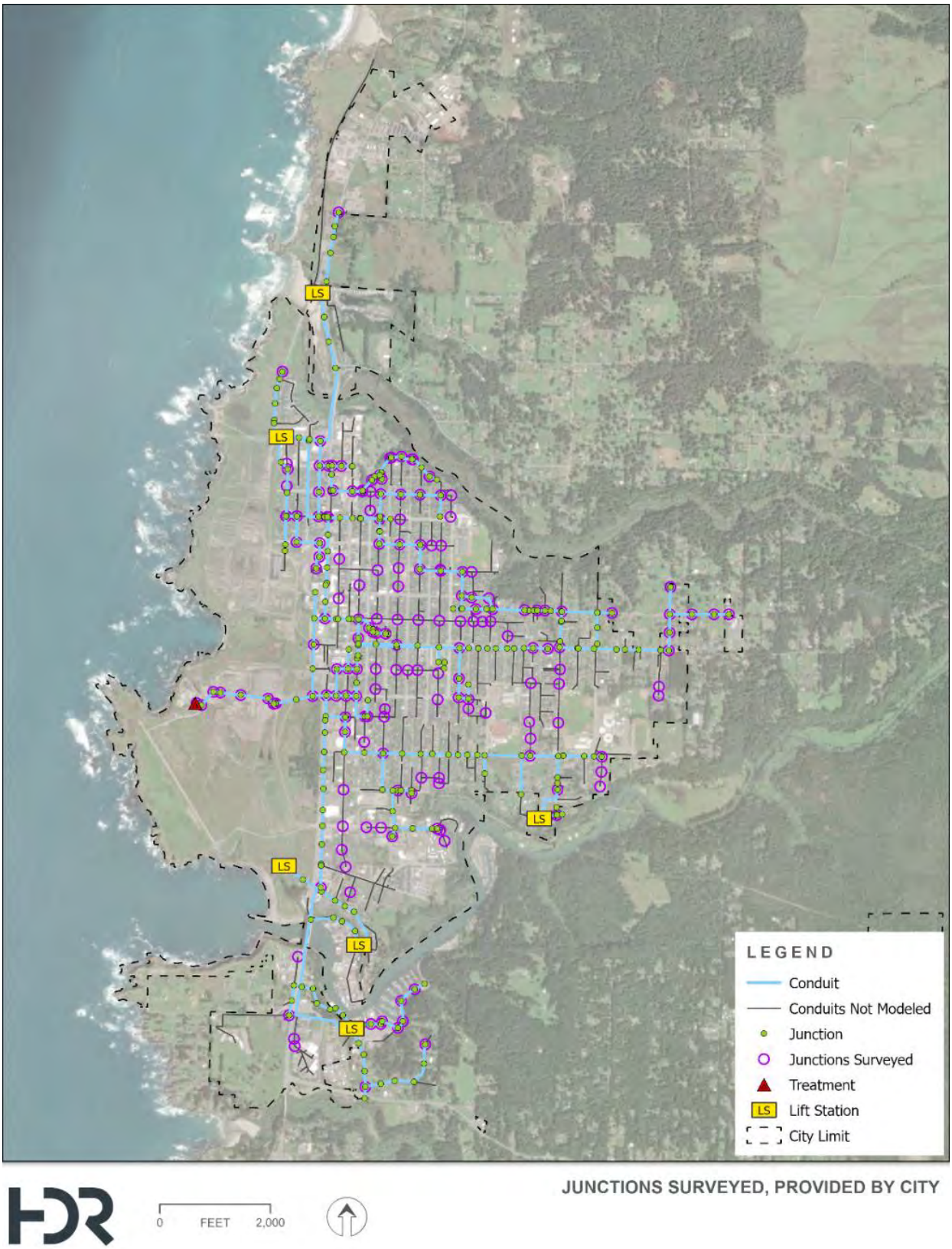


Figure 2-4. Junctions Surveyed with Invert Elevation

2.3 Flow Monitoring

V&A Consulting Engineers (V&A) performed wastewater system flow and rainfall monitoring on portions of the City's system for eight weeks from January 3rd to March 2nd, 2024, at seven flow monitoring stations. The complete report can be referenced in Appendix B – Flow Monitoring. The seven monitoring site locations are listed in Table 2-4, along with the total average dry weather flow (ADWF) and area for each monitoring basin. A monitoring site's contributing area includes all the area upstream of it, which may include multiple basins if one basin is upstream of another. Figure 2-5 shows the location of all monitoring sites and their contributing basins. V&A's monitoring served to establish baseline wastewater system flows and peak flow conditions during rainfall events. This monitoring provided data for model calibration and was used to determine existing dry- and wet-weather flows. ADWF curves were developed during dry days, when infiltration and inflow (I/I) had the least impact on baseline flow.

Table 2-4. List of Monitoring Locations, Total ADWF, and Area

Monitoring Site	Manhole ID	Basin ADWF (MGD)	Basin Area (Acres)	Contributing Area (Acres)[3]
FM-01	Mnhl-Chnnl-4588	0.034	131.0	131.0
FM-02	Mnhl-Chnnl-4058	0.155	114.1	245.1
FM-03	Mnhl-Chnnl-4112	0.228	397.9	729.3
FM-04	Mnhl-Chnnl-4125	0.315	86.4	86.4
FM-05	Mnhl-Chnnl-4117	0.032	12.2	12.2
FM-06	Mnhl-Chnnl-4284	0.011	16.7	16.7
FM-07	Mnhl-Chnnl-4264	0.038	196.2	196.2

[3] Basin area plus all upstream basin areas.

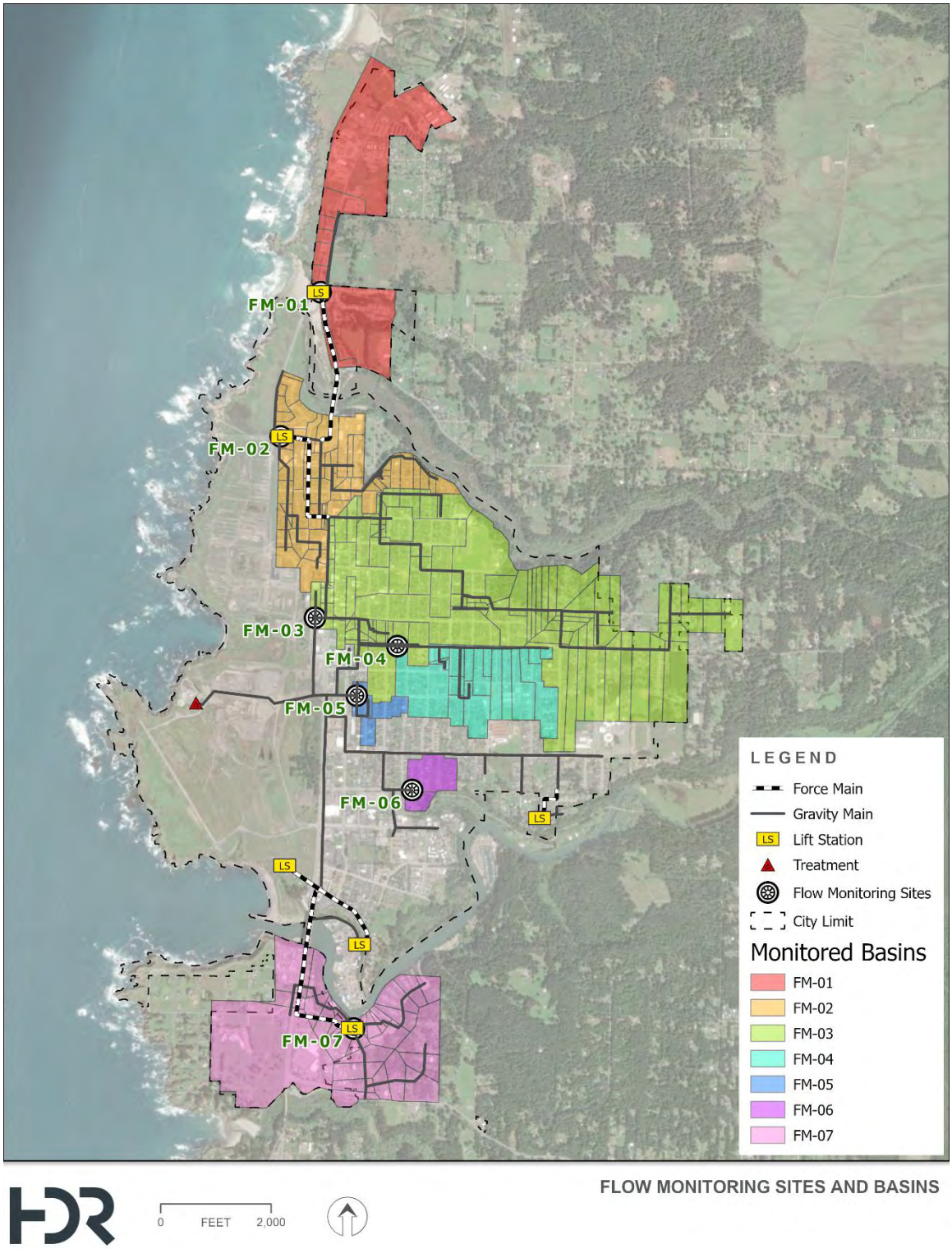


Figure 2-5. Map of Flow Monitoring Sites and Node Sewershed Area

CHAPTER 3 EXISTING AND FUTURE CAPACITY ANALYSIS

3.1 Introduction

This chapter documents HDR's capacity analysis of an existing and future wastewater model for the City. This capacity analysis consisted of spatially calibrating the existing model to existing flows, developing future flows and conditions, and evaluation of system capacity during a 10-year design storm and a selection of proposed projects for a Capital Improvement Program (CIP).

3.2 Infiltration & Inflow (I&I) Analysis

Infiltration and inflow into the wastewater collection system from groundwater had to be accounted for to predict increased flows as a result of rainfall. Rainfall Derived Inflow and Infiltration (RDII) refers to the increased portion of flow in the system during and after a rainfall event. RDII at each node in the model is determined based on the measured rainfall, the sewershed area contributing to RDII at each manhole, and a basin unit hydrograph that characterizes the system's response during a rainfall event. Measured rainfall was acquired by V&A from collecting wastewater flow and rainfall monitoring on portions of the City's system for eight weeks from January 3rd to March 2nd, 2024. Because V&A collected data for multiple monitoring basins, each basin could be analyzed and calibrated individually.

3.2.1 Unit Hydrographs

Unit hydrographs are defined by three parameters (RTKs):

- R = Fraction of rainfall volume entering wastewater system
- T = Time to peak flow response
- K = Ratio of time of recession of response

Figure 3-1 shows how the three hydrographs are used to develop a total RDII response. The rainfall volume entering the system at each manhole in the model is calculated using the rainfall time-series, the sewershed area, and the R value of the basin unit hydrograph (RTKs). The T and K parameters describe how that volume is distributed over time.

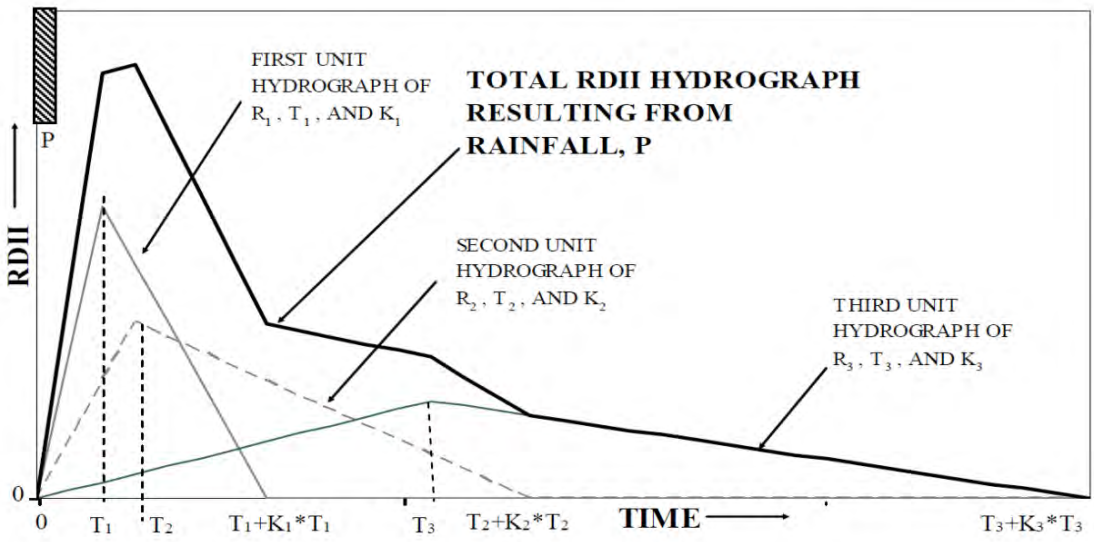


Figure 3-1. RTK Unit Hydrograph Method

3.2.2 Sewershed Area Allocation

Sewershed areas were defined for the model to accurately represent the percentage of rainfall that enters the system and are directly used to calculate inflow volumes. Incorporating too large an area depresses R values that represent the percentage of rainfall that enters the system. For this reason, Areas without sewers, such as the GP Mill Site and the northernmost extents of the City were omitted. Node sewershed areas as described in Section 3.3.2 were allocated to the model as RDII inflow. Each node was also allocated a unit hydrograph to support calibration.

3.2.3 System Cross-Connection

Based on the RTKs and the amount of rainwater that appears to enter FM-04, HDR suspects there may be a cross-connection between the wastewater and storm sewer systems within FM-04. Possible locations for this cross-connection are where the two systems cross, which have been highlighted in Figure 3-2

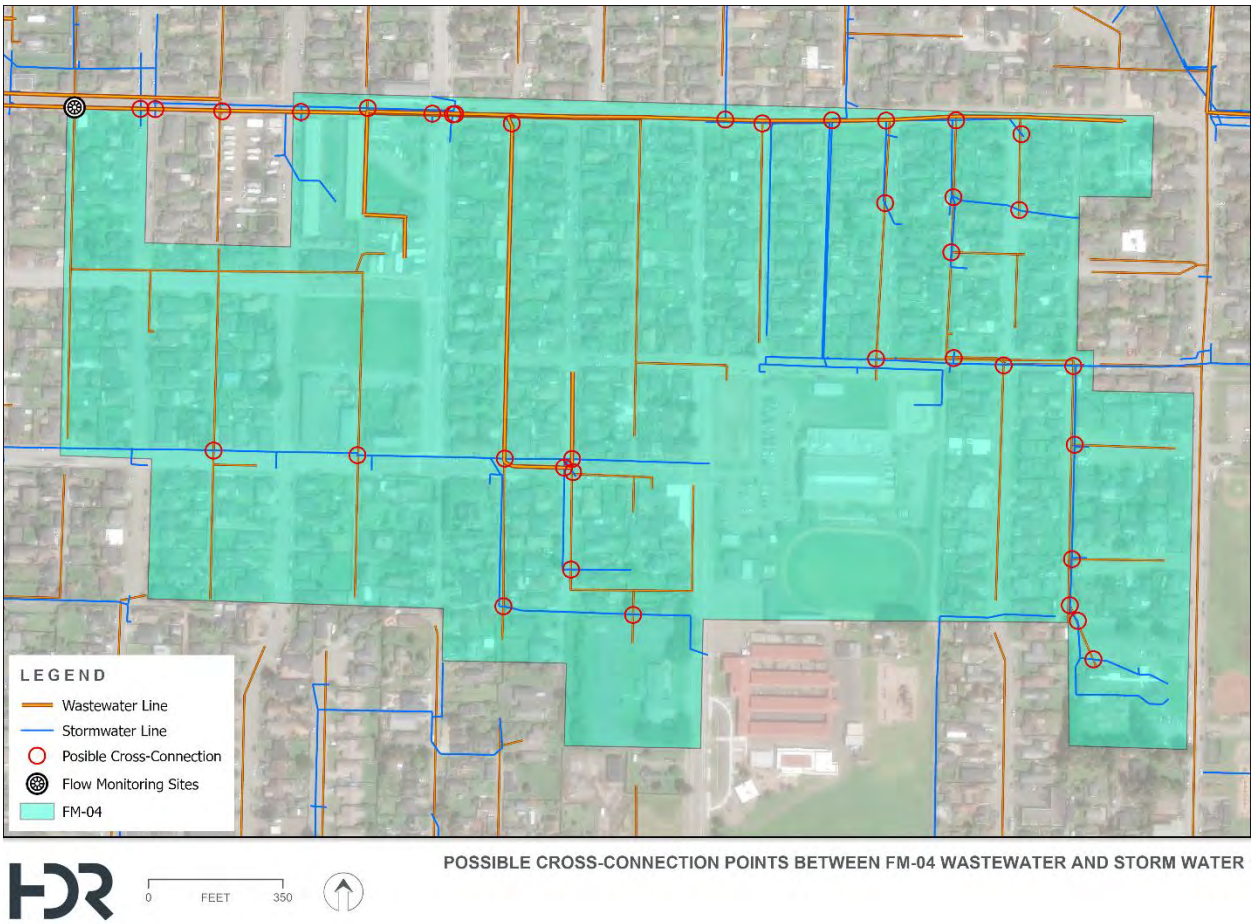


Figure 3-2. Possible FM-04 Sanitary and Storm Sewer Cross-Connections

3.3 Hydraulic Model Calibration

With the hydraulic model of the existing wastewater system developed in AquaTwin Sewer, the model was calibrated to flow measurements collected by V&A to ensure existing and future results were accurate. This effort consisted of loading the model with existing wastewater system flows, and calibrating model results to the collected flow data.

3.3.1 Design Storm Development

V&A performed wastewater system flow and rainfall monitoring portions of the City's system for eight weeks from January 3rd to March 2nd, 2024. Hydraulic analyses were conducted during the storm event of greatest intensity during this flow monitoring period, which corresponded to a five-year 24-hour storm that occurred on January 31st. As rainfall data for a 10-year storm event was not available, this event was modeled by scaling up the 5-year rainfall data from the flow monitoring to meet the NOAA Atlas 14 minimum rainfall criteria for a 10-year storm. A 10-year storm was chosen as it is more conservative than a 5-year storm, and a 25-year storm is generally considered too conservative for the purpose of master planning level analysis in northern California.

3.3.2 Node Sewershed areas

Sewershed areas were developed for each node in the model to describe the area around the node that contributes flow. Sewershed areas were only developed from areas within City limits that are served by the existing collection system. This excludes areas such as the northernmost extents of the City, and much of the City west of Shoreline Highway – referred to as the GP Mill Site. Figure 3-3 shows sewer basins for the existing wastewater collection system.

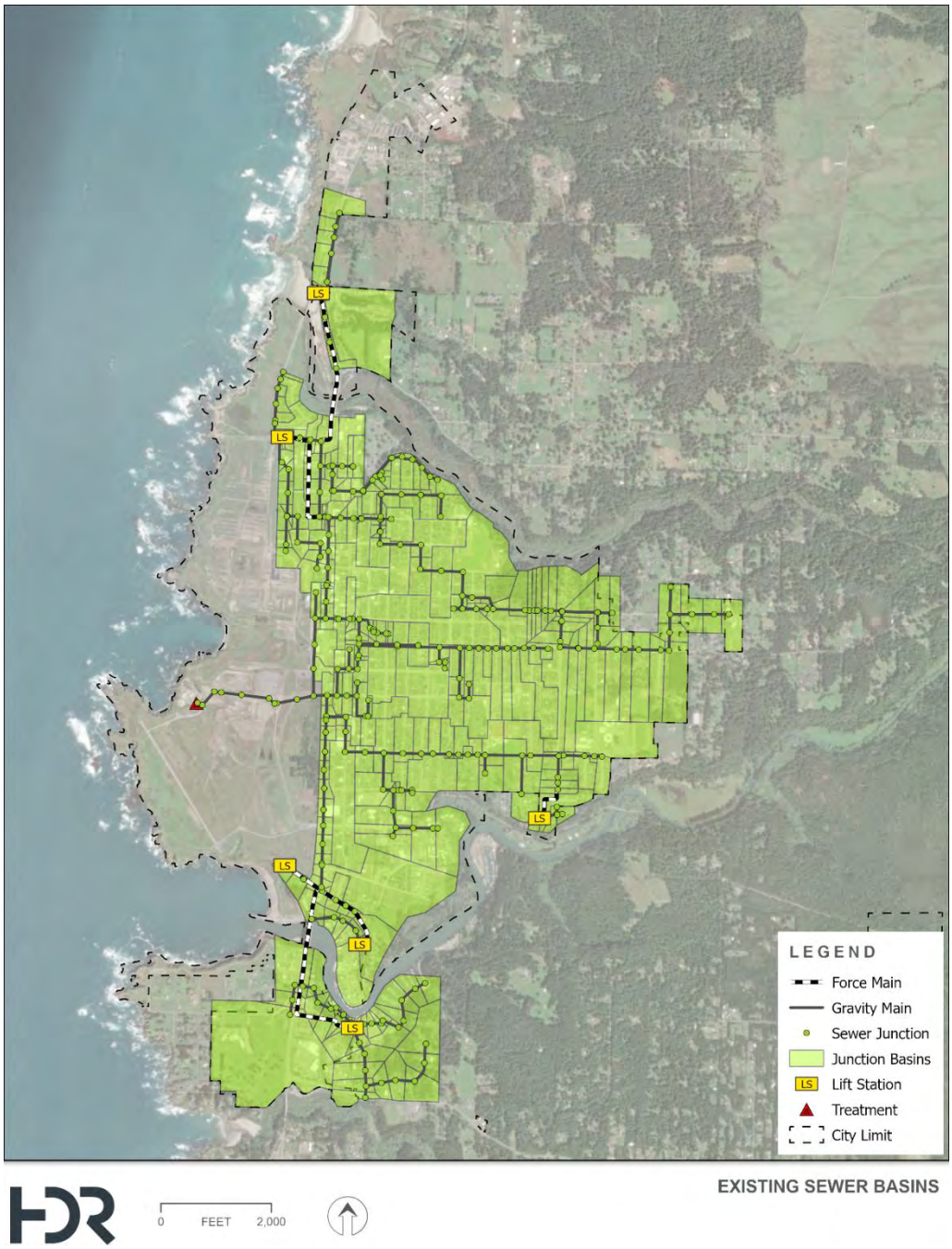


Figure 3-3. Fort Bragg Node Sewershed Area

3.3.3 Dry-Weather Calibration

Dry weather flow (DWF) consists of two flow components: base wastewater production (BWP) and base infiltration (BI). It was assumed that BWP and BI were included as part of the basin ADWFs reported in V&A's flow monitoring. Basin ADWFs were used to develop diurnal patterns and hourly flow rates (GPM) for each monitored basin. An hourly flow rate for the unmonitored parts of the system – referred to collectively as the *unmonitored basin* – was derived from the difference between the total ADWF for the monitored basins (0.813 MGD) and the average influent to the WWTP over the duration of the flow monitoring (2.024 MGD), per data provided by the City. The hourly flow rate for each basin was averaged over its total area to develop an average basin hourly flow (GPM/Acre). Basin areas, total ADWFs, and hourly flows are shown in Table 3-1.

Table 3-1. Total Basin Area and Hourly Flow (GPM)

Monitoring Site	Basin Area (Acres)	Basin ADWF (MGD)	Basin Hourly Flow (GPM)	Average Basin Hourly Flow (GPM/Acre)
FM-01	131.0	0.034	23.6	0.18
FM-02	114.1	0.155	107.6	0.94
FM-03	397.9	0.228	158.3	0.40
FM-04	86.4	0.315	218.8	2.53
FM-05	12.2	0.032	22.2	1.82
FM-06	16.7	0.011	7.6	0.46
FM-07	196.2	0.038	26.4	0.13
Unmonitored	352.9	*1.211*	841.0	2.38
Total	**1,307.3**	**2.024**	-	-

Calculated average hourly flows were then applied to the individual node sewershed areas in the model and loaded in as DWF inflow. DWF results were calibrated by scaling the DWF inflow so that model results for each monitored basin matched its diurnal pattern. Calibration results are included in Appendix C. As no flow monitoring data was available for the unmonitored basin, DWF inflows were scaled so that flow into the WWTP approximated the average influent to the WWTP.

3.3.3.1 Diurnal Patterns

Normalized weekly diurnal patterns were developed from the flow monitoring data and applied to the model. Diurnal patterns were developed for each flow monitoring basin by taking the average flow at each time-step and dividing by the daily average. Figure 3-4 shows the diurnal patterns determined using weekday flows. These patterns are used as the basis for model development. No adjustment was necessary to the diurnal during model calibration.

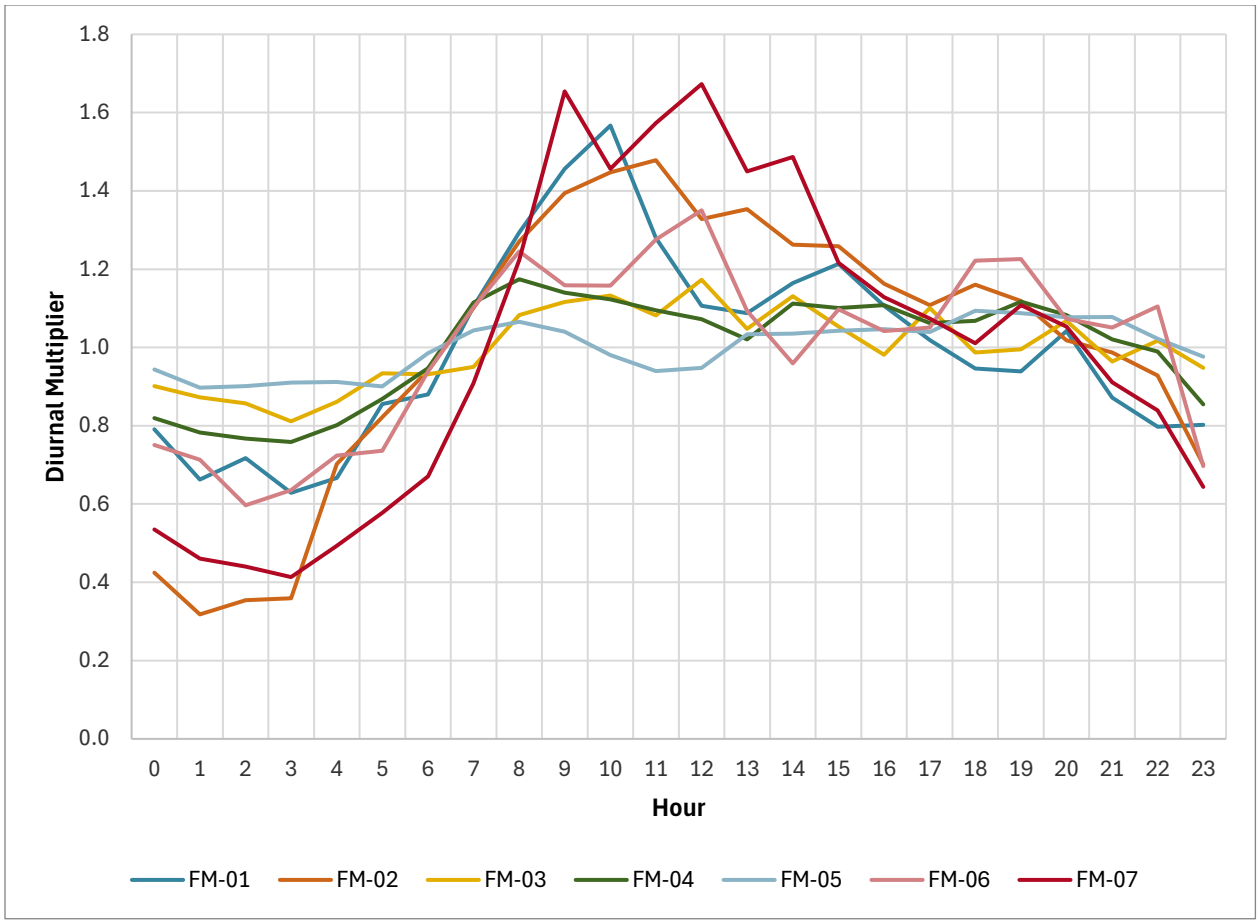


Figure 3-4. Weekday Monitoring Basin Diurnal Patterns

3.3.4 Wet-Weather Calibration Results

Wet-weather flows were calibrated by determining RTKs that result in modeled wet-weather flows that matched observed flows. Calibrated RTKs and model results are included in Appendix C. The unmonitored basin had no flow data to be calibrated against and thus no RTKs could be developed for this basin. To support calibration of the unmonitored basin, FM-03 RTKs were used, as FM-03 is the largest monitored basin and is considered representative of the unmonitored basin.

3.4 Existing and Future Capacity Analysis

3.4.1 Unit Sewer Duty Factors

Unit sewer duty factors for future sewer flow were developed using water meter usage and parcel data provided by the City. A return-to-sewer (RTS) ratio was developed for each basin based on the percent difference between basin ADWF as reported by V&A's flow monitoring and the average water meter demand from January 2020 and June 2021. The calculated RTS ratios are shown in Table 3-2, and were applied to the water meter demand to yield sewer flow at each meter.

Table 3-2. Monitored Basin RTS

Monitored Basin	Total ADWF (MGD)	Basin ADWF (MGD)	Annual 2020-21 (MGD)	Annual 2020-21 RTS
FM-01	0.034	0.034	0.006	589%
FM-02	0.189	0.155	0.064	244%
FM-03	0.732	0.228	0.245	93%
FM-04	0.315	0.315	0.059	538%
FM-05	0.032	0.032	0.019	171%
FM-06	0.011	0.011	0.011	98%
FM-07	0.038	0.038	0.015	258%
Total	**1.351**	**0.813**	**0.418**	

As shown in Table 3-2, contrasting the Basin ADWF with the water meter-based winter water usage results in return to sewer ratios greater than 100% for most monitored basins. As discussed with City staff and the flow monitoring subconsultant, the data indicates a significant presence of groundwater base infiltration (BI) throughout the system.

Since each water meter is assigned to a parcel with specific land use and zoning designations, total sewer consumption (gallons per day - GPD) could be determined per land use type. Total sewer consumptions were then divided by the total area (Acres) of each land use within the monitored basins to develop sewer duty factors (GPD/Acre). These duty factors are shown in Table 3-3 and were used to develop and allocate near-term and build-out sewer flows. As noted from Table 3-2, the City's high BI is included in the duty factors below to account for this unmetered impact on the collections system.

Table 3-3. Sewer Duty Factors (GPD/Acre) per Land Use Type

Land Use Type	Total Sewer Generation (GPD)	Area (Acres)	Sewer Duty Factor (GPD/Acre)[4]
Central Business District	50,556	46	1,107
General Commercial	16,254	27	604
Harbor District	35,379	4	8,307
Heavy Industrial	7,460	46	164
High Density Residential	7,540	11	659
Highway Visitor Commercial	55,626	87	640
Light Industrial	1,732	47	37
Low Density Residential	503,341	296	1,700
Medium Density Residential	59,178	57	1,045
Neighborhood Commercial	1,558	5	328

[4] Includes base infiltration

Office Commercial	17,844	35	512
Open Space	16,333	10	1,633
Parks and Recreation	7,902	13	628
Public Facilities and Services	5,449	99	55
Suburban Residential	1,323	6	217
Timber Resources Industrial	126	5	26
Very High Density Residential	105,441	80	1,313
Grand Total	**893,041**	**872**	**N/A**

3.4.2 Future Sewer Flow Projections

Figure 3-5 shows the anticipated build-out condition for the City as depicted in the 2013 Inland Land Use, Development, and General Plan. This analysis includes projected flows for the future build out to the entire City sphere of influence. Most of these areas cover the rural residential areas located in the west and south of the City's utility service area. Other areas of potential growth include the Harbor District area in the south along the Noyo River.

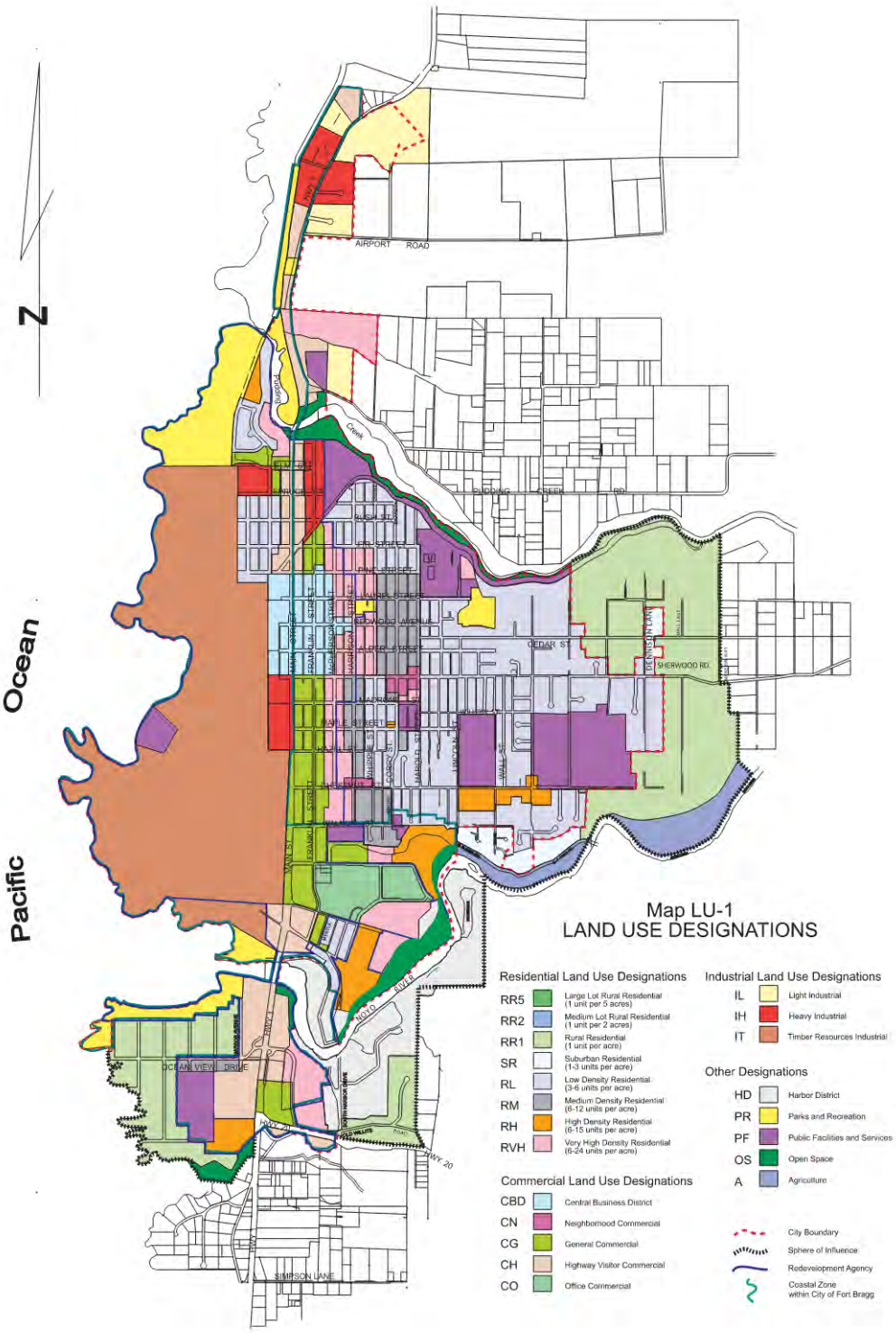


Figure 3-5. City's Future Land Use Categories

Figure 3-6 shows a subsequent land use map provided by the City that shows proposed rezoning within the City. This rezoning plan was used to update future land use categories for the GP Mill Site. This rezoning map does not contain proposed zoning for the Annexation Areas, which are the areas that account for much of the build-out scenario development.

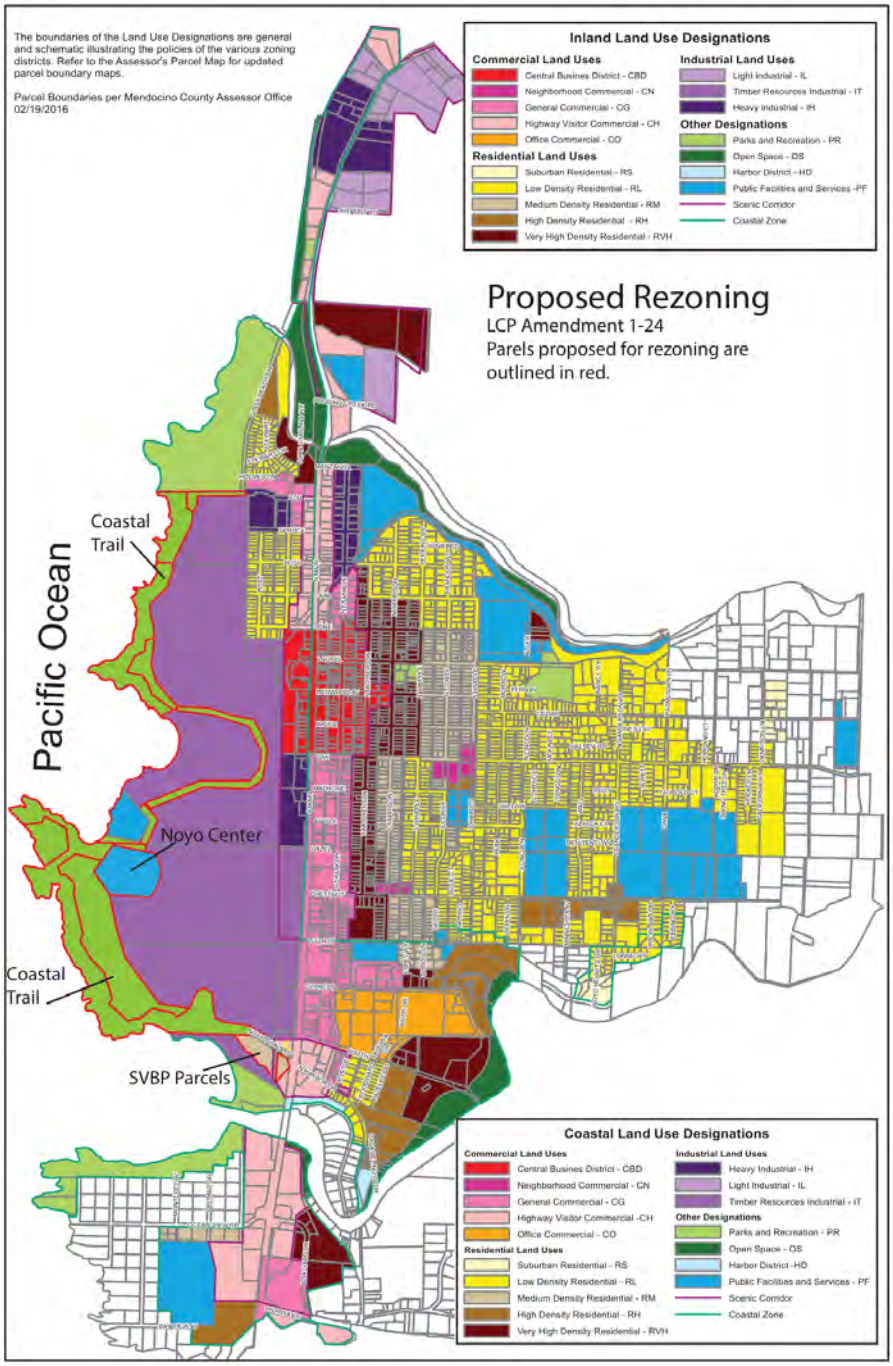


Figure 3-6. City's Proposed Rezoning Plan

The GP Mill Site land use was further supplemented with Hornberger and Worstell's *Mill Site Illustrative Plan for Discussion – In Progress 02.12.2025*. This plan is shown in Figure 3-7 and includes the Noyo Center development south of the wastewater treatment plant. The remaining areas within the GP Mill Site boundary that have no land use designation shown in the figure are planned to remain undeveloped at build-out.

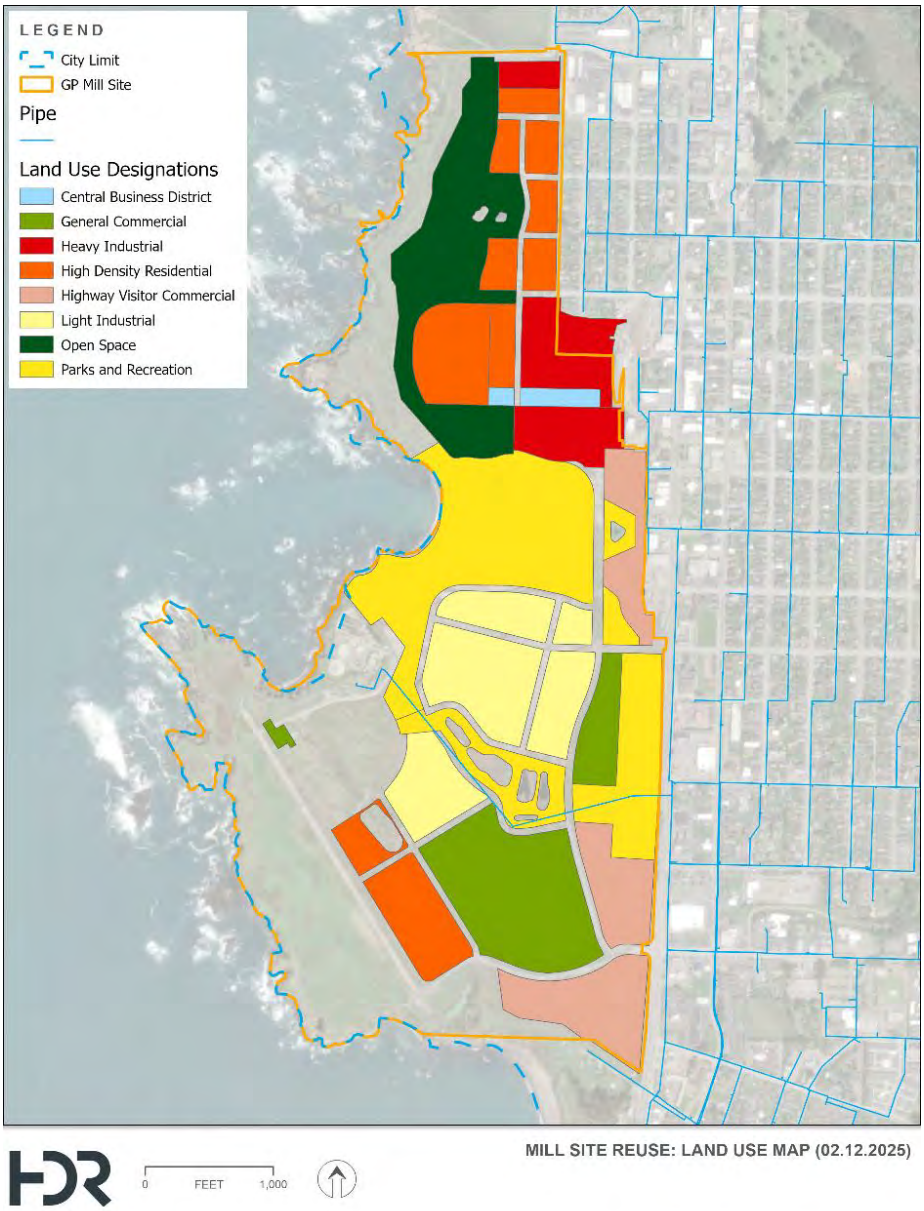


Figure 3-7. GP Mill Site Illustrative Land Use Plan

To determine future capacity needs for the wastewater collection system, two scenarios were developed for analysis based on information provided by the City: near-term and build-out. Developments for these scenarios were specified by the City and are shown in Figure 3-8 and detailed in the following sections.

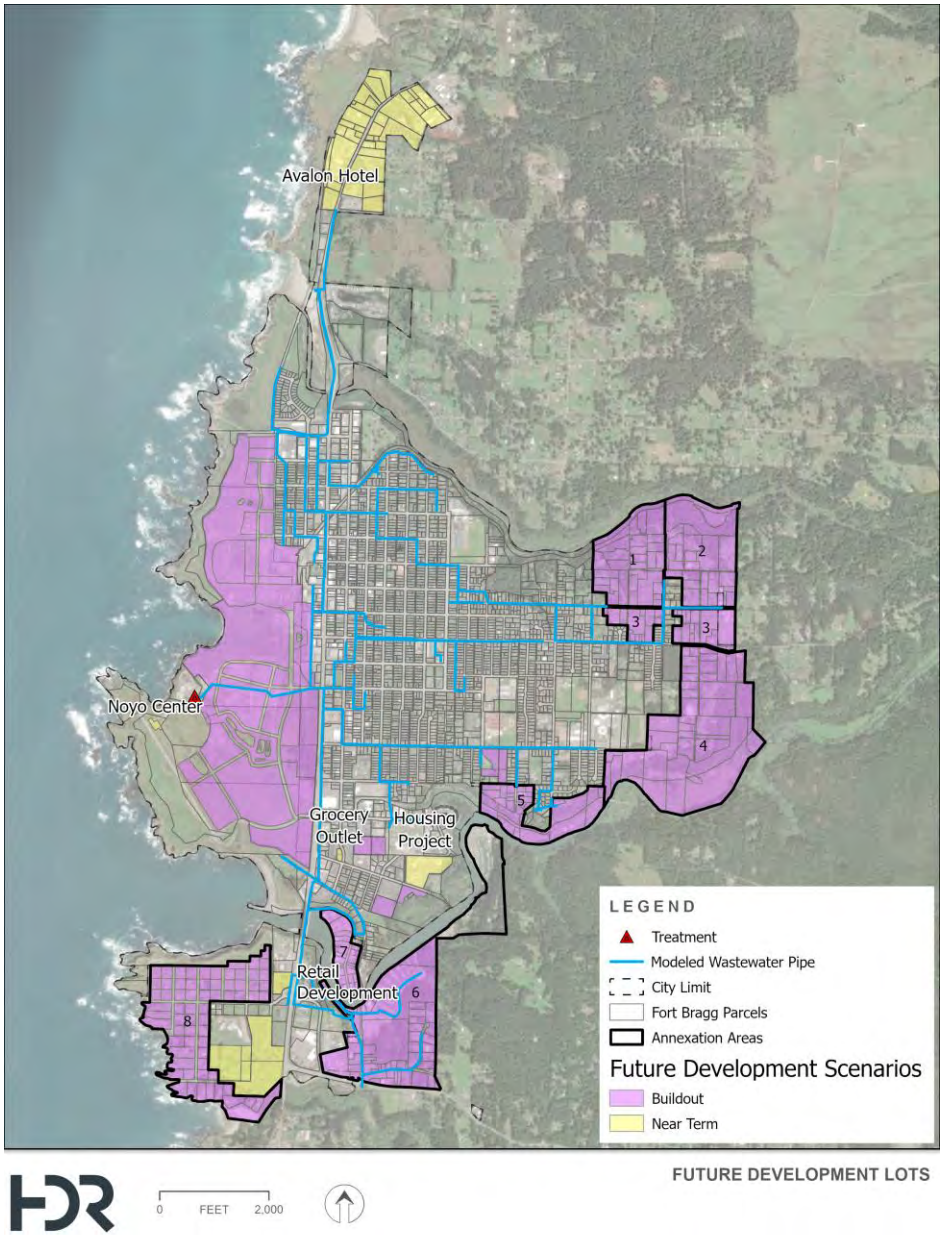


Figure 3-8. Future Development Lots

3.4.2.1 Near-Term

The near-term scenario includes the projected growth over the next 10 years that incorporated undeveloped lots and potential future development plans specified by the City. Based upon input from City Staff, potential near-term developments include two undeveloped lots to the south near the

Mendocino College Coast Center, the Noyo Center in the GP Mill area, and four near-term specific development plans specified by the City. The undeveloped lots (APN: 01845036, APN: 01845041) were specified by the City as being developed in the near term. Flows for these lots have been projected assuming that these areas get developed following the land use categories shown in Figure 3-5. The four specific development plans are listed below:

1. A 69-unit housing project near the intersection of South Street and River Drive. This project was completed in the summer of 2022. However, it has been included in the near-term projections to capture its flows because it was not operational during the metering activity.
2. A 15,000 square-foot retail development south of Noyo Bridge.
3. Grocery Outlet: This property is located near the intersection of South Franklin Street and South Street. It is a 16,157 square-foot, one-story, retail store with a 55-space parking lot.
4. Avalon Hotel: A 65-room inn contained within three separate, three-story buildings for a total area of 43,469 square feet. It consists of a restaurant (660 square feet) with 63 seats and a bar (818 square feet) with 40 seats located in one of the three buildings. Additionally, there is a 3,064 square-foot event center proposed as a separate single-story structure. The total lot area for Avalon Hotel is 3.65 acres.
5. The Noyo Center, part of the development in the GP Mill area.
6. The City also proposed a *North Fort Bragg Sewer Main Extension* project to serve the industrial area on the northernmost end of City Limits that lies outside of the current wastewater service area.

3.4.2.2 Build-Out

The build-out scenario expands on the near-term development scenario and also includes the potential development of the GP Mill Site, five additional undeveloped lots within the City, and the future annexation areas. Annexation Area 6 is unlikely to be developed in a manner that would impact the wastewater system because it’s in a low-lying, heavily forested area. If Annexation Area 6 does develop, it would need to be evaluated at that time.

Areas within the GP Mill Site boundary that have no land use designation are planned to remain undeveloped at build-out and thus have no flows assigned. Flows for the undeveloped lots within the City and the future annexation areas have been projected assuming that they are developed following the land use categories shown in Figure 3-5.

3.4.3 Capacity Analysis and Improvements

With the wastewater model now calibrated with existing and future sewer flows, HDR conducted a system capacity analysis to identify projects for a CIP. These CIP projects will address existing and future deficiencies in the wastewater collection system.

3.4.3.3 Planning Criteria

System capacities for the existing, near-term, and build-out conditions were evaluated during a 10-year storm event. A depth over diameter (d/D) of over 0.8 was considered deficient, as was any amount of flooding at the nodes. Flooding in this case refers to the surcharge height at a node reaching ground level.

Existing Capacity Analysis

Existing facilities with potential capacity limitations and exhibited flooding conditions, based on a 10-year design storm, are shown in Figure 3-9. All lift stations remain within capacity during a 10-year event. It should be noted that capacity results for the unmonitored basins are based on uncalibrated data and thus may be of limited accuracy.

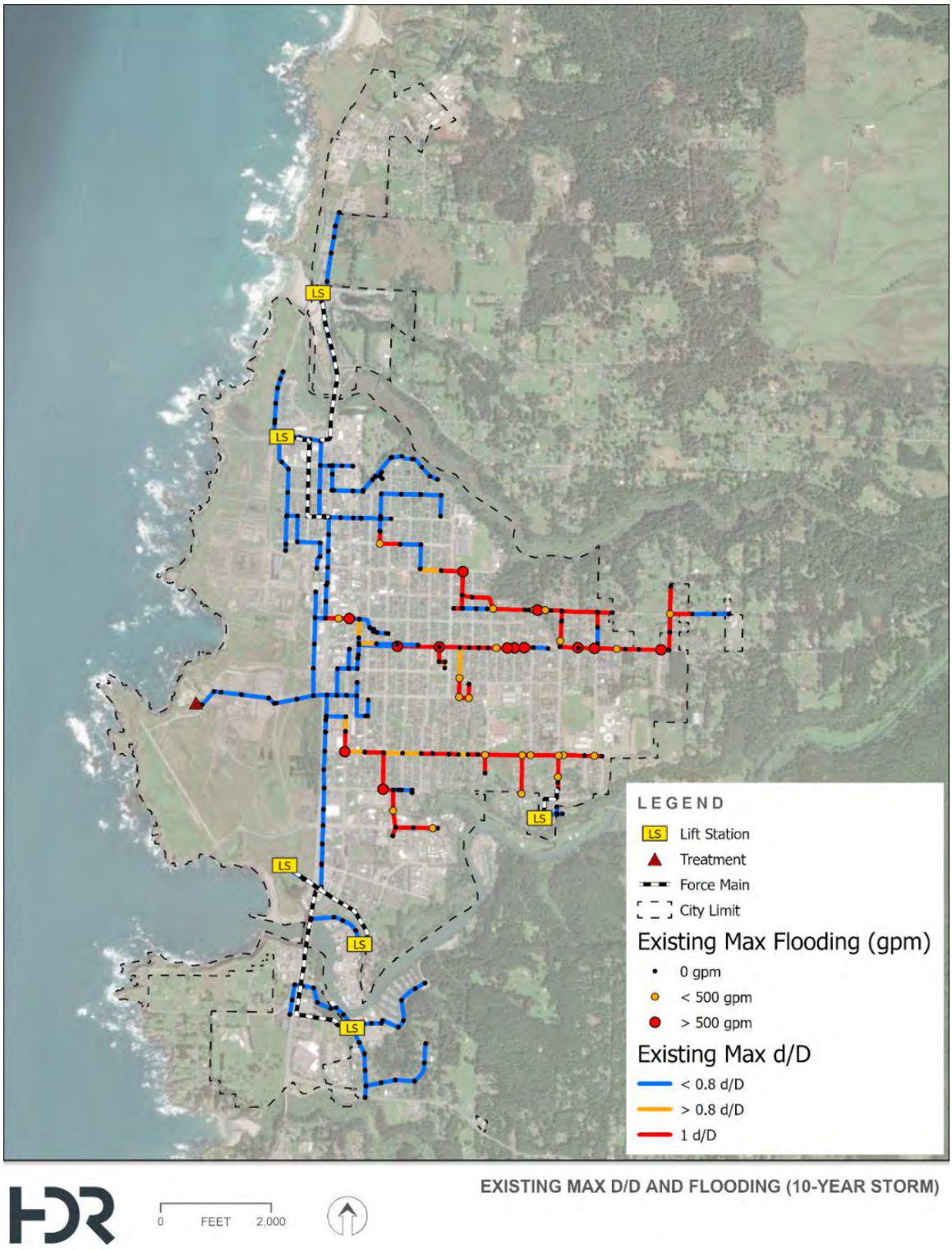


Figure 3-9. Existing Max d/D and Flooding (10-Year Storm)

Preliminary CIP Projects

The analysis of the existing system identified areas that are predicted to experience capacity constraints under projected flows from a 10-year storm under existing, near-term, and build-out conditions. A total of twenty-six preliminary CIP projects were developed to address flooding at the nodes and reduce max d/D to 0.8 or below. These preliminary CIP projects involve upsizing existing gravity mains and lift stations and also constructing new mains and lift stations to serve future areas. These CIP projects are summarized in Table 3-4 and pictured in Figure 3-10. As shown, approximately 30% of these improvements are required to upsize older 6-inch pipelines to more modern 8-inch or greater standards.

Projects P-4 and P-5 require further upsizing to accommodate additional build-out conditions. This additional upsizing is indicated in Figure 3-10 and detailed in Table 3-4. Final CIP projects are developed in Chapter 9. It is recommended that proposed projects within the unmonitored basin not be considered until the basin is metered. Rather, proposed projects within this basin should be revisited after the City acquires new wastewater flow metering data to calibrate the model in this area..

Table 3-4. Preliminary Proposed CIP Projects for Existing, Near Term, and Build-Out (10-Year Storm)

Scenario	CIP ID	Project Name	Project Description	Total Pipe Footage (FT)
Existing	P-1	WWTP Interceptor Replacement	Increase 23 FT of 12-inch pipe diameter to 39-inch. Increase 475 FT of 18-inch pipe diameter to 33-inch. Increase 443 FT of 24-inch pipe diameter to 33-inch. Increase 492 FT of 24-inch pipe diameter to 36-inch. Increase 2,283 FT of 30-inch pipe diameter to 39-inch.	3,716
Existing	P-2	Oak Street Sewer Main Replacement	Increase 167 FT of 6-inch pipe diameter to 10-inch. Increase 1,538 FT of 6-inch pipe diameter to 15-inch. Increase 317 FT of 6-inch pipe diameter to 8-inch. Increase 232 FT of 8-inch pipe diameter to 24-inch. Increase 205 FT of 8-inch pipe diameter to 30-inch. Increase 716 FT of 10-inch pipe diameter to 15-inch. Increase 1,462 FT of 10-inch pipe diameter to 18-inch. Increase 130 FT of 12-inch pipe diameter to 18-inch. Increase 342 FT of 12-inch pipe diameter to 24-inch. Increase 174 FT of 18-inch pipe diameter to 24-inch. Increase 188 FT of 18-inch pipe diameter to 30-inch.	5,471
Existing	P-3	South Franklin Sewer Main Replacement	Increase 662 FT of 6-inch pipe diameter to 18-inch. Increase 340 FT of 8-inch pipe diameter to 18-inch. Increase 633 FT of 8-inch pipe diameter to 21-inch. Increase 364 FT of 12-inch pipe diameter to 18-inch. Increase 358 FT of 12-inch pipe diameter to 21-inch. Increase 66 FT of 12-inch pipe diameter to 24-inch. Increase 606 FT of 18-inch pipe diameter to 24-inch.	3,029

Scenario	CIP ID	Project Name	Project Description	Total Pipe Footage (FT)
Existing	P-4	Cedar Street Sewer Main Replacement	Increase 922 FT of 6-inch pipe to 8-inch. For build-out, 11 FT must be increased to 12-inch, and 908 FT must be increased to 15-inch. Increase 1142 FT of 6-inch pipe to 10-inch. For build-out, 331 FT must be increased to 15-inch. Increase 42 FT of 6-inch pipe to 12-inch. For build-out, must be increased to 15-inch. Increase 304 FT of 6-inch pipe to 15-inch. For build-out, must be increased to 18-inch. Increase 980 FT of 6-inch pipe to 18-inch. For build-out, 649 FT must be increased to 21-inch, and 11 FT must be increased to 24-inch. Increase 472 FT of 8-inch pipe to 10-inch. For build-out, 326 FT must be increased to 15-inch, and 146 FT must be increased to 18-inch. Increase 1401 FT of 8-inch pipe to 12-inch. For build-out, 197 FT must be increased to 15-inch, and 1204 FT must be increased to 18-inch. Increase 3401 FT of 8-inch pipe to 18-inch. For build-out, 3169 FT must be increased to 24-inch, and 232 FT must be increased to 27-inch. Increase 439 FT of 10-inch pipe to 18-inch. For build-out, must be increased to 24-inch. Increase 747 FT of 15-inch pipe to 18-inch. For build-out, 376 FT must be increased to 24-inch, and 371 FT must be increased to 27-inch. Increase 226 FT of 18-inch pipe to 21-inch. For build-out, must be increased to 27-inch. Increase 946 FT of 18-inch pipe to 24-inch. For build-out, must be increased to 30-inch. Increase 1831 FT of 21-inch pipe to 24-inch. For build-out, must be increased to 30-inch. Build-out also requires additional upsizing: Increase 495 FT of 6-inch pipe to 15-inch.	13,349

Scenario	CIP ID	Project Name	Project Description	Total Pipe Footage (FT)
Existing	P-5	East Chestnut Street Sewer Main Replacement	Increase 1316 FT of 6-inch pipe to 8-inch. For build-out, 700 FT must be increased to 10-inch. Increase 176 FT of 6-inch pipe to 10-inch. For build-out, must be increased to 12-inch. Increase 1737 FT of 6-inch pipe to 12-inch. For build-out, 987 FT must be increased to 15-inch. Increase 384 FT of 8-inch pipe to 10-inch. For build-out, must be increased to 12-inch. Increase 1183 FT of 8-inch pipe to 12-inch. For build-out, must be increased to 15-inch. Build-out also requires additional upsizing: Increase 143 FT of 6-inch pipe to 10-inch. Increase 342 FT of 12-inch pipe to 15-inch.	5,281
Existing	P-6	South Harold Street Sewer Main Replacement	Increase 431 FT of 6-inch pipe diameter to 10-inch. Increase 902 FT of 6-inch pipe diameter to 12-inch.	1,333
Existing	P-7	Cypress Street Sewer Main Replacement	Increase 1,356 FT of 8-inch pipe diameter to 10-inch. Increase 193 FT of 8-inch pipe diameter to 12-inch.	1,549
Near Term	P-8	North Fort Bragg Sewer Main Extension	Place new 1,970 FT of 8-inch main.	1,970
Near Term	P-9	Noyo Center Sewer Main Extension	Place new 1074 FT of 15-inch main.	1,074
Near Term	P-10	Bay View Avenue Sewer Main Extension	Place new 1,968 FT of 8-inch main.	1,968

Scenario	CIP ID	Project Name	Project Description	Total Pipe Footage (FT)
Build-Out	P-11	North GP Mill Site Sewer Main Extension	Place new 3,939 FT of 8-inch force main. Place new 3,261 FT of 10-inch main. Increase 472 FT of 6-inch pipe diameter to 8-inch. Install proposed lift station with 80 GPM capacity.	7,672
Build-Out	P-12	South GP Mill Site Sewer Main Extension	Place new 2,360 FT of 10-inch main. Place new 423 FT of 18-inch main.	2,783
Build-Out	P-13	South GP Mill Site Sewer Main Extension	Place new 2,349 FT of 10-inch main.	2,349
Build-Out	P-14	South GP Mill Site Sewer Main Extension	Place new 3,607 FT of 12-inch main.	3,607
Build-Out	P-15	Nurnberger Lane Sewer Main Extension	Place new 5,407 FT of 12-inch main.	5,407
Build-Out	P-16	Dennison Lane Sewer Main Extension	Place new 4,775 FT of 12-inch main. Place new 233 FT of 15-inch main.	5,008
Build-Out	P-17	Cedar Street Sewer Main Extension	Place new 2,183 FT of 8-inch main.	2,183
Build-Out	P-18	Monsen Way Sewer Main Extension	Place new 2,839 FT of 6-inch main.	2,839
Build-Out	P-19	Sherwood Road Sewer Main Extension	Place new 6,799 FT of 12-inch main. Place new 2,047 FT of 18-inch main.	8,846
Build-Out	P-20	East Chestnut Street Sewer Main Extension	Place new 2,988 FT of 10-inch main.	2,988

Scenario	CIP ID	Project Name	Project Description	Total Pipe Footage (FT)
Build-Out	P-21	George Pacific-Haul Road Sewer Main Extension	Place new 621 FT of 4-inch force main. Place new 716 FT of 6-inch main. Place new 852 FT of 12-inch main. Place new 4,302 FT of 15-inch main. Install proposed lift station with 80 GPM capacity.	6,491
Build-Out	P-22	Basin Street Sewer Main Extension	Increase 1,161 FT of 8-inch pipe diameter to 10-inch. Increase 372 FT of 8-inch pipe diameter to 12-inch. Increase 236 FT of 10-inch pipe diameter to 12-inch.	1,769
Build-Out	P-23	North Harbor Drive Sewer Main Replacement	Increase 251 FT of 8-inch pipe diameter to 21-inch. Increase 30 FT of 12-inch pipe diameter to 21-inch.	281
Build-Out	P-24	South Harbor Drive Sewer Main Extension	Place new 730 FT of 12-inch main.	730
Build-Out	LS-1	South Noyo Lift Station Improvement	Increase South Noyo LS capacity from 920 GPM to 1,500 GPM.	N/A
Build-Out	P-25	East Ocean View Drive Sewer Main Extension	Place new 23,420 FT of 8-inch main.	23,420

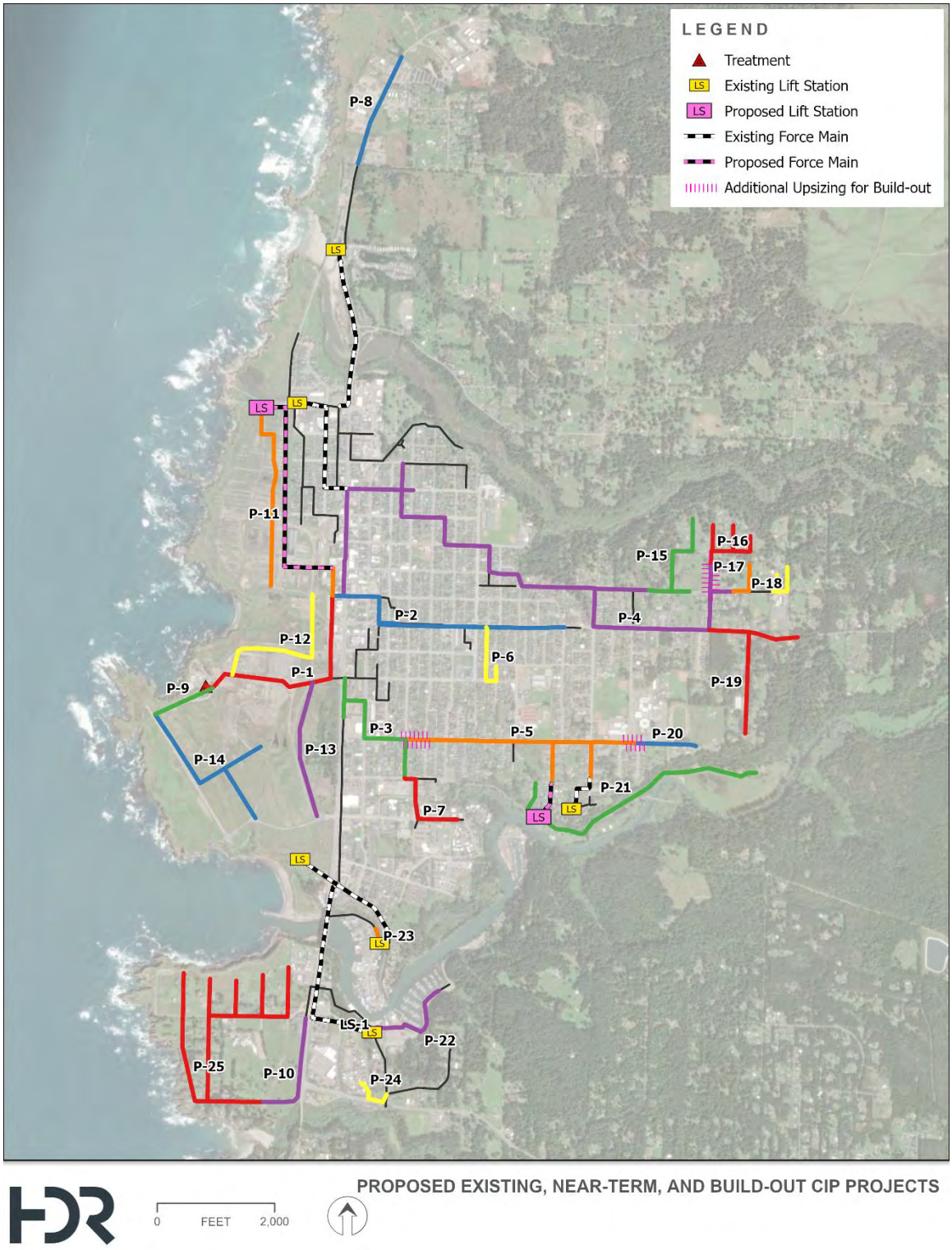


Figure 3-10. Proposed CIP Projects For Existing, Near Term, and Build-Out (10-Year Storm)

CHAPTER 4 RISK ASSESSMENT

This section documents the methodology and analysis used to develop risk scores for the City's wastewater collection system gravity mains. Risk scores are a numerical value representing the relative risk for each pipe segment, calculated using defined likelihood of failure (LoF) and consequence of failure (CoF) factors and weighting.

In this master plan, these risk scores were used to prioritize targeted gravity main condition assessment, but may also be used to prioritize repair, rehabilitation, or maintenance work. Without definitive condition information, these risk scores are only representative of relative risk in comparison to other pipes in the system. Therefore, the scores are appropriate for guiding assessment and planning efforts but should not be interpreted as definitive evidence that rehabilitation is required. Additional field investigation and condition assessment will be necessary to verify actual asset condition and to estimate remaining useful life.

4.1 Risk Assessment Framework

A risk model was developed for gravity mains in the wastewater collection system. The model calculates a Total Risk Score for each pipe by first generating a LoF score and a CoF score, then multiplying them using targeted weighting factors. Because LoF-related risks can be more easily mitigated through repairs, replacements, or other asset interventions, the LoF score is typically weighed more heavily than the CoF score. Section 3 provides the complete risk formula and how the LoF and CoF scores were incorporated.

The relative weights of Likelihood of Failure and Consequence of Failure were defined and applied in collaboration with the City to support level of service objectives. The assigned weights are provided in Table 4-1 below.

Table 4-1. Total Risk – LoF and CoF Weighting

Factor	Weighting Factor (%)
Likelihood of Failure	60
Consequence of Failure	40

4.1.1 Risk Factors

To develop the risk model, potential risk factors were first identified based on common failure modes and consequences then refined to better reflect available data and the City's level-of service objectives. Each factor was assigned a weighted value to represent its relative importance within the overall framework.

Weightings for both the LoF and CoF factors were established using a pair-wise comparison analysis. In this method, each factor is compared against every other factor in a matrix and assigned a score from 1 to 3. The most important factor in each pair receives the highest score, 3. The least important factor in each pair receives the lowest score, 1. If a pair of factors are assessed to be of equal importance, each will receive a score of 2. The scores for each factor are then summed, and the final weighting is calculated as the percentage for that factor's total points relative to the overall point total for all factors.

4.1.2 LoF Factors and Weights

The four criteria selected to evaluate the Likelihood of Failure are summarized in Table 4-2 below, along with their descriptions and associated data sources. Detailed scoring tables for each factor are provided in Appendix D.

The following data sources were used and are referenced in the table below:

- **Fort Bragg Utility Network (UN)** - Fort Bragg GIS Utility Network
- **I&I Analysis** – Infiltration & Inflow Analysis
- **CIWQS** – California Integrated Water Quality System (CIWQS) Sanitary Sewer Database
- **Operations Staff Experience**

Table 4-2. Likelihood of Failure Factors, Data Sources, and Weights

No.	Factor	Data	Data Source(s)	Weight (%)
1	Remaining Useful Life	Pipe Material	Fort Bragg UN	21
		Approximate Install Date	Fort Bragg UN	
2	I&I	RTK Value	I&I Analysis	38
3	SSO History	SSO Count	CIWQS	29
4	Groundwater Fluctuations	Known Groundwater Fluctuation	Operations Staff Experience	12

- **Remaining Useful Life (RUL)** - Pipes that are nearing or have exceeded their estimated service life are more likely to fail and therefore receive a higher LoF score. However, it should be noted that RUL is an estimate based on industry standards or manufacturer data is not always a reliable indicator of actual pipe conditions. Pipes may deteriorate more quickly or slowly depending on site-specific conditions, construction methods, and manufacturing differences. The RUL was calculated as a percentage of life left based on industry data.
- **Inflow and Infiltration –** Gravity mains are non-pressurized pipes that operate largely at atmospheric pressure when not flowing full. And when they are surrounded by highly saturated soils, the resulting pressure differential between external groundwater and the interior of the pipe can cause groundwater to infiltrate into the system, contributing to I&I. This infiltration increases both the hydraulic load that the gravity system must convey without causing overflows and the volume of water that the wastewater treatment plant must treat during peak wet-weather conditions. Significant I&I is often indicative of structural deficiencies, such as cracks, fractures, or offset joints. Meaning these pipes should be prioritized for repair or replacement to maintain a sealed collection system, reduce unnecessary wet-weather flows, and mitigate potential sewer system overflows. As part of this Master Plan, an I&I analysis was conducted to calculate RTK parameters for monitored flow basins, where (R) is the fraction of rainfall volume entering the system, (T) represents the time to peak flow response, and (K) represents the ratio of the recession time to the response time. Pipes located within flow basins exhibiting higher RTK values are therefore assigned higher LoF scores due to their greater likelihood of contributing to ongoing I&I and reflecting underlying structural issues.

- **Sewer System Overflow (SSO) History** – A documented history of SSOs, excluding events attributed to operator or customer error, or structural failures that have since been corrected, indicates a higher likelihood of future failures. These may be underlying conditions like areas susceptible to grease or debris accumulation, root intrusion, or existing system capacity limitations. Accordingly, pipes with past SSO occurrences (which do not meet the exclusion criteria) were assigned higher LoF scores.
- **Groundwater Fluctuations** – Pipes located in areas with known groundwater fluctuations may experience increased stress from ground movement. These fluctuations can displace pipe segments, leading to offset joints or pipe sag, and therefore will result in an elevated LoF score.

4.1.3 CoF Factors

As discussed with the City, the three criteria selected and associated weighting used to evaluate the Likelihood of Failure are summarized in Table 4-3 below, along with their descriptions and associated data sources. Detailed scoring tables for each factor are provided in Appendix D.

Table 4-3. Consequence of Failure Factors Data Sources and Weights

No.	Factor	Data	Data Source(s)	Weight (%)
1	Diameter	Pipe Diameter (Inches)	GIS	17%
2	Critical Facilities	Proximity to Schools, Parks, Hospitals, Coastguard Station	Fort Bragg UN/ ESRI Maps/ City Information/ GIS	33%
3	Proximity to Water Bodies	Proximity (Feet) to Water Bodies	GIS	50%

- **Diameter –** Larger-diameter pipes are assumed to convey higher flow volumes, which means failures can result in larger spills, affect a broader service area, and require more costly repairs or replacements. Accordingly, larger pipes are assigned higher CoF scores than smaller-diameter pipes.
- **Critical Facilities –** Pipes that serve or are located near critical facilities represent locations where an SSO or unexpected service disruption could have greater impact on public health, safety, or operational impacts. These locations will therefore receive higher CoF scores.
- **Proximity to Water Bodies –** Spills occurring near water bodies can introduce pollutants directly into sensitive environments and be more challenging to contain. As a result, pipes with shorter distances to nearby water bodies will receive elevated CoF scores.

4.2 Data Preparation

To accurately score the criteria listed above, some data processing was required. Data preparation processes are detailed below.

4.2.1 Consequence of Failure

- **Diameter** – No data processing was required. Pipe diameter values were taken directly from the City's GIS Utility Network.
- **Critical Facilities** – In coordination with the City, HDR identified parcels associated with essential services and vulnerable populations. Gravity mains serving these parcels, or with upstream manholes located near parcel access points were flagged as being in proximity to a critical facility. When a pipe segment was located near multiple critical facilities, the highest applicable score was applied.
- **Proximity to Water Bodies** – This factor was evaluated using spatial data from the Fort Bragg Utility Network (gravity mains) and waterbody features from United States Geological Survey (USGS) Base Maps. The distance between each pipe segment and the nearest water body was calculated in GIS and used to assign CoF scores.

4.2.2 Likelihood of Failure

- **Remaining Useful Life (RUL)** – RUL is determined by pipe age and material. However, these attributes were not consistently available for the City's gravity mains. The City does maintain reliable spatial data for cured-in-place pipe (CIPP) lining projects, and a significant portion of the system is known to consist of clay pipe installed as early as the 1970s. Therefore clay pipe installed in 1970 was used as a conservative baseline estimate for unknown segments, while CIPP-lined pipes were assigned ages based on known installation dates. RUL was then calculated using material-specific estimated useful lives for clay pipe and CIPP.
- **Inflow and Infiltration** – RTK parameters used for scoring were developed as part of the flow monitoring study described in Chapter 4. No additional data processing was required.
- **SSO History** – SSO records were obtained from the CIWQS database for the ten-year period from 2014-2024. Records were reviewed to remove incidents attributed to incidental or unrelated causes (e.g. operator error, construction accident, private lateral overflow), leaving only those events indicative of capacity constraints, infrastructure failure, root blockage, or susceptibility to fats, oils, and grease (FOG).
- **Groundwater Fluctuations** – City staff identified pipe segments located within areas known to experience groundwater fluctuations. These segments were flagged accordingly for LoF scoring.

4.3 Summary of Findings and Recommendations

A total of 819 active sewer main segments, approximately 30 miles, were assessed using the risk framework. A risk score was calculated for each pipe based on the formula in Figure 4-1 and the process described above. The possible risk scores can range from 0 to 5, with 5 indicating the highest relative risk. In this assessment, risk scores ranged from 0 to 3.05. Due to limited data on pipe age and condition, these scores represent relative, not absolute, risk. They can help prioritize segments for repair or replacement based on condition or hydraulic needs and can also guide system renewal or further condition assessment.

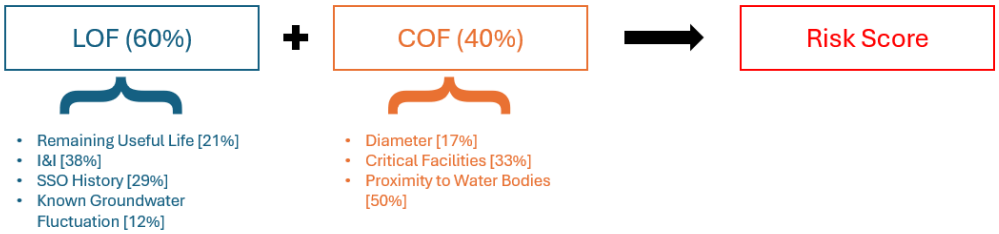


Figure 4-1. Wastewater Collection System Risk Formula

Based on this analysis, the following conclusions are provided:

- The system has a low variance of relative risk scores with approximately 80% of the system falling within a total risk range from 1.5 to 2.5. This flatness may be due in part to a lack of variance in pipe attribute data like material and installation date and the limited number of pipes that were affected by the selected risk factors like SSO history and critical facilities.
- The system has low relative risk scores. The highest risk score calculated is 3.05 out of 5. Approximately 99% of the system has a risk score of 2.5 out of 5 or below.
- LoF scores indicate some high risk pipe. The highest calculated LoF score is 4.03 out of 5. However, the majority of the system have relatively low LoF scores, approximately 73% of the system has an LoF risk score of 2.5 or below. There is only about 1 mile of pipe (3% of the system) with a LoF score above 3.0. Note that the factors used to calculate LoF represent indirect evidence of potential condition. Actual condition (and ultimately likelihood of failure) should be ascertained by condition assessment.
- The most impactful drivers of LoF and Total Risk are I&I and Known Groundwater Fluctuation.
- CoF scores have a nominal impact on the highest risk pipes. CoF scores range from 1.00 to 3.34 out of 5. Some of the highest risk pipes are driven partially by association with critical facilities and to a lesser extent, proximity to water bodies.

Figure 4-2 compares the risk scores with the cumulative pipe length for the collection system. The figure supports the conclusion that there is low relative risk in the system based on the parameters and formulas used in this analysis. The figure shows that there is only approximately one mile of pipe with risk scores greater than 2.5 or higher.

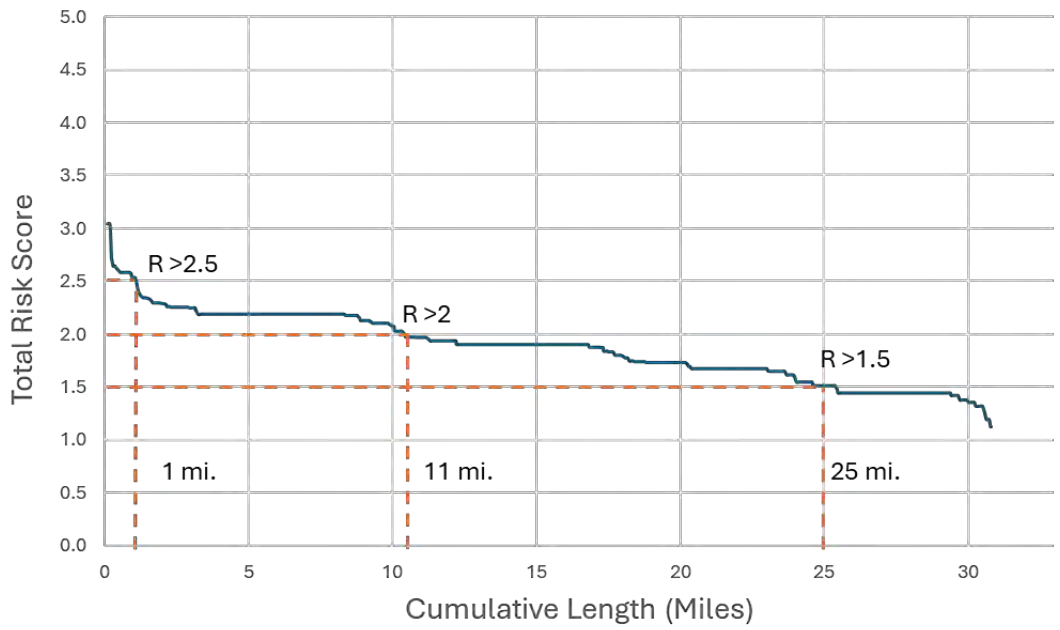


Figure 4-2. Cumulative Length Compared to Total Risk

Figure 4-3. Total Risk shows the distribution of total risk scores across the collection system. The highest-risk segments are primarily located North of Pudding Creek, along Oak Street and East Alder Street, near parks like the Coastal Trail, and in proximity to critical facilities such as schools and the hospital.

Figure 4-4. Likelihood of Failure highlights the estimated likelihood of pipe failure scores across the system. These results closely align with the high-risk areas shown in the Total Risk assessment, particularly North of Pudding Creek and within the City's dense central area. Elevated likelihood of failure in these areas is largely driven by I&I, and groundwater fluctuations.

Figure 4-5. Consequence of Failure shows the consequence of failure score for each pipe segment. The highest-consequence areas include those near critical facilities such as the high school, Mendocino Coast Hospital, and pipes near bodies of water.

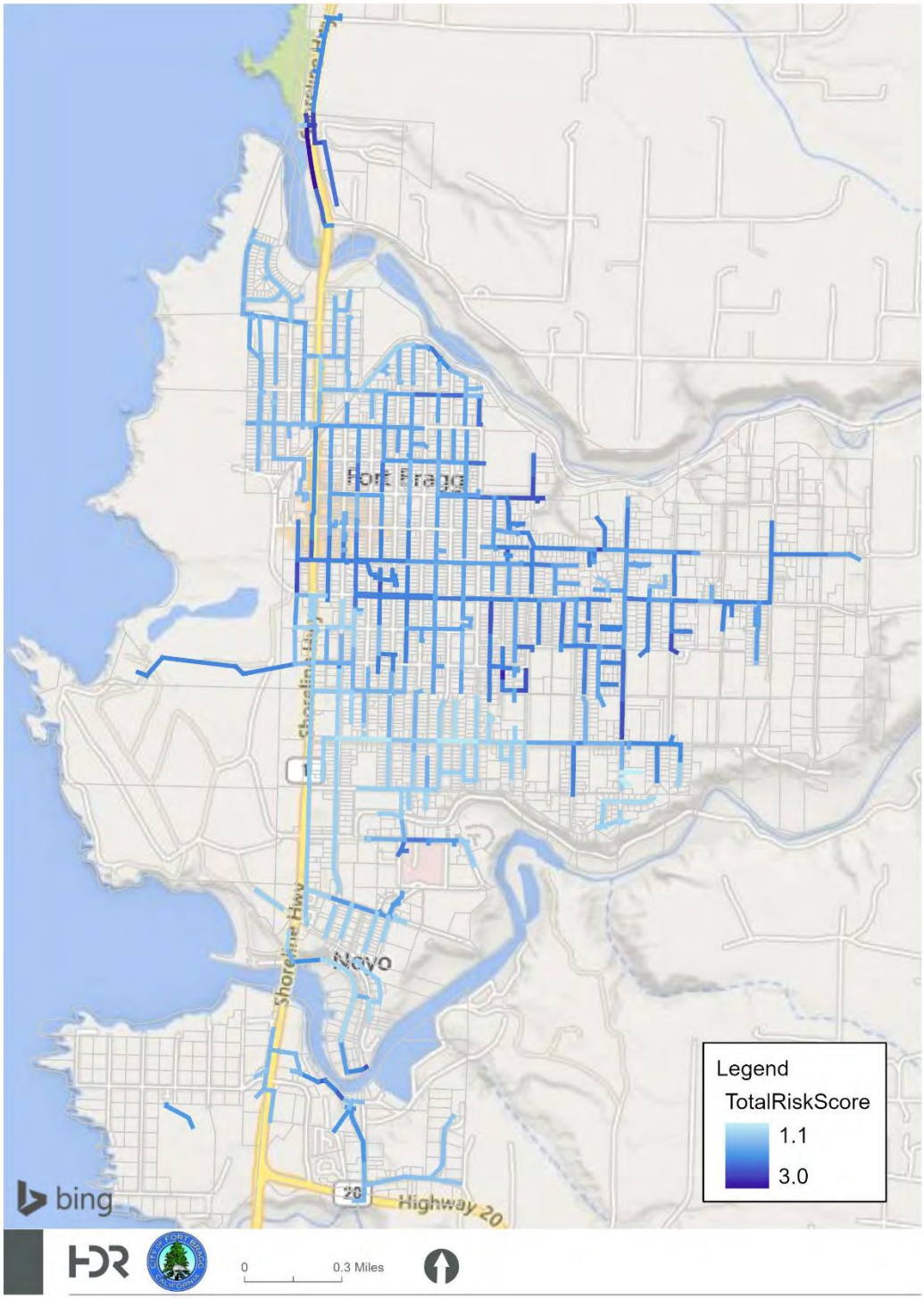


Figure 4-3. Total Risk

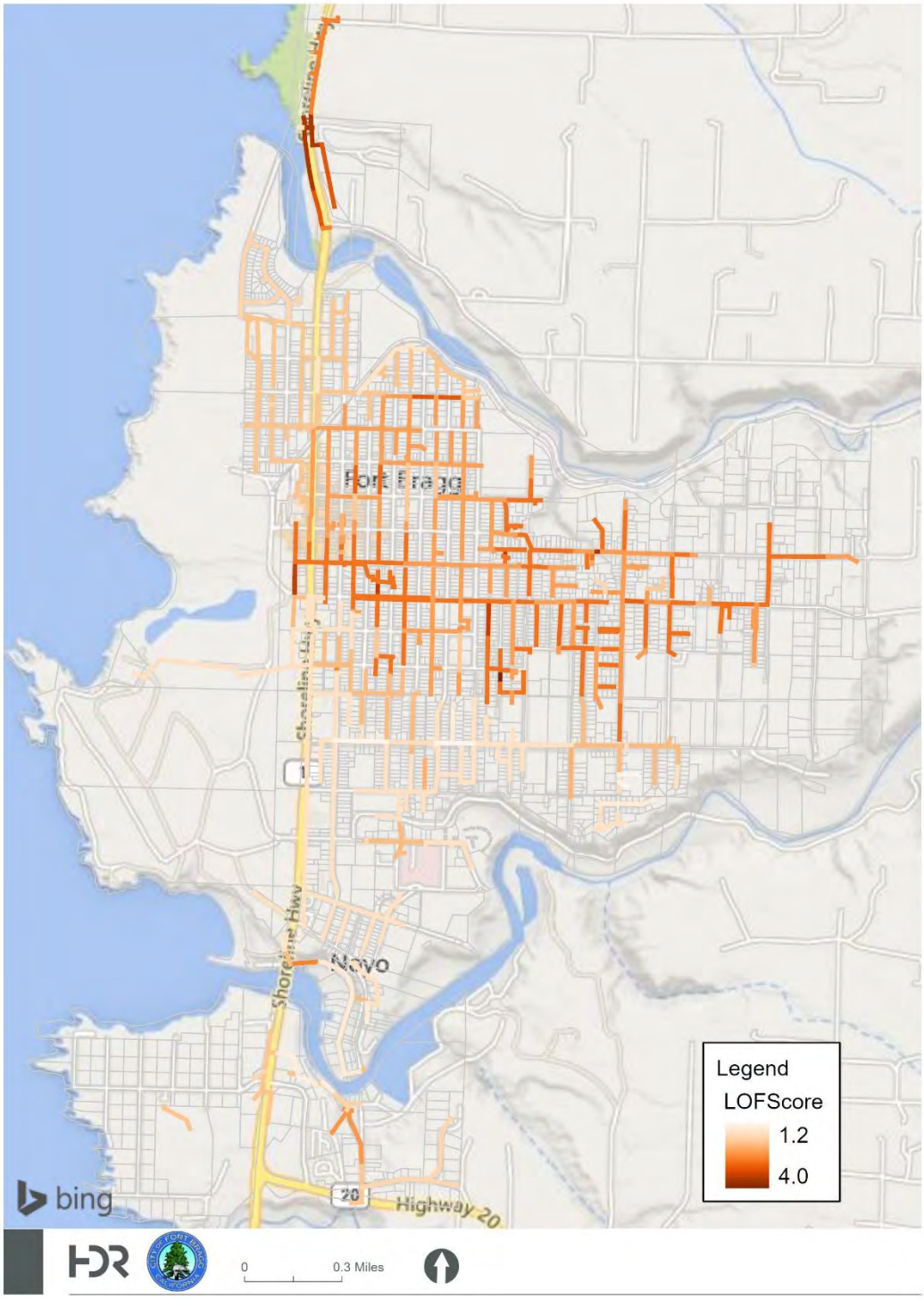


Figure 4-4. Likelihood of Failure

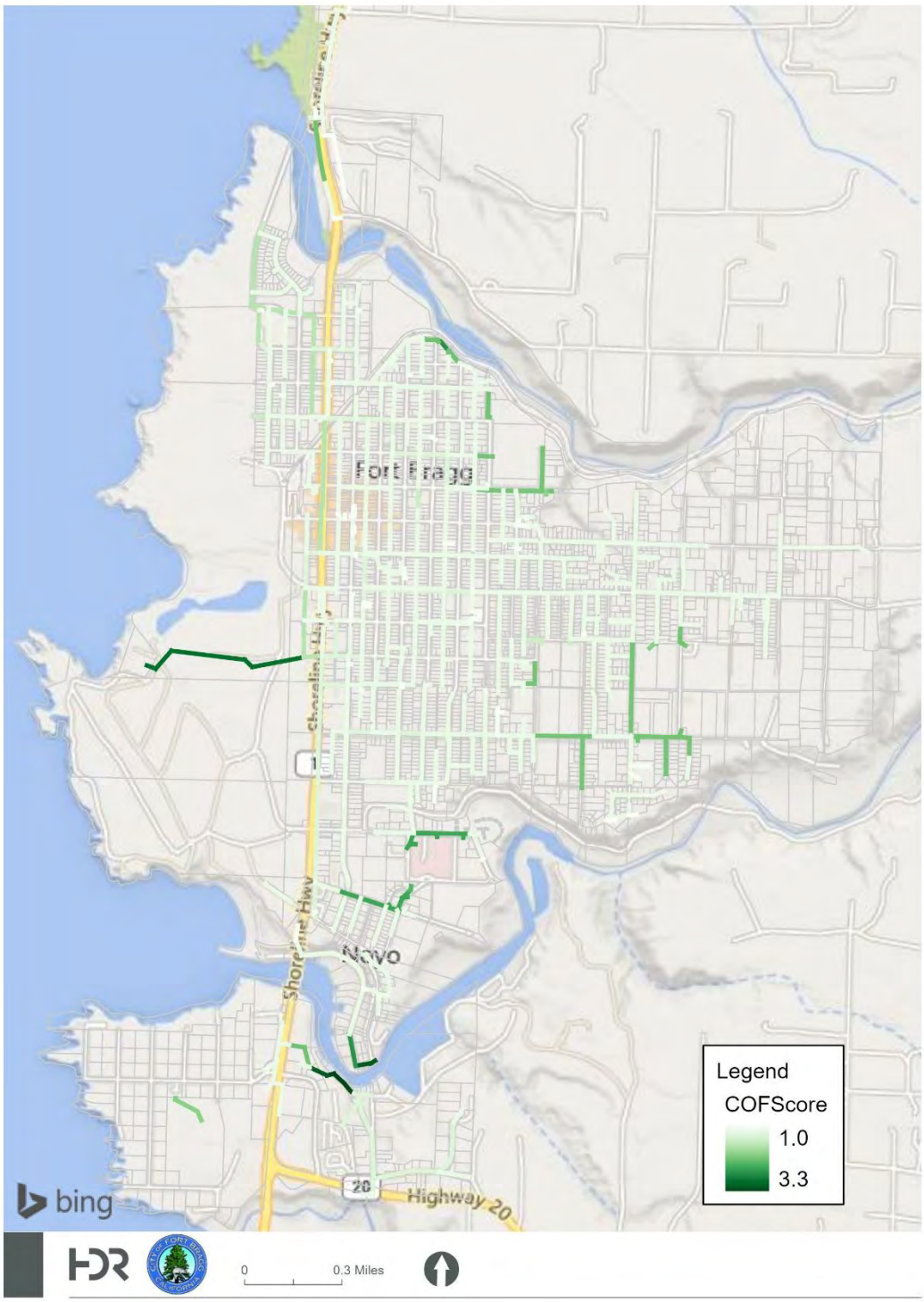


Figure 4-5. Consequence of Failure

4.4 Applying the Risk Model

The risk model provides a numerical value that quantifies the risk factors analyzed for the City. It provides a risk score for each of the pipes relative to the other pipes in the system. Because the risk model incorporates factors that the City believes are major risks to the collection infrastructure, it can be used as a guide to reduce risk of service failure in the system. The factors used for LoF and CoF represent indirect evidence of the condition and criticality of each of the pipes, however none of the factors used provide direct evidence of pipeline condition. Therefore, the risk model should be used to prioritize assessment and rehabilitation work, however it should not be relied upon as direct evidence that a rehabilitation action is needed. Additional assessment will be needed to determine the true condition and expected useful life of any given asset.

Examples of how the risk model can be used are:

- **Prioritizing condition assessment** – The risk model can be used to prioritize condition assessment to ensure that projects identified through the condition assessment results address the highest risk portions of the system.
- **Prioritizing existing capital projects** – When two or more projects are proposed (e.g. valve installation, pipeline expansion or enlargement) the risk model can be used to break a tie when other considerations are equal. If all other considerations are equal and one or more projects must be delayed, the pipe segment with the lower risk score can be differed because the risks are comparatively lower.
- **Prioritizing maintenance** – Frequently maintenance staff must choose between multiple demands on their time. Using the risk model to determine what maintenance activities should be done first enables the City to make risk-based maintenance decisions.

One of the main purposes of the risk model was to facilitate pipe selection for CCTV. The risk model as it currently stands provides indirect evidence of condition based on industry factors and environmental conditions. CCTV inspection provides direct evidence of the condition of the pipe and therefore is a better factor for determining LoF. However, only a small portion (7 %) of the system has been inspected and this portion was selected from the highest risk areas identified by the current risk model. It is recommended that the model continue to be used to select additional areas to visually inspect the pipe until a significant portion of the system is inspected. Once that is complete, the City should update the risk model to directly incorporate CCTV results and to reflect any changes based on pipe renewal. This will further strengthen the model so that it can be more effective in planning new capital projects, selecting priority areas for CCTV inspection, and prioritizing maintenance activities.

CHAPTER 5 CONDITION ASSESSMENT

5.1 Introduction

This section of the Master Plan discusses condition, renewal strategies, and capital renewal projects for each of the key asset groups in the wastewater collection system, lift stations, force mains, and gravity mains.

While earlier sections of this report address the collection system's current and projected capacity, even well-designed and adequately sized systems will naturally degrade and lose functionality over time. Proactive planning for asset renewal helps prevent unexpected failures, supports long-term cost management, and reduces unplanned strain on staff and financial resources. Renewal planning often relies on estimated useful lives (i.e. design life), however, age alone is not always an accurate measure of condition. Many assets continue operating effectively beyond their predicted lifespan and sometimes assets fail early due to environmental and other factors. Condition assessments allow the City to more accurately refine these lifespan estimates and direct renewal funding where it is most needed.

Because condition assessment can sometimes require significant cost and staffing resources, this section considers the cost-benefit of targeted assessments, helping the City to prioritize condition assessment only where it is expected to be cost-effective and provide greater value than relying on standard useful-life assumptions or run-to-failure strategies.

5.2 Lift Stations

As part of this master planning effort, a visual condition assessment was conducted for the City's six lift stations, South Noyo, North Noyo, Sanderson, Pudding Creek, Elm Street, and Noyo Point.

A detailed report of this assessment is included under Appendix G CHAPTER 10Appendix G - Lift Station Visual Assessment Report. The report provides an assessment of condition of these facilities, establishes a desktop estimate of remaining useful lives, and develops a cost opinion range for equipment renewal.

This section will summarize the condition rating methodology, key findings, rehabilitation recommendations, and capital project packaging.

5.2.1 Methodology

Assets relating to the following at each lift station were assessed as part of this condition assessment:

- Below-Grade Inlets & Wet Wells
- Valve Vaults
- Pumps
- Electrical Systems
- Structures
- Site Features

The condition assessment methodology is summarized in Table 5-1 below. Each asset in this assessment was assigned a condition rating from 1 to 5 (1 representing 'excellent' or 'new condition and 5 representing 'Imminent Failure'). Each of these ratings were associated with an evaluated remaining useful life (EVRUL) percentage, ranging from 100% to less than 5% of its original useful life (OUL). Each of these condition ratings is associated with a recommended maintenance effort. A detailed description of the logic applied to assign condition ratings is provided in Appendix G.

Table 5-1. Condition Rating Methodology

Condition Rating	Description	% of OUL EVRUL	Recommended Maintenance Effort
1	Excellent or New Condition	100%	Normal Preventive Maintenance
2	Good - Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	Fair – Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
4	Poor – Significant Deterioration	25%	Rehabilitation, if possible
5	Failure Imminent -Virtually Unserviceable	> 5%	Replace

5.2.2 Key Findings

Most components at each of the lift stations were assessed to be in fair to good condition with the following exceptions:

- **Elm Street Lift Station**
  Many structural components are in poor condition including asphalt driveway, manhole cover, perimeter fencing, building double door, building wall/floor interface, and entry sidewalk. The railing at the abandoned dry well has failed and should be replaced as soon as possible.

- **North Noyo Lift Station**
  The building door is in poor condition, and the site should be repaved.

- **Noyo Point Lift Station**
  The valve vault piping is in poor condition. The pump discharge piping is severely corroded and should be replaced as soon as possible.

- **Pudding Creek Lift Station**
  The generator building is in poor condition and has significant leaks, the building door is in poor condition. The electrical components inside of the pump building have degraded beyond their service life and should be replaced as soon as possible.

- **Sanderson Lift Station**
  The motor control center structure and the valve vault piping are in poor condition.

- **South Noyo Lift Station**
  The building door is in poor condition, and the site should be paved.

5.2.2.1 Recommendations & Project Packaging

All individual rehabilitation recommendations are summarized in Table 5-3 at the end of this section. The table includes a description of the recommendation, timeframe, and a replacement cost estimate. Each of the recommendations are categorized both by discipline (e.g. electrical, mechanical, civil/structural) and project category (e.g. paving, replace/repair structural, electrical, etc.).

These recommendations were also reviewed by City Operations staff, who identified the improvements that could be addressed by in-house maintenance staff and which ones should be contracted as capital improvements.

These categorizations were used to group and define capital projects.

For the Capital Improvement Plan, all the recommended improvements that have been identified to be contracted out have been aggregated into a single project. This is because the work will need to be planned strategically to be able to maintain collection system operations while each station is shut down for repairs and because the different rehabilitation activities are dispersed throughout the stations. The project may need to span two to three years to maintain operations and accommodate increased flows during wet weather seasons. The improvements during the 6-to-10-year timeframe have also been included since they are significantly smaller and would be more efficient to complete if each site is taken offline only once.

To estimate project costs, additional markups have been applied. The mark-up factors are shown below as percentages:

Project planning, staging, and contract overhead:	20%
Engineering:	12%
Construction Management:	12%
Contingency:	35%

These percentages are conservative to account for unanticipated costs due to current economic uncertainty in material and labor costs, as well as cost impacts for potential bypass pumping and staging over multiple years.

Total project costs are provided in Table 5-2 below. A more detailed breakdown of the raw project costs grouped by category across the 1-to-5 year and 6-to-10-year timeframe are shown in Table 5-3. Table 5-4 shows the individual renewal recommendations for each site that make up each of the project categories.

Table 5-2. Summary of Lift Station Improvements

Cost[a]	Component
$177,500	1-5 yr replacement costs
$48,000	6-10 yr replacement costs
$225,500	Raw cost total
$178,145	Project markups
$403,645.00	**Total project cost**

[a] Costs shown in 2025 dollars

Table 5-3. Lift Station Replacement Costs by Timeframe

Project Categories	Sites	Cost[a]
1-5 yr		
Electrical Improvements (Short Term)	Elm St, Pudding Creek, Sanderson	$20,500
Paving (Short Term)	Elm St, N. Noyo, S. Noyo	$33,000
Mechanical Repair/Replace (Short Term)	Elm St, Noyo Point, Sanderson	$42,500
Civil Repair/Replace (Short Term)	Elm St, N. Noyo, Noyo Point, Pudding Creek, S. Noyo	$33,500
Seal/Recoat (Short Term)	Elm St, N. Noyo, Pudding Creek, S. Noyo	$33,000
Wet Well Repair (Short Term)	N. Noyo, Pudding Creek, S. Noyo	$15,000
6-10 yr		
Electrical Improvements (6-10 yr)	Noyo Point	$1,000
Paving (6-10 yr)	Noyo Point, Sanderson,	$5,000
Mechanical Repair/Replace (6-10 yr)	Noyo Point	$4,000
Civil Repair/Replace (6-10 yr)	Noyo Point, Pudding Creek, Sanderson	$15,500
Seal/Recoat (6-10 yr)	Elm St, N. Noyo, Pudding Creek	$7,500
Wet Well Repair (6-10 yr)	Sanderson	$15,000
In-House		
Electrical In-House	Noyo Point, Pudding Creek	$5,500
Mechanical Repair/Replace In House	Noyo Point, S. Noyo, Sanderson	$7,000
Exercise Spare Pump In House	Elm St	$500
Civil Repair/Replace In House	Elm St, Sanderson	$6,000
Seal/Recoat In House	Pudding Creek, Sanderson	$2,500
Wet/Well In House	Pudding Creek	$1,000

[a] Costs shown in 2025 dollars

Table 5-4. Summary of Lift Station Improvements

Location	Improvement	Timeframe (yrs)	Replacement Cost Estimate [a]	Project Type	Discipline	Project Category
S. Noyo	Surface prepare and coat the top of the wet well structure where exposed aggregate visible	<5	$5,000	Capital Improvement	Civil/Structural	Wet/Dry well
S. Noyo	Recoat handrails	<5	$2,000	Capital Improvement	Civil/Structural	Seal/Recoat
S. Noyo	Replace building door	<5	$1,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
S. Noyo	Install asphalt paving and base to dirt area adjacent to wet well	<5	$15,000	Capital Improvement	Civil/Structural	Paving
S. Noyo	Recoat/spot repair damaged coating inside the abandoned drywell	<5	$2,000	Capital Improvement	Civil/Structural	Wet/Dry well
S. Noyo	Add net or grate under to valve vault hatch	<5	$3,000	In-House Repair	Mechanical	Replace/Repair Structure
N. Noyo	Surface prepare and coat the top of the wet well structure where exposed aggregate visible	<5	$5,000	Capital Improvement	Civil/Structural	Wet/Dry well
N. Noyo	Recoat handrails	<5	$2,000	Capital Improvement	Civil/Structural	Seal/Recoat
N. Noyo	Replace building door	<5	$1,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
N. Noyo	Replace site paving and base	<5	$5,000	Capital Improvement	Civil/Structural	Paving
N. Noyo	Recoat/spot repair damaged coating inside the abandoned drywell	<5	$2,000	Capital Improvement	Civil/Structural	Wet/Dry well
N. Noyo	Recoat areas of peeling coating of conduits	6-10	$1,000	Capital Improvement	Civil/Structural	Seal/Recoat
Sanderson	Replace MCC Fiber Reinforced Plastic (FRP) panel	<5	$5,000	Capital Improvement	Electrical	Electrical
Sanderson	Replace MCC wood structure roof and framing. Extend the roof farther past the panel	<5	$5,000	In-House Repair	Civil/Structural	Replace/Repair Structure

Location	Improvement	Timeframe (yrs)	Replacement Cost Estimate [a]	Project Type	Discipline	Project Category
	to provide additional UV protection of panels; or					
Sanderson	Alternatively replace existing wood structure with a new ventilated prefabricated housing	6-10	$10,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Sanderson	Coat the interior of the wet well structure	6-10	$15,000	Capital Improvement	Civil/Structural	Wet/Dry well
Sanderson	Provide backup system to pump controls	<5	$4,000	In-House Repair	Mechanical	Replace/Repair Structure
Sanderson	Provide a safety net or grate under wet well hatch	<5	$1,000	In-House Repair	Mechanical	Replace/Repair Structure
Sanderson	Coat the upper wall of the valve vault	6-10	$1,000	In-House Repair	Civil/Structural	Seal/Recoat
Sanderson	Replace the valve vault piping	<5	$12,000	Capital Improvement	Mechanical	Replace/Repair Structure
Sanderson	Regrade the site entrance	6-10	$3,000	Capital Improvement	Civil/Structural	Paving
Pudding Creek	Remove and recoat the coatings on the underside of the roof inside and outside building, repair roof and wall cracks, repair leaks through the roof vents inside generator building	<5	$20,000	Capital Improvement	Civil/Structural	Seal/Recoat
Pudding Creek	Replace or prepare and recoat generator parts showing corrosion	<5	$10,000	Capital Improvement	Electrical	Electrical
Pudding Creek	Replace failed UPS (battery)	<5	$5,000	In-House Repair	Electrical	Electrical
Pudding Creek	Prepare and recoat transfer switch panel	6-10	$1,000	Capital Improvement	Electrical	Electrical
Pudding Creek	Prepare and recoat portion handrail	6-10	$1,000	Capital Improvement	Civil/Structural	Seal/Recoat
Pudding Creek	Remove surface corrosion on engine silencer piping	<5	$1,000	Capital Improvement	Civil/Structural	Seal/Recoat

Location	Improvement	Timeframe (yrs)	Replacement Cost Estimate [a]	Project Type	Discipline	Project Category
Pudding Creek	Repair top portion of exterior Concrete Masonry Unit (CMU) wing wall	6-10	$1,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Pudding Creek	Remove surface corrosion on generator exhaust louver	6-10	$1,000	Capital Improvement	Civil/Structural	Seal/Recoat
Pudding Creek	Prepare and recoat monorail	6-10	$1,000	Capital Improvement	Civil/Structural	Seal/Recoat
Pudding Creek	Replace all existing electrical inside the pump building	<5	$5,000	Capital Improvement	Electrical	Electrical
Pudding Creek	Prepare and recoat pump discharge piping	<5	$1,000	Capital Improvement	Mechanical	Seal/Recoat
Pudding Creek	Prepare and coat the top wall of the wet well	<5	$1,000	Capital Improvement	Civil/Structural	Wet/Dry well
Pudding Creek	Prepare and recoat portions of the pump building walls	6-10	$1,500	Capital Improvement	Civil/Structural	Seal/Recoat
Pudding Creek	Provide maintenance and remove surface corrosion of the wet well access hatch	<5	$1,000	In-House Repair	Civil/Structural	Wet/Dry well
Pudding Creek	Replace generator building door	<5	$2,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Replace asphalt driveway	<5	$10,000	Capital Improvement	Civil/Structural	Paving
Elm St	Replace manhole cover	<5	$1,000	In-House Repair	Civil/Structural	Replace/Repair Structure
Elm St	Replace inlet slide gate	<5	$10,000	Capital Improvement	Mechanical	Replace/Repair Structure
Elm St	Recoat bypass piping connection	<5	$500	In-House Repair	Civil/Structural	Seal/Recoat
Elm St	Replace handrail into abandoned drywell	<5	$5,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Replace perimeter fencing	<5	$15,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Repair exterior concrete slab over abandoned drywell	<5	$2,000	Capital Improvement	Civil/Structural	Seal/Recoat

Location	Improvement	Timeframe (yrs)	Replacement Cost Estimate [a]	Project Type	Discipline	Project Category
Elm St	Remove surface corrosion from exterior electric service panel	6-10	$500	Capital Improvement	Civil/Structural	Seal/Recoat
Elm St	Remove surface corrosion from exterior radio antenna	6-10	$500	Capital Improvement	Civil/Structural	Seal/Recoat
Elm St	Replace exterior FRP conduit	<5	$500	Capital Improvement	Electrical	Electrical
Elm St	Repair small section of building roof	<5	$1,500	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Replace building double door	<5	$2,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Exercise spare self-priming pump	<5	$500	In-House Repair	Maintenance	Maintenance
Elm St	Prepare and recoat pump frames	6-10	$1,000	In-House Repair	Civil/Structural	Seal/Recoat
Elm St	Repair underside of building roof coating	<5	$1,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Elm St	Check and seal the interface between the building perimeter wall and floor	<5	$4,000	Capital Improvement	Civil/Structural	Seal/Recoat
Elm St	Remove surface corrosion from generator louver	6-10	$500	Capital Improvement	Civil/Structural	Seal/Recoat
Elm St	Remove surface corrosion from engine silencer piping	6-10	$500	Capital Improvement	Civil/Structural	Seal/Recoat
Elm St	Replace concrete entry sidewalk	<5	$3,000	In-House Repair	Civil/Structural	Paving
Elm St	Prepare and recoat exterior water piping	6-10	$1,000	In-House Repair	Mechanical	Seal/Recoat
Noyo Point	Replace MCC panel support	6-10	$3,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Noyo Point	Replace wet well floats and rails	6-10	$4,000	Capital Improvement	Mechanical	Replace/Repair Structure
Noyo Point	Replace the pump discharge elbows	<5	$1,500	Capital Improvement	Mechanical	Replace/Repair Structure

Location	Improvement	Timeframe (yrs)	Replacement Cost Estimate [a]	Project Type	Discipline	Project Category
Noyo Point	Repair/recoat the valve vault coating	6-10	$1,500	Capital Improvement	Civil/Structural	Replace/Repair Structure
Noyo Point	Replace the valve vault piping and valves	<5	$15,000	Capital Improvement	Mechanical	Replace/Repair Structure
Noyo Point	Add nets or grates under the wet well and valve vault hatches	<5	$3,000	In-House Repair	Mechanical	Replace/Repair Structure
Noyo Point	Provide sunshade over MCC and electrical service panel	<5	$5,000	Capital Improvement	Civil/Structural	Replace/Repair Structure
Noyo Point	Regrade site	6-10	$2,000	Capital Improvement	Civil/Structural	Paving
Noyo Point	Remove abandoned electrical junction box in wet well	<5	$500	In-House Repair	Electrical	Electrical

[a] Costs shown in 2025 dollars

5.3 Force Mains

The City currently operates six force mains in the wastewater collection system shown in Figure 5-1. These include:

- Elm Street Lift Station Force Main, a 2,293 ft 14” diameter Techite pipeline
- North Noyo Force Main, a 1,510 ft 12” diameter Techite pipeline
- South Noyo Force Main, a 3,500 ft 10” diameter Techite and Ductile Iron pipeline
- Pudding Creek force main, a 2,922 ft 12” diameter HDPE pipeline
- Noyo Point Force Main, an 819 ft 3” PVC pipeline
- Noyo Heights (Sanderson) Force Main, a 787 ft 4” pipeline of unknown material

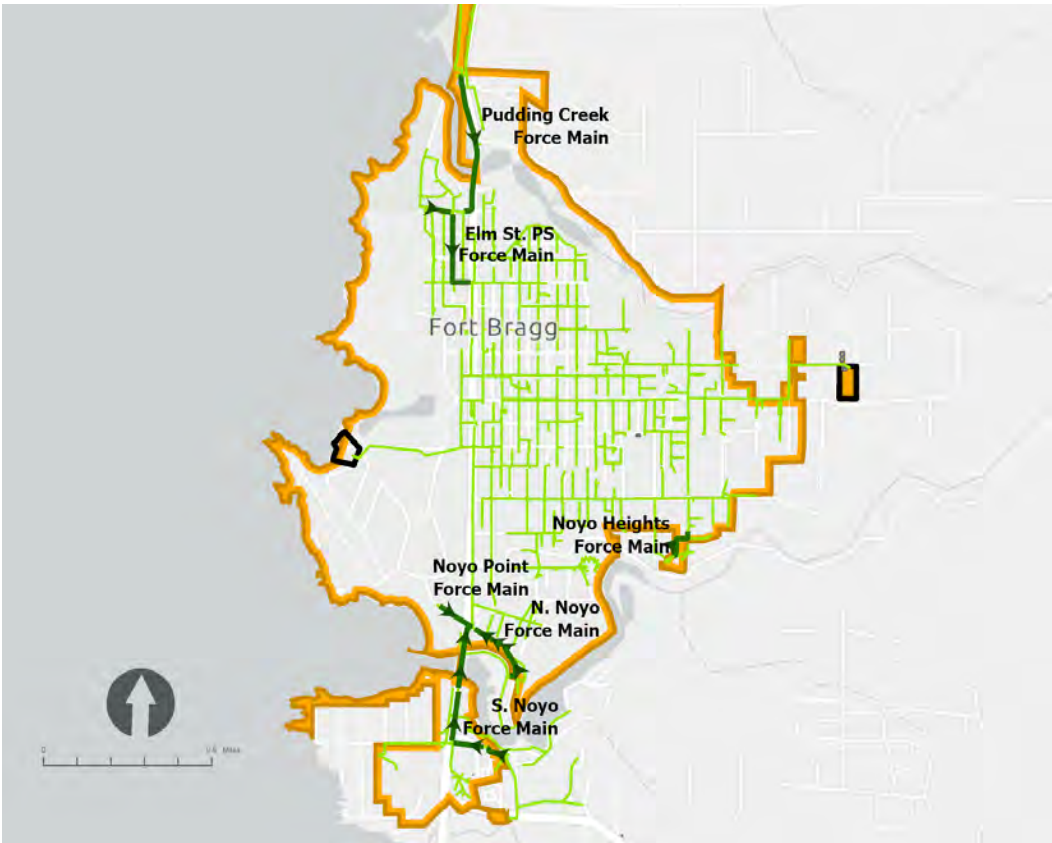


Figure 5-1. Force Mains

The Techite force mains are of particular concern for potential failure. Techite, or fiberglass-reinforced plastic mortar (RPM) pipe is a composite pipe material and was commonly used for wastewater and drainage applications beginning in the latter half of the 20th century. The pipe consists of glass fiber reinforcement embedded in a resin matrix, typically combined with a sand or aggregate “mortar” core to provide stiffness. Long-term field performance of Techite pipe has demonstrated several limitations that can significantly impact reliability as the pipe ages. This type of pipe has been found to fail catastrophically and without warning, and conventional condition assessment methods do not provide a reliable predictor of failure.

The City's existing Techite lines are 50-60 years old and are reaching the end of their design life. Therefore, proactive rehabilitation and/or replacement of the City's Techite pipelines is recommended.

The City has already replaced the Pudding Creek Force Main, formerly a Techite pipeline, with a new HDPE line. The City is also currently executing projects to rehabilitate the North and South Noyo force mains using CIPP technology. Consequently, these lines will not need replacement or rehabilitation in the next 10 years.

The Noyo Point Force Main is a newer 3" PVC line that serves approximately four residences. The likelihood and consequence of failure of this line is low, so it is not recommended for replacement or rehabilitation in the next 10 years.

The Noyo Heights (Sanderson) Force Main is also a small line servicing a few residential properties. The pipe material is unknown, but it's 4" diameter makes it unlikely to be Techite (Techite was typically only used for large diameter pipes). Based on field observations during the Noyo Heights Pumps station condition assessment, it's likely this line is steel. However, the pipe material should be verified during the valve vault piping replacement project at this location outlined in Section 1.1. Because this line also has low likelihood and consequences of failure, it is not recommended for replacement or rehabilitation in the next 10 years.

The Elm Street Force Main is a critical 14" Techite line connected to the Elm Street Lift Station that conveys wastewater from most of the north-western portion of the city (Figure 5-2). Therefore, it is recommended for rehabilitation as soon as practicable. CIPP is the recommended rehabilitation method. As the structural integrity of the old Techite pipe is not assured, it is recommended that the CIPP be designed to replace the full structural strength of the Techite line. This project is identified as project F-01 in the Capital Plan, Chapter 9. Unit costs for the CIPP rehabilitation were based on quotes the City received for the current CIPP rehabilitation project for the North and South Noyo Force Main rehabilitation project.

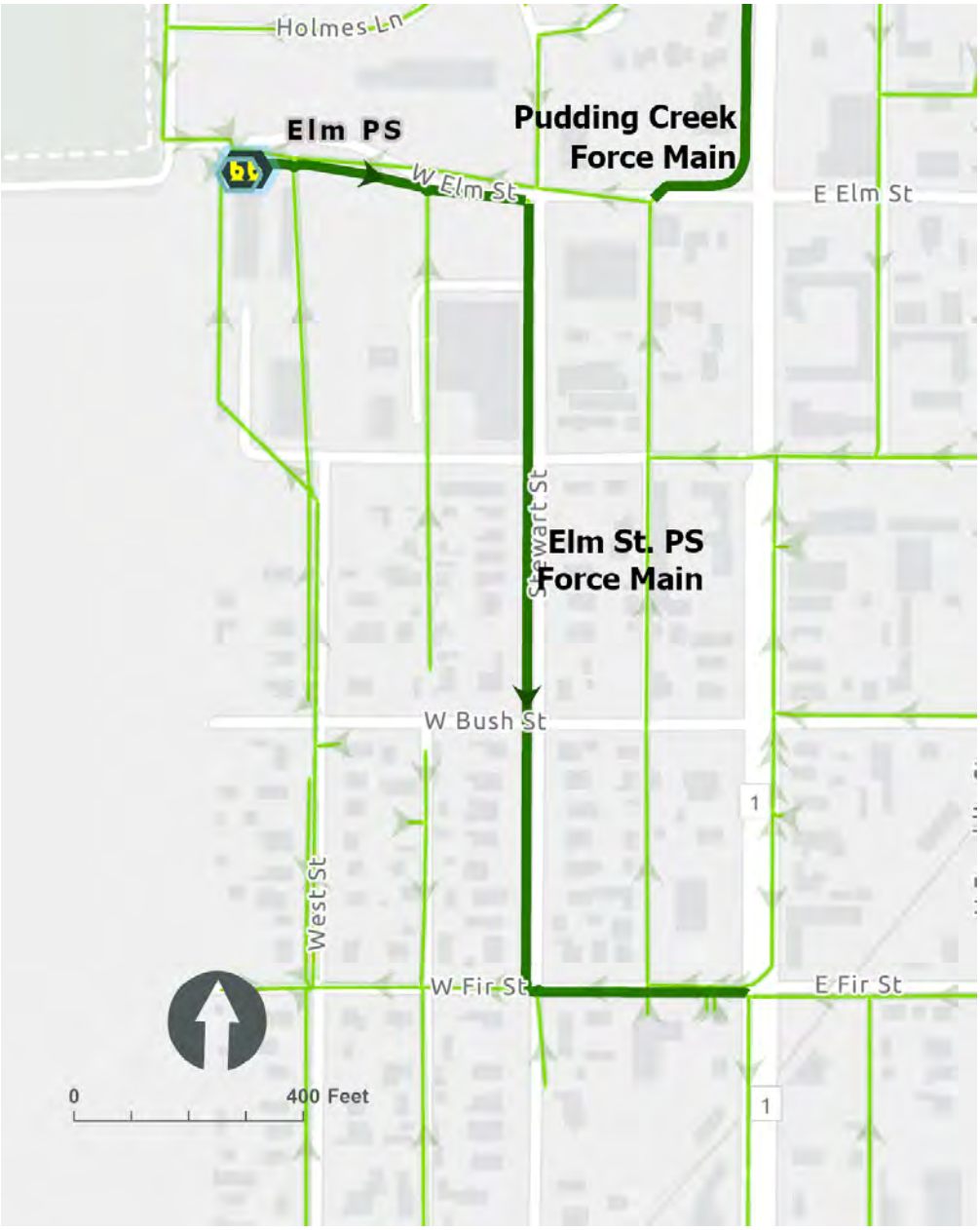


Figure 5-2. Elm Street Lift Station Force Main

5.4 Gravity Mains

As part of this master plan, the City allocated budget to inspect approximately 1.5 miles (19 individual pipe segments) of the system's highest-priority gravity mains using CCTV. While this represents only a small portion of the overall system (approximately 4%), it includes the portion of the system most suspected to be in poor condition. These pipes were selected first based on City staff knowledge of recurring maintenance concerns. The remaining segments were then prioritized by focusing on high-risk pipes located within high-inflow basins (identified during the flow monitoring effort described in Chapter 3), specifically basin FM-04 (located in the center of the City, spanning from Oak Street between South Whipple Street and South Sanderson Way) and basin FM-01 (north

of Pudding Creek). The selected pipe segments can be found in Appendix E - CCTV Inspection Plan.

Targeting condition assessment and repair efforts in these high-inflow basins prioritizes the reduction of RDII. RDII is generally associated with system overflows and increased demand at the wastewater treatment plant during peak wet-weather events, making repairs in these areas particularly impactful.

A National Association of Sewer Service Companies (NASSCO) pipeline assessment certification program (PACP) review of the CCTV videos for the inspected gravity mains was conducted. The inspection process classifies defects encountered along the pipe length and assigns standard codes to characterize the defects. The CCTV defect coding was imported into Aquanuity's AquaTwin platform and evaluated using NASSCO PACP–based criteria, in accordance with the decision support framework defined in the section below.

Of the 19 gravity mains inspected, 15 inspections were complete and successfully captured data across the entire pipe segment. The remaining four were partial inspections, which were required to conclude prematurely due to either significant offsets or root intrusion. In these cases, inspectors were unable to complete a reverse inspection because of accessibility constraints or because the opposite terminal of the line ended at a cleanout, through which the CCTV inspection camera could not pass. The full inspection reports are found in Appendix F - CCTV Results.

5.4.1 Decision Support Framework

NASSCO PACP condition ratings consist of two primary components. Operations and maintenance (O&M) codes, such as root intrusion or deposited grease, identify defects that can largely be mitigated through adjustments to O&M practices. For example, increased cleaning frequency or routine root cutting along the pipe to mitigate root intrusion. Structural condition defects relate to the structural integrity of the pipe and include issues such as cracking or broken pipe. All defects are scored on a scale of 1 through 5, with a score of 5 representing the highest severity/worst condition.

Industry best practices recommend repair or replacement for grade 4 or 5 structural defects, such as collapsed pipe (grade 5) or breaks (grade 4 or 5, depending on severity). Grade 5 defects are typically recommended for immediate repair within the next 5 years, while grade 4 defects are generally recommended to be addressed with lower urgency within 6 to 10 years. Some grade 4 defects, such as cracking or minor offsets, may not warrant significant intervention but should be monitored for signs of worsening condition.

O&M defects rated grade 3 or higher generally indicate maintenance concerns that may require more frequent intervention to maintain full pipe functionality and reduce the risk of sanitary sewer overflow events.

A particular focus of the City, especially for pipes located within basins known to experience high RDII, was the potential presence of historical stormwater system connections that may still exist and contribute to high inflow during wet weather. Accordingly, the CCTV review placed special emphasis on identifying areas of potential cross connections, with the intent of planning future targeted smoke or dye testing activities to confirm their presence where suspected.

Based on this focus, a decision support framework (Table 5-5) was developed and aligned with City priorities for application to the CCTV data collected as part of this gravity main condition assessment effort.

Table 5-5. Decision Support Framework

Grade/Code Type	Recommendation
Structural Defect Grade	
5	Repair within 1 to 5 years
4	Repair within 6 to 10 years
3	Monitor condition on a more frequent basis
0 to 2	Monitor condition on standard schedule
O&M Defect Grade	
3 to 5	Consider increasing cleaning frequency or source control
<3	Clean on standard schedule
RDII-Specific Defects	
Infiltration Runner/Gusher or Tap Active	Un-traceable connections (i.e. infiltration or taps that can't be clearly connected to a nearby property, especially those with high flow) should be smoke or dye tested and rehabilitated if cross-connections are confirmed

5.4.2 Recommendations

Application of the Decision Support Framework to the PACP defects identified eight pipes with O&M or structural defects coded as grade 4 or higher.

One pipe (Swr-Grvty-Mn-5523) was found to have O&M defects that scored grade 3 or higher and had multiple incidents of root intrusion. Since this pipe was unable to be fully inspected due to a large rootball, cleaning and re-inspection is recommended within the next 5 years to evaluate potential pipeline lining needs.

Of the remaining seven pipes, two were assessed during video review as non-critical at this time and are recommended for re-inspection in the 6-to-10-year timeframe.

Only one infiltration defect was coded, identified as an Infiltration Dripper-Lateral (IDL). However, the lateral connection was clearly traced back to a known property and was therefore dismissed as a potential for stormwater cross-connection. Review of the identified lateral connections revealed no obvious untraceable connections, and as a result, no targeted smoke or dye testing is recommended at this time. A summary of gravity main repair recommendations is presented in

Table 5-6, below.

Table 5-6. Gravity Main Repair Recommendations

#	AssetID	Grade	Diameter	Length	Details	Recommendation	CIP ID
1	Swr-Grvty-Mn-4789	4	10"	763	2 JOMs @ 172.9	Structural defects to be addressed by CIP project P-05	P-05
2	Swr-Grvty-Mn-5099	5	8"	200	JOL @ 175.2. Difficult access - East side of Hwy 1	CIPP	R-3
3	Swr-Grvty-Mn-5179	4	6"	522	Multiple JOMs throughout line, not lined	CIPP	R-3
4	Swr-Grvty-Mn-5810	5	8"	241	JOL @ 27.1	CIPP	R-3
5	Swr-Grvty-Mn-5150	5	6"	705	JOL @ 480.9 and 464.4 - Liner Failure? Review Picture	CIPP	R-3
6	Swr-Grvty-Mn-5523	4	6"	335	Large Root Ball - unable to inspect majority of pipe	Clean & re-inspect	R-1
7	Swr-Grvty-Mn-5103	4	8"	496	JOM @ 22.2	Recommended for re-inspection > 5yrs	R-4
8	Swr-Grvty-Mn-5159	4	6"	259	JOM @ 0.1	Recommended for re-inspection > 5yrs	R-4

CHAPTER 6 GEOTECHNICAL DESKTOP ASSESSMENT

6.1 Geologic Assessment and Hazards

HDR prepared a geologic assessment and hazard analysis related to the City's drinking water distribution system as part of the water distribution master plan development in 2025. This assessment was presented in a technical memorandum entitled *Geotechnical Evaluation of City of Fort Bragg Seismic Safey Elements Related to Water Distribution Systems* dated Apri 1, 2025. This report was included as Appendix J of the Water Distribution System Master Plan Report. In the memorandum it is was stated that "Although the memorandum was prepared specifically as part of the water distribution master planning effort, it is applicable to other City agencies responsible for infrastructure such as the stormwater and sewer systems." Rather than repeat the context of that memorandum herein, it is included as Appendix I to this document for background on the city geotechnical and geologic conditions and related seismic and non-seismic hazards. Most of the identified seismic and non-seismic hazards are applicable to the City's wastewater collection system, though some are related to existing water distribution system alignments, such as the distribution main that crosses Noyo River, the Noyo River intake, and the identified slope instability identified along the banks of the Noyo River and Pudding Creek where existing water distribution pipelines and apparent facility are located within the creek or adjacent to identified potentially unstable slopes.

The memorandum is organized as follows:

- Topography and Geology
- Emergency Access
- Water Supply and Distribution System
- Geotechnical Condition Assessment
- Geologic and Non-Geologic Hazards
- Areas of Concern for Rehabilitation of Water Distribution Facilities
- Limitations

This section of the report addresses the Areas of Concern for the Rehabilitation of the Sewer Collection Facilities that also includes a summary of the Sewer Collection system described in more detail in other sections of this report.

6.2 Summary of Wastewater Collection System

The City's wastewater collection system evolved from a smaller localized collection system in the late 1880s to a modern system that included the construction of a wastewater treatment plant in 1971. The plant was significantly upgraded between 2017 and 2022. The wastewater treatment plant upgrades were designed by HDR. The existing collection system consists of 30 miles of pipelines, gravity pipes, six lift stations, and an ocean outfall. The system generally consists of gravity wastewater collection lines within roadways that slope from the east to west, following the general ground topography that tie to service lines following the intersecting streets in a north/south direction. There are a number of facilities that incorporate small lift stations to connect to the

wastewater system and there are larger lift stations that service areas that cannot be connected to the wastewater treatment plant by gravity as follows:

- **South Side of Noyo River**
  South Noyo and College Lift Stations
- **North Side of Noyo River**
  Noyo Point, North Noyo, and Noyo Heights Lift Stations
- **South of Pudding Creek**
  Elm Street Lift Station
- **North of Pudding Creek**
  Pudding Creek Lift Station

The City has also documented areas of high groundwater within sewer line alignment between East Redwood and Cedar Street on the north and East Chestnut on the south. High Groundwater has also been noted along the Noyo River, likely associated with the Noyo River induced groundwater level and North of Pudding Creek at the Ocean Lake Adult Mobile Home Park likely induced by impounded reservoir at the mobile home park.

The approximately 30 miles of pipelines are reported to be a combination of vitrified clay pipe (VCP), CMP, Asbestos Cement Pipe (ACP) and more modern plastic pipe. The VCP likely predates the 1971 system upgrades, ACP was typically installed in the 1970s and modern PVC and ductile iron pipe were used as ACP manufacturing was phased out.

HDR also understands that some of the older sewer lines were likely once part of a combined stormwater and sewer system and it is unknown how storm water connections were abandoned once the combined sewer was discontinued, likely with the construction of the treatment plant.

The sewer system pipe network was likely constructed with granular pipe bedding that could act as a subsurface drain system hydraulically connecting upland areas with the areas to the west. Over time this induces artificially elevated groundwater levels within and adjacent to the pipe trenches. Also, older VCP and ACP and its connections can fail resulting in leakage into the granular ballast.

6.3 Areas of Concern for the Rehabilitation of the Wastewater Collection Facilities

Section 8 of HDRs 1 April 2025 memorandum address seismic and non-seismic hazards the City of Fort Bragg infrastructure including:

- Seismicity
- Fault Offset, Strong Ground Shaking Liquefaction and Tsunami Impacts
- Local Geology including presence of:
  - Fill,
  - Coastal and Inland Marine Deposits,
  - Colluvium along incised river and creek slopes,
  - Alluvium and
  - Beach deposits.

- Corrosivity
- Erosion
- Flooding
- Fire Hazards
- Extreme Weather Events
- Chemically Impacted Sites

The hazards associated with each of these items are included by reference into this report and not reproduced herein.

Areas of Concern are discussed in Section 9 of the memorandum including Densification and Liquefaction, Corrosivity, Groundwater, Seismic Response and Bluff Erosion. The following sections supplement those discussions addressing:

- Occurrence of High Groundwater,
- Slope Instability and
- Seismically Induced Deformation

6.3.1 Occurrences of High Groundwater

The City has noted the occurrences of groundwater or seepage into the utility trenches at a number of locations, as documented in HDR's GIS inventory. The locations of the elevated groundwater can be summarized as follows

1. Noyo Harbor (North and South areas)

2. Cypress Street, focused between Georgia Pacic Haul Road and River Drive, west of the hospital

3. Central Fort Bragg between East Chestnut Street on the south and East Redwood on the north, and between North Main Street on the west and N/S Whipple on the east (about 9 blocks), then moving east 3 blocks between South Harold Street on the west to the east, to California Way on the east (13 blocks), and

4. Day Use Road between the Pudding Creek lift station and the Ocean Lakes mobile home park.

The occurrence of groundwater is likely based on local subsurface conditions and trench backfill material. A brief discussion of each area is presented below.

- **Noyo Lift Station**
  The North and South Noyo lift stations are located at the toe of the existing bluff slope with ground surface elevations of approximately Elev 20 feet (+/- 5 feet) and the wet/dry wall sump base slabs are likely found on the underlying bedrock. However, the force main lines from the sumps and within the utility trenches are likely at a depth of 4 feet within near surface fill and alluvium. Being located at the toe of the steep slope and adjacent to the Noyo River, groundwater conditions are likely to vary based on tide fluctuation and surface run-on/off and associated infiltration in the lower harbor areas. Water infiltration can then accumulate in the granular trench backfill and can be a nuisance if interconnected with extended trench lengths without the use of trench dams.

- **Cypress Street**
  The area of Cypress Street has historically been an open space area with limited surface gradient to promote surface flow. Therefore, rainfall and irrigation water infiltrates into the subgrade resulting in a localized perched water zone. Review of aerial photographs indicate that there appears to be a natural drainage extending from Sequoia Circle northwest toward Cypress Street. Review of 1920 topographic map of Fort Bragg (USACE Tactical Map) indicates there was a mapped drainage that extended to the southeast to the Noyo River and to the northwest to a water feature at the lumber plant, which has been interrupted overtime with subsequent development and roadway construction.

Figure 6-1. Cypress St. Perched Water

- **Central Fort Bragg**
  Central Fort Bragg has generally been in its current configuration for many decades, located on the uplifted terrace that gently slopes from east to west with a relative uniform 160-foot drop in elevation in 9,300 feet (approximately 1.4 feet in 100 feet). The topography generally drains to the north towards Pudding Creek, however, there is local cross drainage. For example, East Alder Street and East Maple Streets both appear to be in topographic low areas and collect stormwater with increased infiltration / elevated groundwater.

- **Pudding Creek Lift Station**
  Pudding Creek Lift Station is located adjacent to the north bank of Pudding Creek with a ground surface of approximately Elev. 20 feet. The lift station wet/dry wells are approximately 18 feet deep and are likely found on the underlying bedrock. As with the other lift stations,

the force main valves and piping is located at a depth of 4 feet below ground surface and is likely located in the overlying alluvium. The lift station is located directly downstream of the lake at the Ocean Lakes Mobile home Park with the lake outfall immediately south of the lift station. Seepage from the lake is likely the source of high groundwater.

6.3.2 Slope Instability

The State Of California has identified the steep creekbanks of Noyo River and Pudding Creek as having a high likelihood of slope instability. The North and South Noyo lift stations could be at risk for the material generated from a slope failure above the lift stations and lift stations, force mains and collection lines are located along the top of slope are also potential at risk for slope deformation undermining the facilities, such as at the south end of Noyo Heights and Sanderson Street South. The risk is greater when the facilities setback less than 20 feet from the top of slope.

6.3.3 Seismically Induced Deformation

The depth of the collection system varies across the city and loose, coarse grained and saturated terrace deposits are susceptible to densification because of strong seismic ground shaking. The amount of settlement can be highly variable and place these facilities at risk for differential movement that could result in change in pipe slopes and, if the magnitude of settlement is large, possible pipe/joint offset. Pipe settlement could also induce pipe joint damage and accompanying leakage, that could also be a source for observed elevation ground water.

There are no pipelines crossing the river or creek and the potential for liquefaction-induced breaks in stream is highly unlikely. However, there are pipes that pass through the State of California Department of Transportation Highway 1 bridges over the Noyo River and Pudding Creek and strong ground shaking could result in differential movement at the bridge abutments and could result in pipe damage or joint separation.

6.4 Recommended Further Action

Section 10 of the attached memorandum provides several recommendations that are applicable to the wastewater collection system, including the following evaluations at critical facilities including the lift stations and the treatment plant:

- Evaluate the peak ground acceleration based on current code requirements. Compare to the design criteria used when the facility was constructed to determine seismic risk to the facility.
- Determine the thickness of fill and/or terrace deposits at the sites, the depth to bedrock and an understanding of the groundwater depth and seasonal fluctuation.
- Mapping of areas of slope instability along pipeline corridors and within 300 feet of a component or facility at a local scale.

In addition, the occurrence of locally elevated groundwater should be investigated to document stabilized water level in the sewer line trenches. The investigation could consist of narrow excavated trenches performed by City maintenance division staff. The exploration will also provide an opportunity to install trench dams to cut off groundwater flow within the pipe bedding, isolating trench segments and allowing the city to better understand where pipe leakage may be of concern.

The construction of trench dams will require excavation into the undisturbed trench wall and trench bottom (typically a distance of 12 inches) and then placing controlled low-density fill (CDF) to the base of structural pavement.

CHAPTER 7 CLIMATE RISK

The Climate Resilience Assessment (CRA) for Fort Bragg's wastewater collection system evaluates how climate change will impact infrastructure reliability and community health. Using historical climate data and future projections, the assessment identifies vulnerabilities and outlines strategies to strengthen resilience against extreme events. This chapter summarizes the vulnerabilities and strategies, and the detailed assessment is available in Appendix H.

7.1 Climate Resilience Assessment

Climate Risks and System Challenges: Fort Bragg faces several primary climate hazards: sea level rise, flooding, wildfires, landslides, and erosion. Rising seas accelerate coastal erosion, increase saltwater intrusion, and shorten the lifespan of pipes and equipment. Inland flooding, driven by more intense precipitation and storm surge, threatens low-lying areas and increases infiltration, while alternating drought and heavy rain events heighten erosion and landslide risks. Wildfires pose direct threats to lift stations and indirect risks by disrupting power supplies and monitoring systems.

Collection System Priorities: The CRA identifies sanitary sewer lines as the highest priority for resilience improvements due to their flood exposure and potential impact on underserved communities. Lift stations are highly vulnerable, with failures likely to cascade across the system. Manholes and junction boxes, while moderately at risk, are essential for maintaining system functionality. Supervisory Control and Data Acquisition (SCADA) systems require ongoing monitoring to ensure operational integrity and rapid response capability.

	Vulnerability	Risk	Prioritization*
Collection System RVA			
1. Conveyance Infrastructure			
Sanitary Lines	H	C	Critical
Manholes and junction boxes	M	H	High
Outfalls	L	L	Low
2. Pumping and Treatment			
Lift stations	C	H	Critical
3. Monitoring and Control			
SCADA systems	M	M	Moderate

** Prioritization is determined as the higher of the two factors, Risk and Vulnerability*

Regional Infrastructure Vulnerabilities: The water treatment plant and Fire Station #2 are located near wildfire-prone areas, which could hinder emergency response and system continuity. Critical regional systems that support wastewater collection operations are also exposed. Transportation networks, particularly Highway 1 bridges, remain elevated but require erosion risk assessments in partnership with Caltrans. Energy transmission lines are susceptible to wildfire, potentially disrupting pumping operations.

7.2 Recommended Resilience Strategies

This section focuses on strategies to strengthen the wastewater collection system, informed by a CRA and supported by regional measures where relevant.

7.2.1 System-Specific Recommendations

The CRA assessed vulnerabilities for key assets: sanitary mains, manholes/junction boxes, outfalls, lift stations, and SCADA systems. Granular analysis enables targeted strategies for components most exposed to climate hazards. Recommended actions include:

- Hardening and elevating lift stations to reduce flood risk.
- Reinforcing sanitary mains and outfalls against erosion and subsidence.
- Securing SCADA systems with redundant power and cybersecurity measures.
- Improving access to critical assets for emergency maintenance.

Hazard	Risk	Sanitary Sewer Lines
Localized Flooding	**High**	Prevent illegal stormwater interconnects. Ensure pressure relief for lines crossing under Noho River and Pudding Creek.
Sea Level Rise	**Critical**	Line or replace sewer mains exposed to saline groundwater as sea levels rise.
		Pipe Anchoring & Corrosion Protection: Install anti-flotation devices and apply advanced coatings or cathodic protection in low-lying areas.
		Surge Mitigation: Incorporate surge relief valves and pressure monitoring at critical low points.
Landslide	**Critical**	Harden steep slopes with engineered stabilization measures.

Hazard	Risk	Manholes and Junction boxes
Localized Flooding	**High**	Prevent illegal stormwater interconnects. Ensure pressure relief for lines crossing under Noho River and Pudding Creek.
		Floodproofing: Elevate or seal manhole covers; install watertight gaskets to reduce inflow.
		Inflow/Infiltration Control: Deploy check valves and improve drainage grading around structures.
Sea Level Rise	**High**	Line or replace sewer mains exposed to saline groundwater as sea levels rise.
Landslide	**High**	Harden steep slopes with engineered stabilization measures.

Hazard	Risk	Lift Stations
Localized Flooding	**High**	Have back-up generators located nearby, but not on site. Seal the structure's openings. Stock pile sand bags for rapid deployment
Sea Level Rise	**Critical**	Have back-up generators(generators, battery storage) located nearby, but not on site, and automatic transfer switches.
		Flood Adaptation: Elevate electrical components and SCADA panels; consider submersible pumps for stations in hazard zones.

Hazard	Risk	SCADA
Sea Level Rise	**High**	Elevate equipment in the lift station. Have back up power source.
		Redundant Communication & Power: Integrate backup power and remote monitoring capability.

7.2.2 Supporting Regional Measures

Regional strategies that enhance wastewater system resilience include ensuring transportation access for repair crews, energy reliability through backup power and distributed resources, and telecommunications continuity for SCADA operations. Natural system restoration (e.g., watershed management) supports source protection and reduces flood impacts.

7.2.3 Next Steps

Develop operational protocols for emergency response and staff safety, including remote coordination and robust communication. Conduct further studies on flooding scenarios, land subsidence, wildfire risk near facilities, and salinity at intake points. Integrate planning across infrastructure, community, and ecological systems to ensure long-term adaptability.

CHAPTER 8 CAPITAL IMPROVEMENT PROGRAM

8.1 Introduction

This chapter provides a list of recommended improvements within the City's wastewater collection system and summarizes the capital improvements and their associated planning level costs. The resulting CIP provides the proposed prioritization, timing, and sizing of the recommended improvements. The recommended capital projects are based on the near-term and build-out scenarios modeled and described in Chapter 4, Existing and Future Capacity Analysis. As with any infrastructure planning assessment, the actual timing and sizing will be dictated by the realized impact of growth and the year-to-year increase in demand in the service area and future annexation areas. This chapter documents the following components of the capital planning process:

- Capital Plan (0 to 5 years, 6 to 10 years, and >10 years), including descriptions, locations, and sizes of collection system improvements
- Planning Criteria used to identify projects and recommended improvements
- Project Prioritization
- Planning level opinions of probable cost (OPC) of improvements through the planning period, including documentation of the cost basis for each type of project

8.2 Ten-Year Capital Plan Overview

Table 8-1 and Table 8-2 below summarize the 10-year capital improvement plan for the wastewater collection system, broken up into 0-to-5-year and 6-to-10-year ranges. The locations of these projects are shown in Figure 8-1 and Figure 8-2. These tables and maps illustrating all CIP project physical locations are also found in Appendix K.

Table 8-3 and Figure 8-3 identify capital projects that are not expected to be constructed within the next 10 years but have been identified as a potential need beyond the 10-year planning horizon. These projects are documented for future planning purposes but are not included in the 10-year capital plan. This table and their corresponding maps are also found in Appendix K.

Each of these CIP summary tables identifies a time frame, a prioritization ranking, and provides details about the project, including planning level costs.

Some of the identified projects are located along roads with pre-existing City projects (e.g. the Water Distribution System Master Plan (2025) and the Paving Plan) and may benefit from bundling with pre-existing work as to minimize disturbance in the roadway. Relevant associated projects and their planning periods are identified in Table 8-1,Table 8-2, and Table 8-3.

CIP projects fall into four categories, each of which had different planning criteria and triggers for project identification. The planning criteria and reasons for each of these projects as well as a description of planning-level cost basis are described further later in this Chapter.

The categories are as follows:

- **Capacity –** Projects intended to correct hydraulic capacity deficiencies, such as predicted manhole surcharging, overflows, and insufficient pipe capacity during key design storms for the existing system.
- **Build-Out -** Projects intended to accommodate future development and associated system build-out. These projects include installation of new pipelines or upsizing of existing infrastructure to support planned growth and projected peak flows under key design storm conditions.
- **Renewal -** Projects focused on replacing or rehabilitating existing infrastructure to maintain reliable system performance.
- **Other -** Projects supporting system planning, including capital plan updates.

Capacity projects were evaluated under a 10-year design storm for two alternatives: (1) existing conditions and (2) future 'build-out' assuming completion of all known planned developments. Planning-level cost estimates are provided in the following tables for each alternative to address capacity deficiencies under current demand or at full build-out. These two alternatives allow the City to evaluate whether to prioritize projects that address existing capacity needs or to advance improvements designed to accommodate future development, based on available funding and knowledge of planned development implementation.

Table 8-1: 0-5 Year Capital Projects

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[5] Existing Project Cost*	*Escalated5 Buildout Project Cost*
1	P-01	Chief Celeri Dr Sewer Main Replacement[6]	Capacity	Replace 1408 FT of 18-inch pipe with 36-inch. Replace 474 FT of 24-inch pipe with 36-inch.		P-10: Chief Celeri Dr Water Main Replacement (0-5 yrs)	$2,853,000	
2	F-01	Elm Street Force Main CIPP Lining	Renewal	CIPP lining of 2293 FT of 14" force main			$1,053,000	
3	P-02	WWTP Inflow Sewer Main Replacement[6]	Capacity	Replace 2305 FT of 30-inch pipe with 42-inch		P-3: Noyo Center Water Line (0-5 yrs)	$6,103,000	
4	P-03	E Alder St Sewer Main Replacement	Capacity	Replace 174 FT of 18-inch pipe with 24-inch. Replace 187 FT of 18-inch pipe with 30-inch. Replace 231 FT of 18-inch pipe with 24-inch. Replace 205 FT of 18-inch pipe with 30-inch.		P-10: Chief Celeri Dr Water Main Replacement (0-5 yrs)	$892,000	
5	P-16	E Oak St Sewer Main Replacement IV[6]	Capacity	Replace 303 FT of 6-inch pipe with 16-inch. Replace 319 FT of 6-inch pipe with 18-inch. Replace 146 FT of 8-inch pipe with 10-inch. Replace 1203 FT of 8-inch pipe with 12-inch.	Replace 303 FT of 6-inch pipe with 18-inch. Replace 319 FT of 6-inch pipe with 18-inch. Replace 146 FT of 8-inch pipe with 18-inch. Replace 1203 FT of 8-inch pipe with 18-inch.	Paving Plan (0-5 yrs)	$724,000	$866,000
6	P-10	S Franklin St Sewer Main Replacement	Capacity	Replace 633 FT of 8-inch pipe with 24-inch.			$351,000	
7	P-11	S Harrison St Sewer Main Replacement	Capacity	Replace 662 FT of 6-inch pipe with 18-inch.			$291,000	

[5] Costs escalated to 2027 dollars

[6] See Project Sheet, Appendix J

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[5] Existing Project Cost*	*Escalated5 Buildout Project Cost*
8	P-06	E Oak St Sewer Main Replacement III	Capacity	Replace 167 FT of 6-inch pipe with 10-inch. Replace 822 FT of 6-inch pipe with 16-inch.		V-1: Oak St. Valves (0-5 yrs)	$377,000	
9	P-34	North Fort Bragg Sewer Main Extension	Build-out		Install new 1970 FT of 8 inch pipe diameter.	P-2: N Fort Bragg Water Main Extension (0-5 yrs)		$471,000
10	P-35	GP Mill Sewer Main Extension I (Noyo Center)	Build-out		Install new 1074 FT of 16-inch pipe diameter.	P-3: Noyo Center Water Line (0-5 yrs)		$471,000
11	R-01	CCTV Condition Inspection	Asset Renewal	Placeholder for CCTV Condition Inspection of gravity mains.			$500,000	
12	R-02	Lift Station Rehabilitation	Asset Renewal	Consolidated electrical, mechanical, and structural upgrades at multiple lift stations,			$442,000	
13	R-03	0-5 yr CIPP Lining Projects	Asset Renewal	Targeted CIPP lining projects based on known pipe condition. CIPP Lining 241 ft 8” line, Pudding Creek CIPP lining 521 ft 6” line, Sanderson Way			$500,000	
14	O-01	Capital Plan Update	Other	10-year capital plan update			$110,000	
						0-5 Yr Subtotal	***$14,196,000***	***$15,280,000***

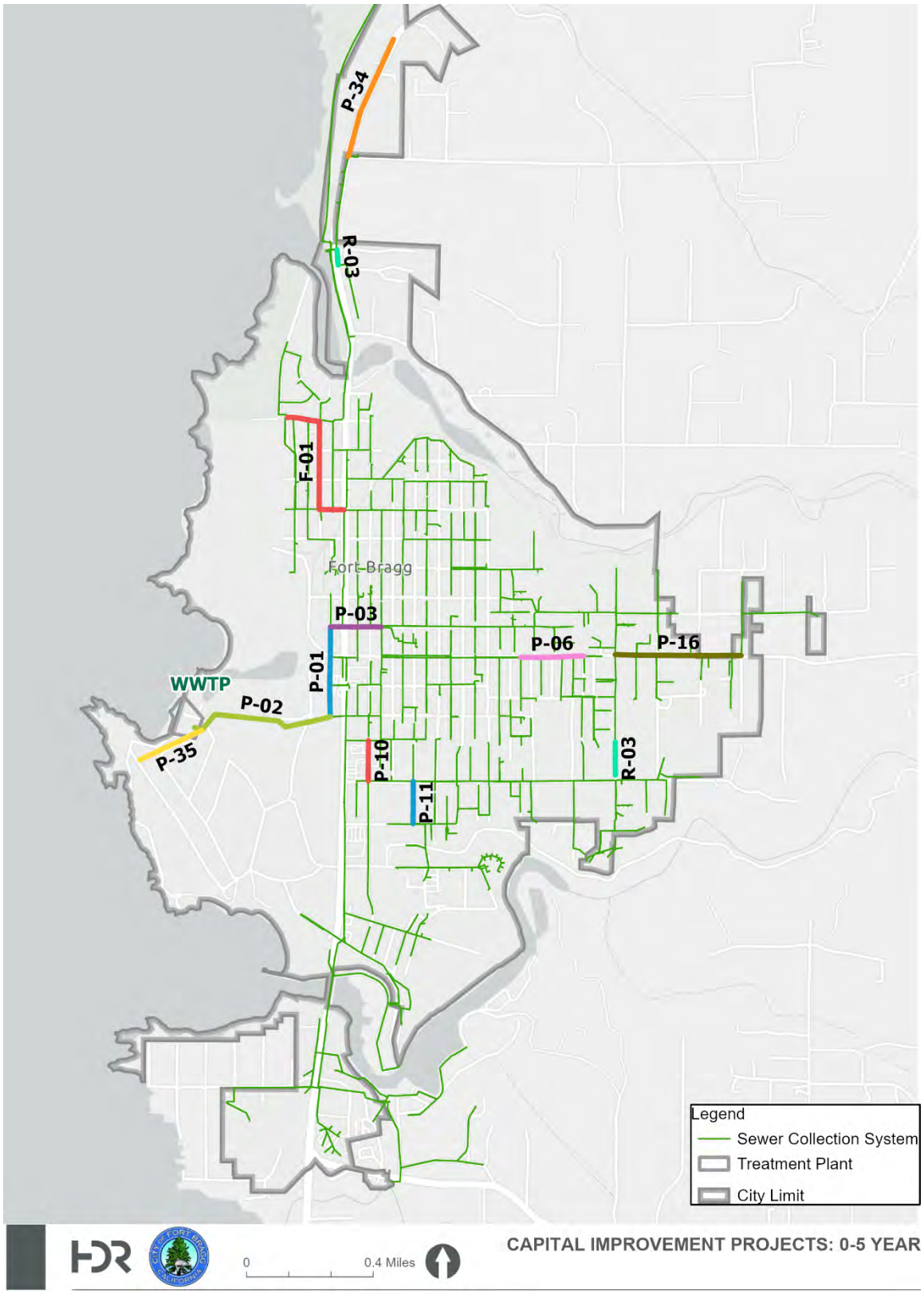


Figure 8-1. - 0-5 Yr Capital Projects

Table 8-2. 6-10 Year Capital Projects

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[7] Existing Project Cost*	*Escalated7 Buildout Project Cost*
15	P-05	E Oak St Sewer Main Replacement II	Capacity	Replace 715 FT of 10-inch pipe with 16-inch. Replace 1462 FT of 10-inch pipe with 18-inch. Replace 716 FT of 6-inch pipe with 16-inch.		V-1: Oak St. Valves (0-5 yrs)	$1,399,000	
16	P-13	Cedar St Replacement I	Capacity	Replace 919 FT of 6-inch pipe with 8-inch. Replace 11 FT of 6-inch pipe with 18-inch. Replace 1241 FT of 8-inch pipe with 18-inch.	Replace 11 FT of 6-inch pipe with 12-inch. Replace 906 FT of 6-inch pipe with 16-inch. Replace 11 FT of 6-inch pipe with 24-inch. Replace 1241 FT of 8-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$961,000	$1,224,000
17	P-18	E Laurel St Sewer Main Replacement	Capacity	Replace 783 FT of 8-inch pipe with 18-inch.	Replace 783 FT of 8-inch pipe with 24-inch.		$399,000	$504,000
18	P-26	E Chestnut St Sewer Main Replacement II	Capacity	Replace 176 FT of 6-inch pipe with 10-inch. Replace 1734 FT of 6-inch pipe with 12-inch. Replace 143 FT of 6-inch pipe with 8-inch. Replace 384 FT of 8-inch pipe with 10-inch. Replace 1180 FT of 8-inch pipe with 12-inch.	Replace 176 FT of 6-inch pipe with 12-inch. Replace 748 FT of 6-inch pipe with 12-inch. Replace 986 FT of 6-inch pipe with 16-inch. Replace 143 FT of 6-inch pipe with 10-inch. Replace 384 FT of 8-inch pipe with 12-inch. Replace 1180 FT of 8-inch pipe with 16-inch. Replace 342 FT of 12-inch pipe with 16-inch.	P-9: East Chestnut Street Water Main Replacement (6-10 yrs)	$1,567,000	$1,725,000
19	P-29	Maple St Sewer Main Replacement	Capacity	Replace 180 FT of 6-inch pipe with 10-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$66,000	

[7] Costs escalated to 2032 dollars

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[7] Existing Project Cost*	*Escalated7 Buildout Project Cost*
20	P-31	South Harold St Sewer Main Replacement	Capacity	Replace 902 FT of 6-inch pipe with 12-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$364,000	
21	P-24	N Sanderson Way Sewer Main Replacement	Capacity	Replace 647 FT of 6-inch pipe with 18-inch.	Replace 647 FT of 6-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$330,000	$416,000
22	P-23	N McPherson St Sewer Main Replacement	Capacity	Replace 225 FT of 18-inch pipe with 24-inch. Replace 410 FT of 6-inch pipe with 10-inch. Replace 42 FT of 6-inch pipe with 12-inch. Replace 231 FT of 8-inch pipe with 18-inch.	Replace 225 FT of 18-inch pipe with 30-inch. Replace 410 FT of 6-inch pipe with 10-inch. Replace 42 FT of 6-inch pipe with 16-inch. Replace 231 FT of 8-inch pipe with 30-inch.		$429,000	$1,068,000
23	P-15	Dennison Ln Sewer Main Replacement	Capacity	Replace 331 FT of 6-inch pipe with 10-inch. Replace 325 FT of 8-inch pipe with 10-inch.	Replace 331 FT of 6-inch pipe with 16-inch. Replace 325 FT of 8-inch pipe with 16-inch. Replace 494 FT of 6-inch pipe with 8-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$239,000	$526,000
24	P-33	Georgia-Pacific-Haul Rd Sewer Main Replacement	Capacity	Replace 681 FT of 8-inch pipe with 10-inch. Replace 193 FT of 8-inch pipe with 12-inch.			$326,000	
25	P-28	S Sanderson Way Sewer Main Replacement	Capacity	Replace 613 FT of 6-inch pipe with 8-inch.			$216,000	
26	P-27	Minnesota Ave Sewer Main Replacement	Capacity	Replace 700 FT of 6-inch pipe with 8-inch.			$246,000	
27	P-20	E Redwood Ave Sewer Main Replacement	Capacity	Replace 703 FT of 8-inch pipe with 18-inch.	Replace 703 FT of 8-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$359,000	$452,000
28	P-32	Cypress St Sewer Main Replacement	Capacity	Replace 674 FT of 8-inch pipe with 10-inch.			$245,000	

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[7] Existing Project Cost*	*Escalated7 Buildout Project Cost*
29	P-30	Park St Sewer Main Replacement	Capacity	Replace 250 FT of 6-inch pipe with 10-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$91,000	
30	P-04	E Oak St Sewer Main Replacement I	Capacity	Replace 316 FT of 6-inch pipe with 8-inch.		P-13: E. Alder St Water Main Replacement (6-10 yrs)	$112,000	
31	P-08	E Chestnut St Sewer Main Replacement	Capacity	Replace 363 FT of 12-inch pipe with 18-inch. Replace 340 FT of 8-inch pipe with 18-inch.		P-3: Noyo Center Water Line (0-5 yrs)	$359,000	
32	P-21	N Harold St Sewer Main Replacement	Capacity	Replace 433 FT of 8-inch pipe with 18-inch.	Replace 433 FT of 8-inch pipe with 24-inch.		$221,000	$279,000
33	P-25	N Whipple St Sewer Main Replacement	Capacity	Replace 439 FT of 10-inch pipe with 18-inch.	Replace 439 FT of 10-inch pipe with 24-inch.		$224,000	$282,000
33	P-14	Cedar St Replacement II	Capacity	Replace 399 FT of 6-inch pipe with 10-inch.		P-1: Cedar St Water Line Replacement (0-5 yrs)	$145,000	
35	P-07	N Franklin St Sewer Main Replacement	Capacity	Replace 130 FT of 12-inch pipe with 18-inch. Replace 342 FT of 12-inch pipe with 24-inch.		P-13: E. Alder St Water Main Replacement	$286,000	
36	P-19	E Pine St Sewer Main Replacement	Capacity	Replace 375 FT of 15-inch pipe with 18-inch. Replace 370 FT of 15-inch pipe with 18-inch.	Replace 375 FT of 15-inch pipe with 24-inch. Replace 370 FT of 15-inch pipe with 30-inch.		$380,000	$971,000
37	P-17	E Fir St Sewer Main Replacement	Capacity	Replace 196 FT of 8-inch pipe with 12-inch. Replace 944 FT of 18-inch pipe with 24-inch.	Replace 196 FT of 8-inch pipe with 16-inch. Replace 944 FT of 18-inch pipe with 30-inch.		$686,000	$1,951,000
38	P-12	S Main St Sewer Main Replacement II	Capacity	Replace 66 FT of 12-inch pipe with 24-inch.			$432,000	
39	P-22	N Main St Sewer Main Replacement	Capacity	Replace 1829 FT of 21-inch pipe with 24-inch.	Replace 1829 FT of 21-inch pipe with 30-inch.		$1,176,000	$3,605,000

Priority	CIP ID	Project Name	Category	Project Description	Buildout Project Alternative Description	Assoc. Projects	*Escalated[7] Existing Project Cost*	*Escalated7 Buildout Project Cost*
40	P-09	Hazel St Sewer Main Replacement	Capacity	Replace 357 FT of 12-inch pipe with 24-inch.			$230,000	
41	P-36	S Main St Sewer Main Extension	Build-Out		Install new 2334 FT of 8-inch pipe diameter.			$647,000
42	R-04	CCTV Condition Inspection	Asset Renewal	Placeholder for CCTV Condition Inspection of gravity mains.			$634,000	
43	R-05	6-10 yr CIPP Lining Projects	Asset Renewal	Placeholder for CIPP lining projects to be identified through condition assessment			$761,000	
44	O-02	Capital Plan Update	Other	10-year capital plan update			$127,000	
						6-10 Yr Subtotal	***$13,010,000***	***$19,689,000***

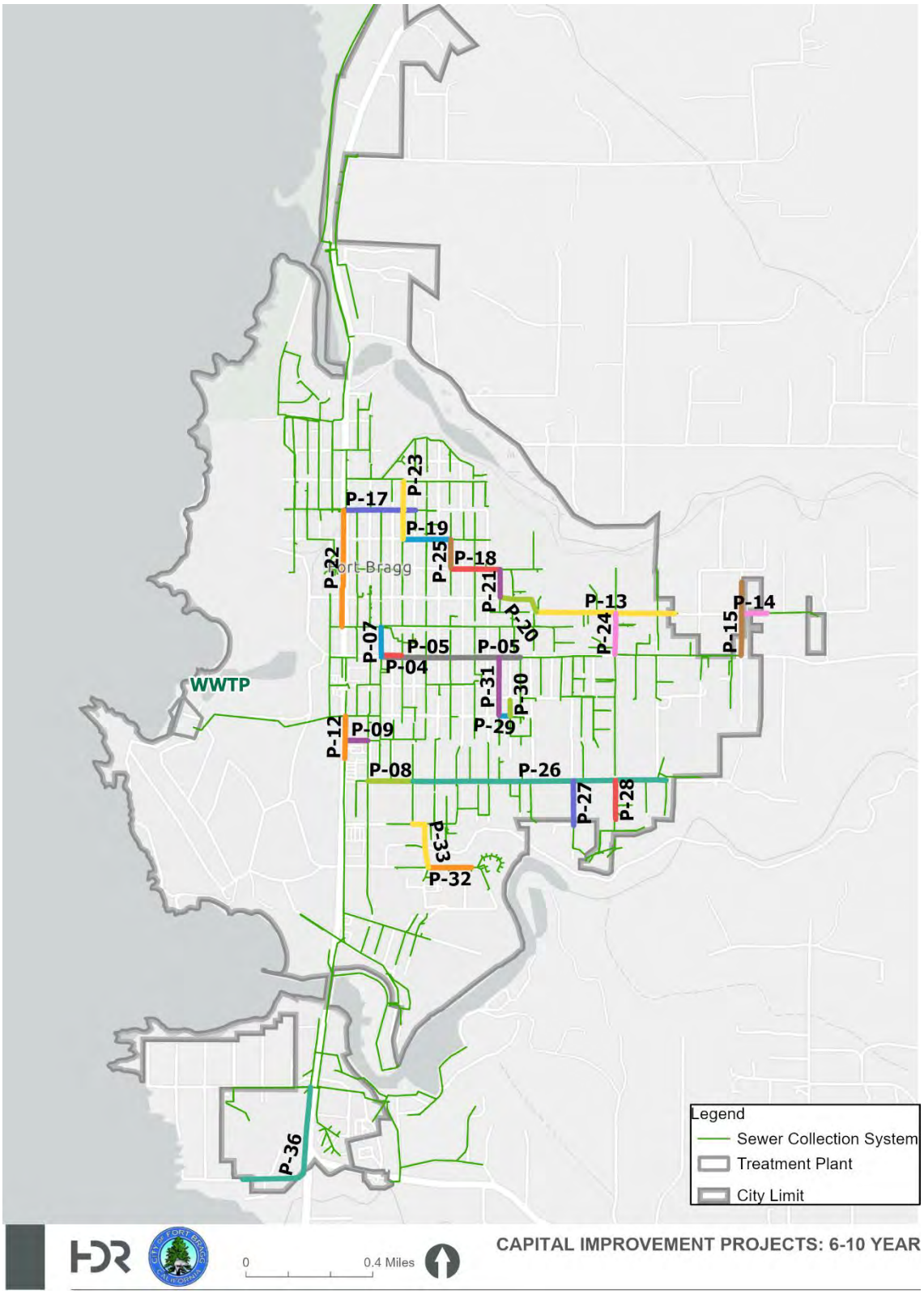


Figure 8-2. 6-10 yr Capital Projects

Table 8-3. >10 Year Capital Projects

Priority	CIP ID	Project Name	Category	Project Description	Assoc. Projects	*Escalated[8] Project Cost*
45	P-53	Basin St Sewer Main Replacement	Build-Out	Increase 235 FT of 10-inch pipe diameter to 12-inch. Increase 1160 FT of 8-inch pipe diameter to 10-inch. Increase 372 FT of 8-inch pipe diameter to 12-inch.		$728,000
46	P-40	Cedar St Sewer Main Extension I	Build-Out	Install new 694 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$250,000
47	P-45	Cedar St Sewer Main Extension I	Build-Out	Install new 2182 FT of 8-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$661,000
48	P-46	Cedar St Sewer Main Extension III	Build-Out	Install new 2839 FT of 8-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$859,000
49	P-43	Dennison Ln Sewer Main Extension	Build-Out	Install new 3439 FT of 12-inch pipe diameter. Install new 232 FT of 16-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$1,332,000
50	P-49	E Chestnut St Sewer Main Extension	Build-Out	Install new 2988 FT of 10-inch pipe diameter.		$942,000
51	P-44	Fawn Ln Sewer Main Extension	Build-Out	Install new 1335 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$480,000
52	P-47	Fort Bragg Sherwood Rd Sewer Main Extension	Build-Out	Install new 1613 FT of 12-inch pipe diameter. Install new 2046 FT of 18-inch pipe diameter.		$1,552,000
53	P-50	Georgia-Pacific-Haul Rd Sewer Main Extension	Build-Out	Install new 852 FT of 12-inch pipe diameter. Install new 4301 FT of 16-inch pipe diameter. Install new 232 FT of 8-inch pipe diameter. Install proposed lift station with 80 GPM capacity.		$2,786,000
54	P-37	GP Mill Sewer Main Extension II	Build-Out	Install new 2360 FT of 10-inch pipe diameter. Install new 422 FT of 18-inch pipe diameter.		$945,000
55	P-38	GP Mill Sewer Main Extension III	Build-Out	Install new 2348 FT of 10-inch pipe diameter. Install new 3606 FT of 12-inch pipe diameter.		$2,036,000

[8] Costs escalated to 2035 dollars

Priority	CIP ID	Project Name	Category	Project Description	Assoc. Projects	*Escalated[8] Project Cost*
56	P-39	GP Mill Sewer Main Extension IV	Build-Out	Install new 3261 FT of 10-inch pipe diameter. Install new 3939 FT of 8-inch pipe diameter. Install proposed lift station with 80 GPM capacity	P-10: Chief Celeri Dr Water Main Replacement (6-10 yr)	$2,808,000
57	P-55	Highway 20 Sewer Main Extension	Build-Out	Install new 729 FT of 12-inch pipe diameter.		$262,000
58	P-51	Jacobsen Ln Sewer Main Extension I	Build-Out	Install new 620 FT of 4-inch pipe diameter.		$116,000
59	P-52	Jacobsen Ln Sewer Main Extension II	Build-Out	Install new 483 FT of 8-inch pipe diameter.		$147,000
60	P-48	Lyta Way Sewer Main Extension	Build-Out	Install new 5186 FT of 12-inch pipe diameter.		$1,863,000
61	P-54	N Harbor Dr Sewer Main Replacement	Build-Out	Increase 30 FT of 12-inch pipe diameter to 24-inch. Increase 251 FT of 8-inch pipe diameter to 24-inch.		$197,000
62	P-41	Nurnberger Ln Sewer Main Extension	Build-Out	Install new 3059 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)	$1,099,000
63	P-56	Ocean View Sewer Main Extension	Build-Out	Install new 23053 FT of 8-inch pipe diameter.		$6,974,000
64	P-42	Peterson Ln Sewer Main Extension	Build-Out	Install new 1654 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement(0-5 yr)	$594,000
65	LS-1	South Noyo LS Improvement	Build-Out	Increase South Noyo LS capacity from 920 GPM to 1,500 GPM.		$7,337,000
					>10 Yr Subtotal	***$33,968,000***

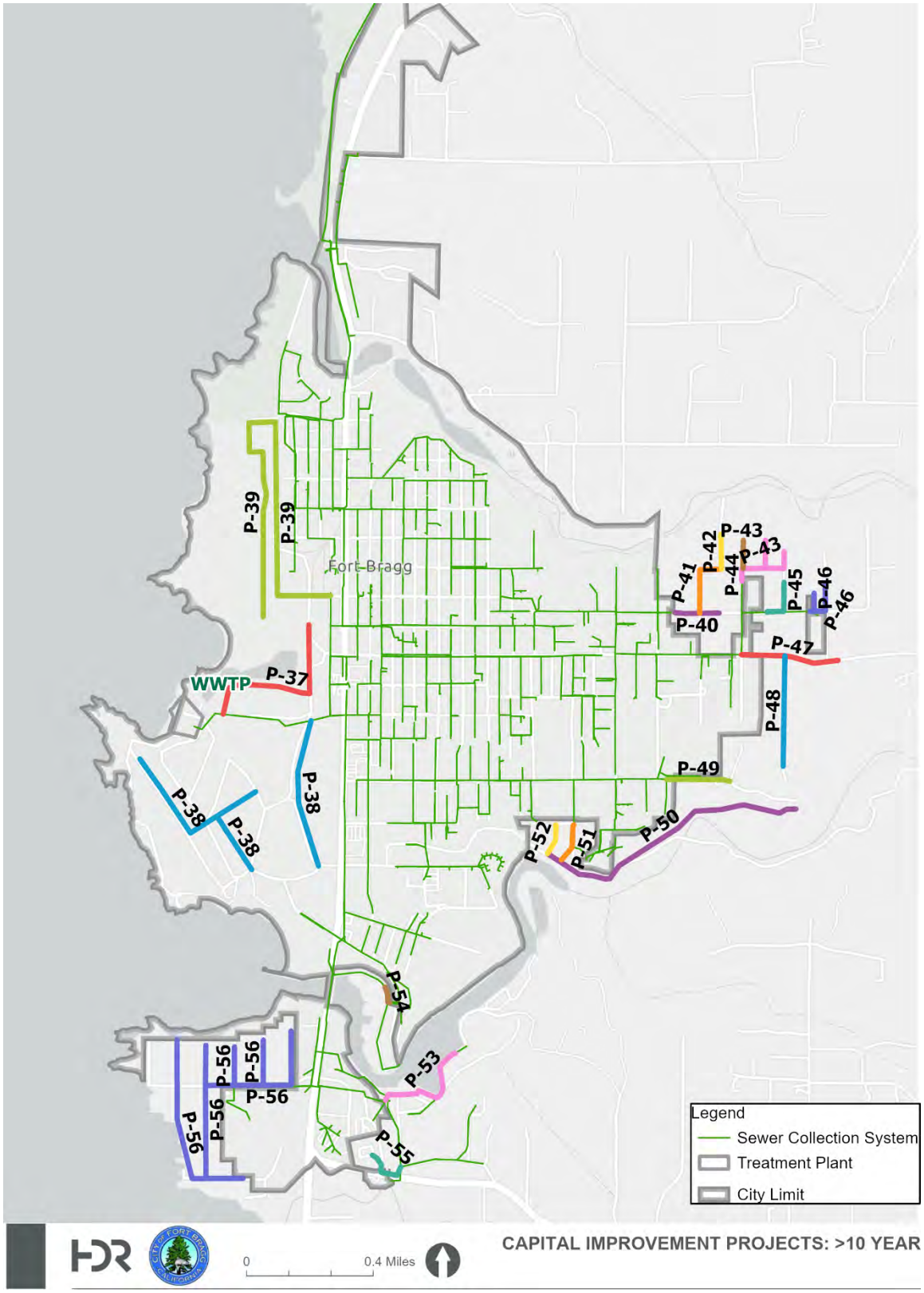


Figure 8-3. >10 Yr Capital Projects

8.3 Planning Criteria

CIP projects fall into three categories, each of which had different criteria and triggers for project identification. The planning criteria and reasons for each of these projects as well as a description of planning-level cost basis are described further in this section.

8.3.1 Capacity Projects

Capital projects categorized under capacity improvements were identified through the capacity analysis effort described in Chapter 4 – Existing and Future Capacity Analysis. A capital project was identified wherever a capacity deficiency was identified when modeled under a 10-year design storm.

Capacity deficiencies were identified using industry best practices. Deficiency indicators include sanitary sewer overflows (SSOs), surcharge at manholes, or insufficient pipe capacity (specifically, d/D ratios greater than 0.8). Using a conservative approach, any pipe meeting one or more of these criteria was recommended for capital improvement. Where applicable, multiple improvement alternatives were identified to evaluate opportunities for enhancing overall system hydraulic performance. In coordination with the City, Individual pipe segments with deficiencies were combined into system reaches to make reasonable capital project extents.

8.3.2 System Renewal

System Renewal projects focus on the proactive replacement and rehabilitation of aging infrastructure. Renewal projects were identified for lift stations, force mains, and gravity mains based on the condition assessment efforts described in Chapter 6 – Condition Assessment.

In addition to the gravity main projects identified through condition assessment, an annual CIPP liner budget has been added, this allows the City to proactively address system repairs as infrastructure continues to age. CIPP liner is the preferred method of general gravity main repair as it is a cost-efficient alternative to open trench repair or replacement and can adequately address structural concerns and will perform similarly to an open trench repair project.

Results from the CCTV condition assessment and decision support framework analysis identified the need for near-term CIPP lining projects for segment Swr-Grvty-Mn-5810 along Highway 1 (241 ft, 8” line) and Swr-Grvty-Mn-5179 in S. Sandersen Way (521 ft, 6” line). These address structural deficiencies found during the CCTV inspection.

Renewal projects for the gravity collection system should be added to the CIP when condition assessment identifies structural deficiencies as defined by the decision support framework outlined in Section 6.

8.3.2.1 Condition Inspection of Gravity Mains

A condition assessment inspection program for the City’s gravity mains is recommended. Placeholder projects R-01 (years 0-5) and R-04 (years 5-10) are identified to implement this program. This will enable the City to identify and prioritize the most appropriate system renewal projects and ensure that rehabilitation efforts are focused on assets with demonstrated structural

need. Estimated placeholder inspection costs were developed based on the cost of the CCTV inspection and flow study carried out as part of this Master Plan.

8.3.3 Other

This capital plan includes non-construction projects that support the City's ongoing efforts to improve and refine capital planning and asset maintenance practices. These capital program–related projects are necessary for the City to effectively respond to changing system conditions, evolving priorities, and regulatory and stakeholder requirements over time. This section describes the underlying drivers for these projects.

8.3.3.2 Capital Plan Update

It is recommended that the City update its 10-year capital plan at least every five years to adapt to changing conditions and to reassess the need, timing, prioritization, and funding of identified CIP projects. This project provides an estimated budget to support those update efforts. Key activities include updating current and projected capacity demands, verifying and refining the hydraulic model, updating the risk assessment model, and revising or extending the 10-year capital plan as appropriate.

8.4 Prioritization strategy

CIP projects for gravity mains were initially prioritized first by identifying predicted SSO volume in gallons, with higher SSO volume having higher priority. Next, projects with manhole surcharge were prioritized in ascending order of minimum surcharge. Last, projects with pipe overcapacity (d/D > 0.8) were prioritized in descending order of overcapacity. This initial list was reviewed with the City and revised based on staff knowledge and risk scores, including known conditions or impact to local businesses or environmental health and safety.

As discussed in Section 6.2, the Elm Street Force main is constructed of Techite pipe, which is subject to sudden and catastrophic failure. Therefore, this was identified as a high-priority project and placed in the 0-5 year timeframe.

The Lift Station Rehabilitation project consolidates all of the electrical, mechanical, and structural projects identified during the Lift Station inspections. These projects are largely maintenance activities and should be addressed relatively soon so as not to evolve into larger problems. Therefore, this project was placed in the 0-5 year timeframe. The City may, however, decide to break this project up into different projects and prioritize them individually based on the preferences and knowledge of City staff.

8.5 Cost Estimating

This section discusses the unit costs used to develop the OPC for each of the recommended capital projects. Costs are order of magnitude, planning level costs and consist of construction costs, engineering, legal and administrative costs, and expenditures for land acquisition. The OPCs are intended to assist in budgeting for the implementation of the CIP.

It should be noted that OPCs for projects vary depending on the phase of the project when they are developed, which determines the level of detail. The Association for the Advancement of Cost

Engineering International (AACE International) recommended practices, outline typical cost estimate accuracy based on the overall status of the project. The cost estimates for the projects identified in the 10-year CIP should be considered study-level estimates (Estimate Classification 4) with an expected accuracy of +50 to -30 percent. OPCs should be verified and updated during the pre-design phase of each project.

8.5.1 Unit Costs

Unit costs and OPCs are based on information known at this time (e.g., system needs, projected growth rates, development patterns). Costs are order of magnitude, planning level costs and consist of construction costs; engineering, legal, and administrative costs; and expenditures for land acquisition. The OPCs are intended to assist in budgeting for the implementation of the CIP.

Project costs in the ten-year capital plan overview have been adjusted for inflation using Engineering News-Record's (ENR) Construction Cost Index (CCI). The ENR CCI is computed from prices of construction material and labor and is based on a value of 100 in the year 1913 and escalated each year. Cost data in this report are based on the 2024 ENR CCI (20-city average) of 11,455. Future CCI was projected using the formula for compound growth (see formula below) and assuming an annual escalation rate of 3%.

$$Future\ ENR\ CCI = Base\ CCI * (1 + r)^n$$

$$Base\ CCI\ (2024) = 11{,}455$$

$$r = Anual\ Escaltion\ Rate$$

$$n = number\ of\ years\ in\ the\ future$$

Project cost data presented in this report was adjusted using the ratio of the future CCI to the base (2024) CCI (see formula below). Projects were adjusted for the mid-point of their respective timeframes. For example, projects identified for the next 5 years were adjusted for 2027 dollars and projects identified for the five-to-ten-year range were adjusted for 2032 dollars.

$$Adjusted\ Project\ Cost = 2025\ Project\ Cost * \frac{Future\ ENR\ CCI}{Base\ CCI}$$

Construction costs are intended to cover the material, equipment, labor, and services necessary to build the proposed project. Prices used in this study were obtained from budgetary prices provided by vendors, as well as a review of construction costs from projects in the region, similar recent master plans in the region, cost estimating guides, and other pertinent sources of construction cost information.

Facility costs (e.g., lift station improvements) include allowances for site work, soil conditions, site piping, mechanical/HVAC, electrical, and instrumentation and control. Linear project costs (e.g., pipeline costs) include allowances for fittings and for incidental items such as dewatering, erosion control, traffic control, utility coordination and mitigation, and concrete removal and replacement.

Engineering, legal, and administrative services may include items such as preliminary investigations and reports, site and route surveys, geotechnical and foundation explorations, preparation of design drawings and specifications, engineering services during construction, construction observation, sampling and testing, start-up services, legal fees, financing fees, and administrative costs. The

costs presented in this report include a 29 percent allowance, based on input from the City for design (12%), permitting (2%), and construction management (15%), and a 20% contingency.

8.5.2 Capacity & Build-Out Projects

Construction cost estimates were developed based on the current conceptual design information for the Fort Bragg Wastewater System Improvements project. Cost estimates are based on available project descriptions including pipe length and diameter, and unit costs were derived using industry-standard production rates, cost databases, and historical data from similar projects.

The estimate is organized by standard construction divisions and includes demolition, buried piping, and major equipment. Direct costs (labor, materials, equipment, and subcontractors) were combined with typical contractor markups, and applicable sales tax has been included. As this estimate is based on limited design data, it should be considered an opinion of probable cost, and actual costs may vary due to design refinement, site conditions, and market factors.

8.5.3 System Renewal

8.5.3.1 CIPP Lining

A recurring placeholder budget for CIPP lining projects is included at five-year intervals. The annual budget amount was derived from prior Water Enterprise capital budgets for CIPP lining and in consultation with City staff.

8.5.3.2 Lift Station Improvements

Planning-level cost estimates (i.e., rough order-of-magnitude) were developed for each recommended improvement based on engineering judgment and experience after site visits to each lift station. Individual improvements to be contracted out were identified in consultation with City Staff, and were consolidated into one lump sum to be executed in any order and combination across the 10-yr Capital Plan.

8.5.3.3 Condition Assessment

Planning-level cost estimates for Condition Assessment CCTV inspections were developed based on costs for CCTV inspection conducted under the Condition Assessment efforts described in Chapter 6, with a target of full system inspection every 10 years.

8.5.3.4 Force Main Renewal

Planning-level cost estimates for force main renewal were developed based on recent cost estimates for the South Noyo and North Noyo force main lining projects.

8.6 Preliminary Engineering Reports

Preliminary Engineering Reports were developed for three priority and representative projects from the Capital Plan: P-01 (Chief Celeri Drive Sewer Main Replacement), P-02 (WWTP Inflow Sewer Main Replacement), and P-16 (East Oak Street Sewer Main Replacement). An additional report was developed for P-16 reflecting the option to include capacity for potential future buildout. These reports provide the level of detail necessary to support the funding process, including project

schedules, planning-level cost estimates, mapping, project descriptions, and design triggers. These preliminary Engineering Reports can be found in Appendix J.

The projects were selected in consultation with City staff, taking into consideration the project prioritization previously discussed, City staff knowledge of system conditions, and staff knowledge of other co-located projects.

8.7 Condition Assessment Program

A condition assessment inspection program for the City's gravity mains is recommended. Placeholder projects R-01 (years 0-5) and R-04 (years 5-10) are identified to implement this program. This will enable the City to identify and prioritize the most appropriate system renewal projects and ensure that rehabilitation efforts are focused on assets with demonstrated structural need. Estimated placeholder inspection costs were developed based on the cost of CCTV inspection efforts carried out as part of this Master Plan.

One goal of the condition assessment program should be to identify and characterize infiltration into the gravity main system. As noted in Chapter 4, the flow studies performed as part of the master planning effort identified likely significant groundwater infiltration and/or storm drain cross-connections in monitoring basins FM-02 and FM-04. This was evidenced by persistent high base flows during the wet-weather season, even between rain events. Infiltration sources could be either high groundwater levels during the wet season, cross-connection to the storm drain system, or others causes. Addressing the causes of this infiltration may reduce wet-weather flow in these basins and may consequently reduce the need for increased hydraulic capacity in these areas.

Focused condition assessment is recommended in these areas, especially in the potential cross-connection locations identified in section 3.2.3. Assessment methods may include:

- CCTV inspections
- Pole camera manhole inspections
- Smoke testing for illicit connections and cross-connections
- Dye testing for cross-connections
- Focused flow studies

The results of the assessment should be used to identify and prioritize CIP projects that will reduce this infiltration. After completing infiltration mitigation projects, focused flow studies in these areas should be conducted to re-characterize the performance of the system during the wet season, and the hydraulic model should be re-run with the updated parameters. Evaluating the new results for d/D, manhole surcharge, and SSO should be used to further refine CIP prioritization and my eliminate the necessity for some capacity-related CIP projects identified in this master plan.

CHAPTER 9 FUNDING OPPORTUNITIES

This section discusses the various funding opportunities and strategies that are available to the City and how they might be applied to the projects presented in the ten-year capital plan.

9.1 Overview

This section provides a summary of potential funding options from state and federal sources that may be considered for funding projects listed in section 8.2, Ten-Year Capital Plan Overview, above. No opinions or recommendations on debt or financing structures are provided as these decisions need to be made in the context of the City's financial situation, long-term financial plans, project costs, and funding available during the respective application period(s).

Significant recent changes have occurred in water infrastructure programs based on the new funding priorities of the current federal Administration. The previous federal Administration's passage of the Infrastructure Investment and Jobs Act (IIJA) prioritized funding allocations for projects focused on resiliency, climate change, sustainability and green infrastructure. New federal priorities have transitioned to expanding and improving U.S. energy infrastructure. While there is still water infrastructure related funding available through IIJA, strategically aligning projects to specific programs and new federal priorities is an important next step to improve the likelihood of project funding and reduce the time and costs of applying to multiple programs.

In general, most funding programs cover construction costs as well as development phase activities, including preliminary engineering work and environmental document preparation, acquisition of property, legal work, and engineering design including permit fees. Costs incurred prior to a funding award may be covered, depending on the program-specific restrictions. Federal funding programs will have additional requirements which are not addressed in this report—such as Davis-Bacon prevailing wages, Build America, Buy America Act or American Iron and Steel provisions, adherence to federal procurement (including Brooks Act), environmental review, etc.—as part of assistance agreements.

It is important to consider applying to these programs as early as practical since engineering and environmental review documents must be prepared and reviewed prior to commencing with construction. Preparing applications early leaves time for drafts to be reviewed by agency partners and proper permit acquisition prior to deadline requirements. Since each funding program has specific requirements surrounding permits and project timelines, the individual program's process, timeline, and requirements should be reviewed within the context of the City's overall goals, financial situation, project timelines, and debt policies. The following programs have been identified as potential funding sources for projects listed in the Master Plan and are summarized herein:

- Water Infrastructure Finance and Innovation Act (WIFIA)
- Community Development Block Grants (CDBG)
- U.S. Department of Agriculture Water and Waste Disposal Loans and Grants
- Economic Development Administration (EDA) Grants
- Congressional Earmarks
- State Revolving Funds (SRF)
- U.S. Army Corps of Engineers' (USACE) Section 219 Environmental Infrastructure Program
- California Climate Bond (Proposition 4)

9.2 Water Infrastructure Finance and Innovation Act

WIFIA is a long-term, supplemental loan program administered by the EPA. This program is intended to move projects forward that need additional funding beyond the capacity of other funding programs (e.g., SRFs). WIFIA can provide direct loans and loan guarantees to eligible borrowers for water infrastructure projects. WIFIA can only fund 49 percent of project costs; other funding sources must be obtained for the other 51 percent. If other funding sources include other federal programs, the total federal involvement is limited to 80 percent. Most water-related infrastructure projects are eligible under WIFIA. All SRF eligible projects are eligible under WIFIA. In addition to general costs associated with a project, WIFIA loans can also include debt issuance reserve funds and debt issuance costs.

Highlights of WIFIA:

- $7.5 billion in available funding until fully expended
- Funding available for 49% of project
- No more than 80% from federal sources
- $5 million project minimum for communities of 25,000 or less
- Interest based on U.S. Treasury securities
- Maturity up to 35 years
- Debt payments can be sculpted
- Defer payments up to 5 years after substantial completion
- If invited to apply after submittal of letter of interest, application fee is $100,000 (large communities) or $25,000 (small communities)
- Credit assurance review fee is typically $100,000–300,000 (application fee is credited)
- Service fees do apply for the life of the loan (+/- $8,000–26,000 per year)

WIFIA is typically used for larger projects with a minimum project size of $20 million. Similar projects in a CIP can be combined to form one larger project to meet the minimum project size or to simplify the overall process by having one loan instead of multiple loans if the projects will be constructed over a limited timeframe (i.e., EPA suggests a 5-year period).

The interest rate on WIFIA loans is based on U.S. Treasury securities and may be lower than bonds (depending on maturity, ratings, and market). One advantage of WIFIA financing is the ability to defer repayment of principal and interest for 5 years after substantial completion of the project. Another potential advantage of WIFIA financing is the ability to negotiate the repayment terms. For example, U.S. Treasury rates at longer debt maturities may be much lower than other market debt instruments at the same maturity when compared to shorter term debt where the spread may be less. At shorter maturities, the spread between private market rates and U.S. Treasury rates may not be enough to provide a significant benefit. By issuing debt at a shorter maturity in the private market (for the 51 percent of costs that WIFIA will not cover) and then pushing WIFIA debt to a longer maturity (e.g., 30–35 years), sculpting repayments may provide a potential interest saving versus issuing both sources of debt at equal, longer maturities. However, bond markets and the U.S. Treasury securities market can vary significantly, and somewhat independently, year to year. WIFIA debt can be prepaid without penalty.

EPA accepts Letters of Interest (LOI) on a rolling basis from the date listed in the Notice of Funding Availability (NOFA). Prospective borrowers can submit a LOI for review by EPA on a rolling basis from the date listed in the NOFA until the earlier of (1) the commitment of all available funding made available for that round or (2) publication of a subsequent notice cancelling or overriding the current

NOFA. A rolling selection process allows EPA to provide year-round access to WIFIA funding and quicker selection decisions to prospective borrowers. The LOI is essentially a pre-application that EPA reviews and prioritizes against other LOIs. If the project is prioritized within the funding range, EPA will invite the prospective borrower to make a formal application (the application $100,000 fee is then due). Prospective borrowers must submit a formal application within a year of the invitation to apply.

9.3 U.S. Department of Housing and Urban Development Community Development Block Grants

The U.S. Department of Housing and Urban Development (HUD) provides annual funding to states, cities, and counties to stimulate the development of urban communities. In California, annual funding allocations are administered by the California Department of Housing and Community Development. Based on Federal and State requirements, eligible projects must benefit low- and moderate-income persons, aid in the prevention of extreme poverty areas, or meet an urgent need. Eligible non-entitlement applicants in California include cities with populations below 50,000 or counties with a population of less than 200,000. One of the eligible activities under the program are public improvements including water and wastewater system updates. For public facilities projects to be eligible, the improvement must directly benefit a disadvantaged community.

Based on recent U.S. census data, Fort Bragg has a median household income that is below the state average and a higher population of person in poverty when compared to the state average. Based on these statistics, valve and water line replacement projects may qualify for HUD funding if Fort Bragg can present a compelling case that improvements are needed to serve portions of the City with moderate income levels. Portions of GP Mill Sewer Main Extension projects may be eligible if it serves future developments that will address local housing needs. Fort Bragg should consider reaching out to the California Department of Housing and Community Development to discuss proposed water conveyance projects and how they align with the department's future funding priorities.

9.4 Economic Development Administration Public Works and Economic Adjustment Assistance Programs

The Economic Development Administration (EDA) awards grants for projects that advance economic development. Special consideration is given to projects that incorporate EDA priorities, including workforce development. Eligible projects include acquisition and improvement of land for public works use, water and sewer improvement projects, and other construction and pre-construction improvements that assist with community economic development. For the current funding cycle, EDA was appropriated $121.5 million for the public works program. Historically, the average grant award has been $1.4 million, but EDA expects awards in the current cycle to range between $600,000–5,000,000. The program has cost-match requirements that vary depending on the community's relative needs.

The GP Mill Sewer Extension projects may qualify for EDA grant funding if the City can show that the project will serve new developments and industries needed for local economic development. EDA's primary mission is to fund projects in communities that are experiencing economic stress due to loss of industry. Fort Bragg projects align with EDA priorities because the City's economy was

built on timber and logging. With the recent reduction in lumber milling, the City could make a compelling case that it would benefit from funding due to economic challenges from loss of industry.

9.5 U.S. Department of Agriculture Water and Waste Disposal Loans and Grant Program

The United States Department of Agriculture (USDA) allocates funding for clean drinking water, sanitary sewer disposal, and stormwater drainage for households in eligible rural areas through Water and Waste Disposal Grants. Most state and local governmental agencies are eligible for funding. Eligible service areas include rural areas with populations of 10,000 or less and tribal lands in rural areas. Funding is available in the form of long-term, low-interest loans with up to a 40-year payback period. It should be noted that interest may be set at market rates for counties with a high median household income (MHI). A cost-benefit analysis should be used to evaluate if a USDA loan would be worth applying for when compared to water revenue bonds. To qualify, Fort Bragg must propose projects that expand services to very small, rural parts of the town. Eligible activities include legal and engineering fees, acquisitions, start-up operations and maintenance, interest incurred during construction, and the purchase of facilities to expand service. Potentially applicable interest rates are shown in Table 9-1.

Table 9-1. Interest Rates Effective April 1, 2025

Financial Status	Interest Rate
Poverty	2.500%
Intermediate	3.375%
Market	4.250%

Fort Bragg qualifies as a small and rural community based on the USDA's eligibility criteria of providing loans to populations of 10,000 or less. For large projects including WWTP Inflow Sewer Main Replacement or the Oak Street Sewer Main Replacements, the low interest rates offered by the USDA may offer some cost savings over the lifetime of the project when compared to market interest rates. USDA loan funding should primarily be used to fund larger projects that cannot be funded primarily through rate revenues and reserves.

9.6 Congressional Earmarks

Earmarks are direct congressional funding for a specific local project. Earmarks are administered through federal agencies and projects must qualify based on established program requirements. Earmarks are not merit based and circumvent the traditional grant application process. Earmarked projects are selected for funding and then follow an application process to ensure projects meet agency/program guidelines. Accessing earmark funding requires direct support from a congressional representative. To receive earmark funding, the utility needs to have a strong connection to a congressional representative and have direct meetings to present the value of the project to the state/county/community.

SRF funding may be reduced significantly due to allocations of funding to earmarks In FY2026, congress elected not to earmark SRF funding and the entirety of the SRF allocations will be allotted to the states. However, the trend of earmarking funds from the SRF programs may continue in the

future. If Fort Bragg has a high priority project, it could consider reaching out to a congressional representative about earmark funding for the project. Earmarked funding could result in significant saving for the City if awarded.

9.7 State Revolving Funds

SRF programs are low-interest, revolving loan programs administered by the state with EPA oversight. There are two SRF programs: the Clean Water SRF (CWSRF) and the Drinking Water SRF (DWSRF). The CWSRF distributes funding annually for wastewater utility treatment and conveyance improvements. Examples of eligible projects include treatment facility upgrades, collection system rehabilitation, non-point source projects, and estuary projects. SRF requirements in many states, including California, are a mixture of federal and state-level requirements based on state law or state management preferences.

For example, federal statutes limit additional subsidization to disadvantaged communities (DACs), but the state SRF will have discretion on how a disadvantaged community is defined for their state program. The California CWSRF program is administered by the California Water Board and operates as a direct local loan program. Based on federal regulations, states must set interest rates for loans below market rates. The California Water Board set interest rates at 2.1% for 2026. Loan repayment periods are typically less than 30 years but a maximum term of 40 years. The CWSRF interest rates for specific funding allocations in federal fiscal year (FFY) 2025/2026 are provided in Table 9-2.

Table 9-2. CWSRF Interest Rates

Loan	Community Type	Interest Rate	Loan Forgiveness
Planning	<3,300 connections or <10,000 persons <80% of state MHI (DAC) <60% of state MHI (SDAC)	N/A	Up to 100%
Forgivable Loans	Small DAC	N/A	Up to 100%
Repayable Construction	Small SDAC with Water Rates >=1.5% MHI	0.00% Interest	Up to 100%
Expanded Repayable Construction	Small DAC or Expanded Small DAC/SDAC	½ General Obligation Bond Rate	N/A

Base Program Principal Forgiveness (equivalent to a grant and referred to as a grant in some cases by the SRF program) is available in the base program to help small and disadvantaged communities fund water infrastructure projects. These are applied to applicants that intend to obtain an SRF subsidized loan.

Entities meeting the criteria for financial hardship consideration may be eligible for reduced interest rates and loan principal forgiveness. Principal forgiveness eligibility is predominantly based on the MHI of the community a water system serves. The size of the population served also contributes to the interest rates or loan forgiveness awarded for a project. The types of projects eligible for forgiveness either address a public health order or a drinking water emerging contaminant. Some

forgiveness is also available for projects eligible for Green Project Reserve funding (GPR) with a sustainability factor. GPR funding is reserved for projects that utilize green infrastructure, create energy saving, or have some environmental benefits. The CWSRF Disadvantaged Community (DAC) criteria and principal forgiveness criteria is provided on Table 9-3 and Table 9-4, respectively.

Table 9-3. CWSRF Disadvantaged Community Citeria

Disadvantaged Community Definitions	
Disadvantaged Community= MHI 80% or Less of State Annual MHI	
Disadvantaged Community (DAC)	MHI <80% statewide MHI
Small Community	<3,300 connections or <10,000 people
Expanded Small Community	3,3000-6,600 connections or 10,000 – 20,000 people
Medium DAC	20,000 – 100,000 people and a MHI< 80% state MHI

Table 9-4. CWSRF Principal Forgiveness Criteria

Construction Grants and Principal Forgiveness			
Type of Community	Residential Water Rates as a % of MHI	% of Total Eligible Project Cost	Max Amount Per Connection
Small DAC/SDAC; Eligible NTNC That Serves a Small DAC/SDAC; Expanded Small DAC/SDAC; or Small Non-DAC with MHI < 150% of Statewide MHI	N/A	Up to 100%	$80,000
Medium DAC	>=1.5%	Up to 50%	$40,000

After an initial review, Fort Bragg may meet the disadvantaged community requirements. The 2024 American Community Survey 5-year estimates lists Fort Bragg's MHI as $56,481 which is about 56% of the state MHI of $100,149. The City's population in 2024 was 7,032 which is also below the small community definition of having a population of 10,000 or less. Depending on the project Fort Bragg may be eligible for principal forgiveness/grant funding through the state SRF program. It is recommended to City confirm its eligibility with a State Water Board representative. The CWSRF application and funding schedule is provided in Table 9-5.

Table 9-5. CWSRF Schedule

Historical Schedule of Annual Water Board SRF Milestones	
Submit Capitalization Grant Applications to the U.S. EPA	June
Draft Intended Use Plan (IUP) and Draft Supplemental IUPs Posted for Public Comment	June
Board Workshop	July
Deadline for Public Comments on Draft IUP and Draft Supplemental IUPs	Late July

Historical Schedule of Annual Water Board SRF Milestones	
State Water Board Considers IUP and Supplemental IUP at Regularly Scheduled Meetings	August
Receive Capitalization Grant Agreements from the U.S. EPA	October

As noted in Table 9-5, there are several SRF milestones. SRF funding is made available under the California State Water Resources Control Board (SWRCB) and projects must be on the Intended Use Plan (IUP) Fundable List to receive CWSRF funding. Additionally, the IUP serves as the guide for SRF funding and receives annual updates.

Further, The CWSRF application consists of four packages: General Information, Technical, Environmental, and Financial Packages.

- The General Information Package provides an overview of applicant and project data.
- The Technical Package details water rights, vulnerabilities, adaptation, and mitigation measures to highlight the project specific impacts (e.g. how does the project specifically impact the project area?).
- The Environmental Package summarizes environmental documents and environmental contact information.
- The Financial Package details applicant financial information to determine the ability to maintain infrastructure or financial security associated with the project.

All the near-term CIP projects would likely qualify for SRF funding. The City should prioritize applying for SRF funding with projects that have the greatest societal benefit. Projects that serve disadvantaged portions of the community and improve public safety will score highest on the SRF scoring criteria. Additionally, the City should apply for projects where other alternative funding sources are not available. The GP Mill Sewer Main Extension projects (P-35, P-37, P-38, P-39) may be partially funded through developer agreements. Therefore, projects like the Chief Celeri Drive Sewer Main Replacement (P-01) and the Oak Street Sewer Main Replacement IV (P-16) should be prioritized when applying for SRF funding.

The SRF process should be started early in the project schedule, particularly if bond supported loans are needed. In California, application packages including environmental reviews should be completed in the spring to be eligible for the upcoming fiscal year. It should be noted that submitting a General package will assign a SWRCB Project Manager who can help advise on submission of the other packages. If projects are selected and placed on the state's intended use plan, it may take a year or more for contracts to be approved and for the project to receive funding. If the City intends to use SRF funding for any proposed projects, it is suggested that conversations with SWRCB officials begin approximately a year and a half before project funding is needed. It should also be noted that eligibility for SRF funding is contingent on completion and approval of environmental reviews before the start of any construction activities.

9.8 USACE Section 219 Environmental Infrastructure Program

The USACE Section 219 Environmental Infrastructure Program (219 Program) provides the authority for the Army Corps to partner with non-federal entities to facilitate the development of various types of water-related environmental infrastructure across the United States. Examples of eligible projects under the 219 Program include (but are not limited to) water supply, wastewater treatment, and stormwater management. As stipulated in the authorities of the 219 Program, the USACE has a high degree of discretion over which projects it carries out, subject to statutory guidelines.

Generally, the steps to securing a partnership and funding with the USACE under the 219 Program are as follows:

1. Identify project need, details, scope, and cost.
2. Confirm eligibility under Section 219 general criteria.
3. Secure Congressional authorization via the biennial Water Resources Development Act (WRDA) or other piece of legislation.
4. Engage USACE local division to determine interest, capacity, and personnel.
    a. The City is located in the San Francisco District, which is within the South Pacific Division.
        i. phone: 415-503-6958/ 415-503-6804, email: cespn-pa2@usace.army.mil
5. Secure Congressional appropriations via the annual appropriation process.
6. Negotiate and sign a Project Partnership Agreement (PPA) with the USACE.
7. Project execution and completion.

As noted above, Congress must provide the USACE with specific authorization under the bipartisan Water Resources Development Act (WRDA) which is generally negotiated and passed every two years. This will require the City to work with its Congressional Delegation.

The Section 219 Program cost share is 75% federal and 25% non-federal. There will be no less than 25% non-federal cost share required for all projects. Additionally, pre-agreement costs will be 100% federal with 100% of the operation, maintenance, repair, rehabilitation and replacement (OMRR&R) costs of the project after construction coming from the non-Federal sponsor.

9.9 Climate Bond (Proposition 4)

In November 2024, the Climate Bond (Proposition 4) was voter approved for $10 billion in infrastructure investments aimed at protecting drinking water, reducing wildfire and flood risks, restoring natural places, supporting healthy working lands, and expanding access to parks and outdoor spaces. As of April 23, 2026, more than half of allocated funds has been committed (as shown in Table 9-6).

Table 9-6. Climate Bond Funding

Breakdown of Climate Bond Funding By Chapters			
Chapter	**Allocation**	**Committed[9]**	**Balance[10]**
Ch. 2 Safe Drinking Water, Drought, Flood, and Water Resilience	$3,771,500,000	$2,092,225,000	$1,679,277,000
Ch. 3 Wildfire and Forest Resilience	$1,488,750,000	$956,149,000	$532,598,000
Ch. 4 Coastal Resilience	$1,191,000,000	$419,149,000	$771,848,000
Ch. 5 Extreme Heat Mitigation	$446,625,000	$370,022,000	$76,603,000
Ch. 6 Protect Biodiversity and Accelerating Nature-Based Climate Solutions	$1,191,000,000	$613,971,000	$577,028,000
Ch. 7 Climate Smart, Sustainable, Resilient Farms, Ranches, and Working Lands	$297,750,000	$251,777,000	$45,976,000
Ch. 8 Parks Creation and Outdoor Access	$694,750,000	$516,930,000	$177,821,000
Ch. 9 Clean Air	$843,625,000	$612,409,000	$231,217,000
Ch. 10 Statewide Bond Costs	$75,000,000	$21,989,000	$53,011,000
	$10,000,000,000	$5,854,621,000	$4,145,379,000

Based on the project scope, Chapter 2 of the Climate Bond are the most relevant to the proposed project. Under Chapter 2 Safe Drinking Water, Drought, Flood, and Water Resilience, the following programs are potential funding opportunities: Water Quality and Clean, Safe Reliable Drinking Water and Water Reuse and Recycling grant programs.

Water Quality and Clean, Safe Reliable Drinking Water grant program supports failing and at-risk water systems and consolidations (drinking water) and projects addressing violations and septic-to-sewer projects (wastewater). The total bond allocation for this grant program is $585,000,000. The DWSRF and CWSRF IUP serve as guides for these Climate Bond funds.

[9] **"Committed"** represents dollar amounts proposed to the Legislature or authorized through the state budget process for programs or projects. It also includes any outyear dollars that administering departments have proposed in new budget requests or in proposals approved in prior budgets or in legislation. These figures are updated approximately every six months and published in the Proposition 4 Allocation Balance Report.

[10] **"Balance"** represents dollar amounts available for new budget appropriations (which give departments the authority to spend) or commitments for the purposes specified in the Proposition 4 bond language.

Water Reuse and Recycling program provides low interest loans and grants for the planning and construction of California recycled water projects. Its total bond allocation is $386,250,000 to support municipal wastewater.

9.10 Funding Recommendations

As outlined in the Fort Bragg Master Plan, some of the City's wastewater infrastructure including the Chief Celeri Drive Sewer Main, the WWTP Inflow Sewer Main, and Elm Street Force Main CIPP need to be addressed to properly serve the City. This is especially important due to the potential for structural deterioration of pipe infrastructure, which could present leak and flow concerns with older pipes causing release into freshwater bodies or the ocean. Table 9-7 outlines the funding mechanisms described in this section and identifies high-priority CIP projects that may be eligible based on eligibility requirements. One or several of these programs and strategies could be utilized when considering how to fund long-term CIP projects. Additionally, Table 9-8 describes the current available funding levels and type of funding mechanisms for each program that has been identified as a potential funding mechanism for Fort Bragg. It is important to note that funding levels and eligibility requirements are prone to yearly changes. The tables below provide initial funding guidance, but updated funding availability and program requirements should be reviewed before developing an application.

Long-term, sewer rate increases may be needed to recover revenue for projects that do not closely align with grant priorities. For other projects that serve new development areas like the GP Mill Sewer Extension projects, developer agreements should be leveraged when possible. This will allow the City to focus its attention on applying for other improvement projects like conveyance system rehabilitation and updates. It is best practice to conduct a rate study every five years to project revenue requirements based on anticipated increases in operations and maintenance (O&M) costs. A current rate study is also necessary for the SRF financial package. Fort Bragg's recent rate study should satisfy this requirement. For larger system improvement and expansion projects beyond localized sewer main extensions, long-term debt like SRFs, WIFIA, and Water Revenue Bonds will likely provide more support than many of the grant programs that are more prone to year-to-year budget decisions. For treatment capacity expansions and infrastructure modernization projects over $20 million, WIFIA loans could be considered. All the near-term CIP projects could also be combined into a single application for WIFIA as a larger wastewater transmission improvement project. Although current WIFIA interest rates are not as competitive as they were previously, the ability to defer principal payments and sculpting repayments is worth consideration. Programs like WIFIA will only fund new infrastructure projects, long-term maintenance and repairs should predominantly be funded using wastewater rate revenue when possible. Mid-sized projects like the Chief Celeri Drive Sewer Main Replacement or the Elm Street CIPP lining project could be funded through a combination of rate increases, and SRF funding.

The loan process should be started early whenever possible, and efforts in capital improvement planning can aid this process. When planning for future land use changes, capital improvement planning with funding programs in mind is important to secure funding and allowing for a quick response when additional funding opportunities arise. When developing a funding strategy, it is helpful to develop a long-term plan which includes project milestones and how they line up with funding application deadlines. Developing a long-term funding plan would allow the City to apply for program funding early, providing adequate time for necessary environmental and compliance reviews that can create project delays and delay funding awards.

As described in the grants section, some grant funding is available that may cover the cost of system expansions that service low income and disadvantage communities. Based on U.S. Census and SRF criteria, Fort Bragg qualifies as a low-income disadvantaged community. The City's disadvantaged status can be leveraged when applying to programs like HUD Community Development Grants and the EDA Public Works and Economic Adjustment Assistance Program. When applying for grants, projects that improve transmission or serve disadvantaged parts of the City should be prioritized. For EDA funding, GP Mill Sewer Extension projects may be eligible if the City can show that it will serve new developments that are needed for local economic development.

New Federal funding priorities have made grant funding levels more uncertain. Some annual funding programs have temporarily paused or halted funding allocations all together. With uncertainty regarding the future of some federal grant programs, the City should monitor funding notices and maintain communication with funding agencies to learn about updates to grant funding availability as soon possible to maximize the potential for these outside funding sources. Project planning, initial environmental reviews, and early engineering designs should be developed as soon as possible. Starting to plan early will assist with the development of grant applications that will have limited application windows when notices of funding availability are posted. A correlation of the City's water system CIP and potential funding source eligibility is provided in Table 9-7. A summary of the criteria associated with the potentially applicable funding sources is provided in Table 9-8.

Table 9-7. Potential Funding and Project Eligibility Matrix

CIP ID	Project Name	WIFIA	HUD CDBG	EDA Public Works	USDA Loans and Grants	EPA SRF	Climate Bond (Prop 4)	USACE Section 219
P-01	Chief Celeri Drive Sewer Main Project	X		X		X	X	X
F-01	Elm Street Force Main CIPP Lining	X		X		X	X	X
P-02	WWTP Inflow Sewer Main Replacement	X		X		X	X	X
P-16	E Oak Street Replacement IV	X		X		X	X	X

Table 9-8. Available Funding Summary

Source	Funding Type	Available $[a]	Notes
WIFIA	Long-Term Loan	49% of eligible projects over $20M and $5M for small communities	Interest rate based on U.S. Treasury Securities Maturity up to 35 years Sculpted debt • Letters of Interest on a rolling basis

Source	Funding Type	Available $[a]	Notes
CWSRF	Loan/Some Grant Funding Available	$391 million	Low interest for 20-year maturity Amount of funding is likely to decline after 2026 Broad eligibility
HUD Community Development Block Grants	Grant	$3.3 billion in FY2026	Funds allocated to state, city, and county Project must resolve a problem that will help revitalize the community Short project completion window, 24 months
EDA Public Works and Economic Adjustment	Grant	$30 million	Must promote economic development in disadvantaged areas Percent match requirements depending on disadvantaged status
USDA Water and Wastewater Loans and Grants	Predominately loans and some grants	Varies based on annual funding allocations	Projects must serve rural communities (population less than 10,000) Interest rates vary based on communities disadvantaged status Up to 40-year payback period
USACE Section 219 Program	Congressional authorization	$5 million	Projects must secure Congressional authorization Projects must engage USACE staff Cost share: 75% federal, 25% non-federal Must involve water-related environmental infrastructure projects

Source	Funding Type	Available $[a]	Notes
California Natural Resources Agency (CNRA) Climate Bond (Proposition 4)	Voter Approved Bond Funding-Grant/Non-Grant	$10 billion	Projects must safeguard our communities, natural resources, and future in the face of climate change. Eligibility under chapter 2 Water Quality and Clean, Safe Reliable Drinking Water and Water Reuse and Recycling grant programs. All funding has been allocated but not committed.

[a]Available funds provided in 2025 dollars

References

WIFIA – https://www.epa.gov/wifia

DWSRF- https://www.waterboards.ca.gov/drinking_water/services/funding/SRF.html

CWSRF - https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

HUD Community Development Block Grants - https://www.hud.gov/hud-partners/community-cdbg

EDA Public Works and economic adjustment - https://www.eda.gov/funding/funding-opportunities/fiscal-year-2025-public-works-and-economic-adjustment-assistance

USDA Water and Wastewater loans and grants - https://www.rd.usda.gov/programs-services/water-environmental-programs/water-waste-disposal-loan-grant-program

USACE 219 – https://www.nap.usace.army.mil/Portals/39/docs/Civil/219/219AUTH-Updated-Jan-2025.pdf?ver=6G7ygOU8z7J7qDMRthQRfw%3d%3d

Climate Bond (Prop 4) - https://bondaccountability.resources.ca.gov/Propositions/Proposition_4_Climate_Bond

American Community Survey (ACS) Data- https://data.census.gov/profile/Fort_Bragg_city,_California?g=160XX00US0625058#income-and-poverty

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

Like many communities, the City's wastewater collection system faces the challenges of aging infrastructure, evolving system demands, and climate change. Much of the gravity system was constructed in the 1960's or earlier and is made of materials with estimated useful lives of 70 to 75 years. This makes the older parts of the system 65+ years old, and the City is seeing effects of system degradation due to infrastructure age. Additionally, the major force mains in the City's system were constructed of Techite, which is a pipe material that has been demonstrated to be increasingly fragile with age, and are also reaching the end of their useful life.

Currently, the City's wastewater collection system performs it's function adequately, however the City anticipates that additional focus and resources will be needed to rehabilitate and maintain the system into the future, and to enhance it to meet future system demands. This 2025 Wastewater Collection System Master Plan will help the City identify and prioritize these needs to improve system reliability and to minimize emergency conditions now and into the future. This plan provides a transparent, data-driven, and repeatable capital planning process that identifies and prioritizes improvements and other planning actions for the wastewater collection system.

The flow study and hydraulic analysis of the system showed it is generally well-sized for current needs. However, capacity deficiencies were identified in some areas, which are likely compounded by infiltration and inflow into the system. These deficiencies are further exacerbated when future build-out is included in the analysis. Projects P-03 through P-33 address the current capacity deficiencies, with options to accommodate anticipated build-out capacity needs as well. The capital plan prioritizes these projects based on identified under-capacity areas from the hydraulic model, risk of failure, City staff experience, and – where available – condition information.

Additionally, key elements of the system show significant degradation and are at the end of their useful lives. Noteworthy projects identified to address degradation include the Chief Celeri Drive gravity main (P-01) and the WWTP Inflow gravity main (P-02).

The four major force mains are another concern. These were originally constructed of Techite pipe and are at the end of their useful lives. To address this problem, the City has already replaced the Pudding Creek force main with HDPE pipe and is currently executing projects to rehabilitate the North and South Noyo force mains. The Elm Street pump station force main is the final Techite main to be addressed and is included in project F-01.

The North Fort Bragg Sewer Main extension and the proposed Noyo Center development are the only known near-term development projects expected to increase system demands beyond the existing system capability. The anticipated capacity improvement projects (P-34 and P-35) have been included in the 10-year CIP, with the Noyo Center sewer main extension pending the start of the Center's development.

Given the system's age, this Master Plan also recommends implementing a systematic condition assessment program (projects R-01 and R-04) and a placeholder budget for renewal projects identified from this program (projects R-03 and R-05). This will allow the City to prioritize renewal projects based on the condition assessment framework, focusing renewal funding where it is most needed. A primary goal of the condition assessment program should be to identify and characterize

infiltration into the gravity main system. Focusing renewal projects on these problem infiltration areas can help mitigate the need and urgency for downstream capacity projects.

It is recommended that the City update its 10-year capital plan every five years to adapt to changing conditions and to reassess the need, timing, prioritization, and funding of identified CIP projects (O-01 & O-02).

Following City Council review, this Master Plan and CIP will be incorporated into the City's annual budgeting process. To support project implementation, project sheets have been developed, and project funding eligibility has been assessed for three of the highest priority projects (P-01: Chief Celeri Dr Sewer Main Replacement, P-02 WWTP Inflow Sewer Main Replacement, and P-16: E Oak St Sewer Main Replacement IV).

Appendix A. Manhole Survey

Job Description: GPS locate Sanitary Sewer Manhole within the City of Fort Bragg

MSURV Job Number 24833 Job Date: 12/1/2024-3/21/2025

Projection: State Plane 83: CA 2

Lat/Lon Datum: NAD 83 (2011) EPOCH 2010

Vertical Datum: NAVD 88 Geoid: 2018

Control Point (CP)
Control Check (CHK)
Clean Out, No Inv.
Unable to Locate, Location to be verified with City of Fort Bragg
Total Station Control (TS)

ASSID HDR	SSM	Point#	Northing	Easting	Description	Elevation in f	Invert in ft.	Geoid	Ellipsoid Elev	Latitude (Dec Deg)	Longitude (Dec Deg)	HRMS	VRMS	PDOP	HDOP	VDOP	SATS	DATE	TIME	NOTE
MNHL_CHNNL_4039	5A	1230	2299758.8828	6051903.9569	MH5A,NRIM,INV-9.10	48.16	9.10	-102.55	-54.39	39.46317	123.80569	0.0390	0.0727	0.8634	0.4692	0.7247	30	DT02-27-2	TM10:12:24	
MNHL_CHNNL_4040	2	1241	2291082.3513	6049639.1644	MH2,NRIM,INV-6.88	51.36	6.88	-102.78	-51.42	39.43923	123.81310	0.0310	0.0522	0.9066	0.5479	0.7223	25	DT02-27-2	TM13:23:43	
MNHL_CHNNL_4043	2A	1240	2291067.3958	6049765.9689	MH2A,NRIM,INV-7.98	53.32	7.98	-102.78	-49.46	39.43919	123.81265	0.0414	0.0722	0.9916	0.5797	0.8046	26	DT02-27-2	TM13:16:26	
MNHL_CHNNL_4045	3	1239	2291022.5910	6050134.7895	MH3,NRIM,INV-11.46	58.87	11.46	-102.76	-43.89	39.43909	123.81134	0.0404	0.0719	0.9945	0.5782	0.8093	26	DT02-27-2	TM13:13:01	
MNHL_CHNNL_4046	95	1242	2290962.6583	6050631.4254	MH95,NRIM,INV-13.31	64.16	13.31	-102.73	-38.58	39.43895	123.80958	0.0317	0.0507	0.9637	0.5675	0.7788	26	DT02-27-2	TM13:48:34	
MNHL_CHNNL_4050	1	1234	2298300.1530	6051526.1134	MH1,NRIM,PCLFT,INV-17.20_TS	20.24	17.20	-102.59	-82.35	39.45914	123.80693	NA						DT02-27-2	TM10:30:04	
MNHL_CHNNL_4051	14	1004	2296877.2556	6050889.6071	MH14,N-RIM,INV-3.95	56.83	3.95	-102.64	-45.81	39.45520	123.80908	0.020	0.028	0.749	0.418	0.621	34	DT01-14-2	TM11:46:48	
MNHL_CHNNL_4057	28	1007	2295728.8725	6050852.6145	MH28,NRIM,INV-7.32'	54.33	7.32	-102.66	-48.33	39.45205	123.80915	0.022	0.038	0.888	0.483	0.745	30	DT01-14-2	TM12:19:15	
MNHL_CHNNL_4058	29	1275	2295697.8691	6050846.4069	MH29,NRIM,INV-8.96	55.74	8.96	-102.66	-46.92	39.45196	123.80915	0.0348	0.0523	0.9009	0.4706	0.7682	28	DT03-11-2	TM11:39:57	
MNHL_CHNNL_4059	30	1274	2295696.0083	6050829.6297	MH30,NRIM,INV-6.93	55.46	6.93	-102.66	-47.21	39.45196	123.80927	0.0282	0.0420	0.8647	0.4544	0.7357	29	DT03-11-2	TM11:36:22	
MNHL_CHNNL_4069	42	1267	2295171.5275	6051727.4729	MH42,NRIM,INV-6.94	69.86	6.94	-102.62	-32.76	39.45057	123.80595	0.0425	0.0713	0.7978	0.4354	0.6685	32	DT03-11-2	TM10:10:33	
MNHL_CHNNL_4070	43	1212	2295175.7381	6051565.3428	MH43,NRIM,INV-6.84	67.76	6.84	-102.63	-34.87	39.45057	123.80657	0.0283	0.0416	0.9868	0.5099	0.8449	26	DT02-26-2	TM11:41:57	
MNHL_CHNNL_4072	45	1010	2295111.2364	6050985.9091	MH45,N-RIM,INV-5.14	66.65	5.14	-102.66	-36.01	39.45036	123.80862	0.021	0.032	0.918	0.453	0.798	32	DT01-14-2	TM13:33:55	
MNHL_CHNNL_4073	51	1276	2294700.3673	6051551.5500	MH51,NRIM,INV-8.47	73.17	8.47	-102.64	-29.47	39.44926	123.80658	0.0370	0.0561	0.8784	0.4693	0.7426	28	DT03-11-2	TM11:46:05	
MNHL_CHNNL_4074	60A	1025	2294710.9042	6052159.7596	MH60A,NRIM,INV-6.30	78.19	6.30	-102.61	-24.41	39.44932	123.80443	0.027	0.048	0.977	0.520	0.827	27	DT01-14-2	TM15:04:51	
MNHL_CHNNL_4075	50	1016	2294260.4840	6051149.5360	MH50,NRIM,INV-6.73	73.19	6.73	-102.67	-29.47	39.44803	123.80798	0.025	0.037	0.923	0.456	0.802	31	DT01-14-2	TM14:12:29	
MNHL_CHNNL_4076	54	1228	2294231.8839	6051720.9257	MH54,NRIM,INV-7.63	80.95	7.63	-102.64	-21.69	39.44799	123.80595	0.0354	0.0551	0.8600	0.4464	0.7351	32	DT02-27-2	TM09:43:01	
MNHL_CHNNL_4077	52	1020	2294255.4943	6051543.9368	MH52,NRIM,INV-10.40	77.75	10.40	-102.64	-24.90	39.44804	123.80658	0.028	0.047	0.979	0.510	0.835	27	DT01-14-2	TM14:42:51	
MNHL_CHNNL_4079	148A	1209	2295291.5762	6052834.0297	MH148A,NRIM,INV-3.20	87.29	3.20	-102.56	-15.27	39.45096	123.80208	0.0441	0.0633	0.9383	0.4648	0.8151	25	DT02-26-2	TM11:10:41	
MNHL_CHNNL_4085	159	1037	2294212.7876	6052647.9172	MH159,NRIM,INV-8.82'	84.78	8.82	-102.59	-17.81	39.44798	123.80267	0.0212	0.0328	0.8881	0.4522	0.7644	33	DT01-21-2	TM13:04:44	
MNHL_CHNNL_4086	155	1205	2294203.9549	6053016.5066	MH155,NRIM,INV-12.85	95.94	12.85	-102.57	-6.63	39.44798	123.80136	0.0425	0.0630	0.8469	0.4474	0.7191	32	DT02-26-2	TM10:44:07	
MNHL_CHNNL_4087	153A	1199	2294653.6585	6053029.0409	MH153,NRIM,INV-3.54	97.70	3.54	-102.56	-4.86	39.44921	123.80135	0.0240	0.0448	0.9126	0.5209	0.7494	29	DT02-26-2	TM10:03:58	
MNHL_CHNNL_4088	151	1202	2294635.5848	6053752.4835	MH151,NRIM,INV-1.90	109.41	1.90	-102.52	6.88	39.44920	123.79875	0.0419	0.0817	0.8606	0.4891	0.7081	28	DT02-26-2	TM10:25:54	
MNHL_CHNNL_4089	151A	1204	2294631.6185	6053944.3403	MH151A,NRIM,INV-2.93	112.51	2.93	-102.51	9.99	39.44920	123.79815	0.0313	0.0494	0.8927	0.4831	0.7506	30	DT02-26-2	TM10:35:44	
MNHL_CHNNL_4090	150	1203	2294247.9832	6053931.0536	MH150,NRIM,INV-3.70	117.77	3.70	-102.52	15.25	39.44815	123.79815	0.0350	0.0660	0.9342	0.5083	0.7838	26	DT02-26-2	TM10:34:27	
MNHL_CHNNL_4092	165A	1043	2293725.4948	6053759.9676	MH165A,NRIM,INV-3.39	113.56	3.39	-102.54	11.03	39.44671	123.79870	0.0315	0.0491	0.7926	0.4346	0.6629	33	DT01-21-2	TM13:59:36	
MNHL_CHNNL_4093	165	1042	2293729.5934	6053585.6631	MH165,NRIM,INV-3.81	106.35	3.81	-102.54	3.80	39.44671	123.79935	0.0208	0.0323	0.8072	0.4339	0.6807	34	DT01-21-2	TM13:52:47	
MNHL_CHNNL_4094	164	1041	2293739.8898	6053384.7656	MH164,NRIM,INV-5.61,,	101.43	5.61	-102.55	-1.13	39.44673	123.80005	0.0194	0.0298	0.8794	0.4537	0.7534	32	DT01-21-2	TM13:45:48	
MNHL_CHNNL_4095	168A	1046	2293268.4885	6053749.8729	MH168A,NRIM,INV-5.52'	110.35	5.52	-102.54	7.81	39.44545	123.79870	0.0273	0.0502	0.9276	0.5245	0.7651	30	DT01-21-2	TM14:20:56	
MNHL_CHNNL_4096	170	1047	2293301.4887	6053374.7943	MH170,NRIM,INV-4.22'	106.04	4.22	-102.56	3.48	39.44552	123.80003	0.0213	0.0385	0.9234	0.5124	0.7682	31	DT01-21-2	TM14:27:19	
MNHL_CHNNL_4097	166	1049	2292820.2466	6054135.0011	MH166,NRIM,INV-6.86'	120.40	6.86	-102.53	17.88	39.44424	123.79735	0.0209	0.0387	1.0367	0.5478	0.8801	28	DT01-21-2	TM14:42:19	
MNHL_CHNNL_4101	78	1166	2293009.6923	6052277.0288	MH78,NRIM,INV-4.03	94.78	4.03	-102.62	-7.85	39.44466	123.80390	0.0346	0.0627	0.9802	0.5670	0.7996	22	DT02-11-2	TM14:03:31	
MNHL_CHNNL_4105	77	1278	2292766.6449	6051906.4952	MH77,NRIM,INV-7.85	80.69	7.85	-102.64	-21.96	39.44397	123.80515	0.0632	0.1055	1.0791	0.5992	0.8974	19	DT03-11-2	TM12:52:27	
MNHL_CHNNL_4106	73	1167	2293483.5659	6051919.0519	MH73,NRIM,INV-6.75	84.41	6.75	-102.63	-18.23	39.44594	123.80520	0.0365	0.0702	0.9863	0.5867	0.7930	22	DT02-11-2	TM14:09:17	
MNHL_CHNNL_4108	83	1164	2292394.2190	6052266.9021	MH83,NRIM,INV-6.25	82.05	6.25	-102.63	-20.58	39.44297	123.80385	0.0300	0.0498	0.9007	0.5051	0.7457	27	DT02-11-2	TM13:47:03	
MNHL_CHNNL_4109	190	1094	2292402.9378	6052600.6412	MH190,NRIM,INV-4.93	98.67	4.93	-102.61	-3.94	39.44301	123.80275	0.0308	0.0613	0.9196	0.4927	0.7765	26	DT02-10-2	TM10:10:55	
MNHL_CHNNL_4113	90	1035	2291933.1110	6051462.0313	MH90,NRIM,INV-8.92'	67.85	8.92	-102.68	-34.83	39.44166	123.80675	0.0208	0.0333	0.8935	0.4822	0.7522	30	DT01-21-2	TM11:37:31	
MNHL_CHNNL_4115	96	1225	2291016.1957	6051682.9888	MH96,NRIM,INV-8.13	66.97	8.13	-102.68	-35.71	39.43916	123.80585	0.0503	0.0746	0.8564	0.4551	0.7254	31	DT02-27-2	TM09:21:54	
MNHL_CHNNL_4116	98	1158	2291009.0833	6052037.4782	MH98,NRIM,INV-6.29	73.70	6.29	-102.66	-28.96	39.43916	123.80460	0.0379	0.0652	0.9069	0.4736	0.7735	30	DT02-11-2	TM13:10:35	
MNHL_CHNNL_4117	99	1159	2291005.1741	6052225.7376	MH99,NRIM,INV-7.75	80.00	7.75	-102.65	-22.65	39.43916	123.80394	0.0351	0.0610	0.9479	0.4900	0.8114	28	DT02-11-2	TM13:17:54	
MNHL_CHNNL_4118	92	1238	2290995.7344	6051436.6984	MH92,NRIM,INV-6.01	60.95	6.01	-102.69	-41.75	39.43909	123.80675	0.0263	0.0486	0.9440	0.5324	0.7796	25	DT02-27-2	TM12:55:37	
MNHL_CHNNL_4119	88	1163	2291493.4241	6051873.4500	MH88,NRIM,INV-6.65	73.90	6.65	-102.66	-28.77	39.44048	123.80522	0.0259	0.0433	0.9256	0.5013	0.7781	27	DT02-11-2	TM13:46:16	
MNHL_CHNNL_4120	87	1162	2291495.3074	6052075.5993	MH87SDLID,NRIM,INV-4.28	80.25	4.28	-102.65	-22.41	39.44049	123.80450	0.0311	0.0542	0.9870	0.5197	0.8390	26	DT02-11-2	TM13:33:30	
MNHL_CHNNL_4123	84	1235	2292070.4236	6052259.3849	MH84,NRIM,INV-6.09	85.79	6.09	-102.64	-16.85	39.44208	123.80385	0.0382	0.0639	0.8445	0.4390	0.7214	32	DT02-27-2	TM10:50:53	
MNHL_CHNNL_4126	192	1098	2292131.9929	6052756.0714	MH192,NRIM,INV-6.10	95.15	6.10	-102.61	-7.46	39.44228	123.80214	0.0354	0.0569	0.8253	0.4378	0.6996	36	DT02-10-2	TM10:50:13	
MNHL_CHNNL_4127	191	1097	2292145.4937	6052593.9182	MH191,NRIM,INV-3.25	91.65	3.25	-102.62	-10.97	39.44231	123.80275	0.0418	0.0721	0.8366	0.4442	0.7089	36	DT02-10-2	TM10:47:53	
MNHL_CHNNL_4128	195	1095	2292235.3182	6052455.9351	MH195,NRIM,INV-3.16	89.50	3.16	-102.62	-13.12	39.44255	123.80325	0.0336	0.0593	0.8637	0.4641	0.7284	32	DT02-10-2	TM10:18:06	
MNHL_CHNNL_4129	185	1093	2292389.9184	6052970.5131	MH185,NRIM,INV-5.13	103.05	5.13	-102.59	0.46	39.44300	123.80140	0.0446	0.0792	0.7581	0.4173	0.6330	26	DT02-10-2	TM10:04:05	
MNHL_CHNNL_4130	177	1091	2292365.9926	6053729.1605	MH177,NRIM,INV-5.63	120.45	5.63	-102.55	17.89	39.44297	123.79870	0.0475	0.0857	0.8603	0.4538	0.7308	32	DT02-10-2	TM09:51:41	
MNHL_CHNNL_4131	176	1090	2292358.3707	6054109.7924	MH176,NRIM,INV-6.27	125.47	6.27	-102.54	22.94	39.44297	123.79736	0.0585	0.0984	0.8046	0.4201	0.6862	28	DT02-10-2	TM09:43:51	
MNHL_CHNNL_4132	297	1293	2292354.1080	6054345.6037	MH297,NRIM,INV-5.20	129.33	5.20	-102.52	26.80	39.44297	123.79655	0.0333	0.0483	0.8923	0.5310	0.7171	27	DT03-11-2	TM14:38:00	

MNHL_CHNNL_4133	296	1110	2292351.1039	6054509.0400	MH296,N-RIM,INV-3.90	129.03	3.90	-102.51	26.52	39.44297	123.7959	0.0372	0.0567	0.8089	0.4259	0.6877	27	DT02-10-2TM12:01:29
MNHL_CHNNL_4134	289	1109	2292352.9206	6054656.9640	MH289,N-RIM,INV-7.29	129.34	7.29	-102.51	26.83	39.44299	123.7954	0.0544	0.0821	0.7932	0.4196	0.6732	27	DT02-10-2TM11:59:59
MNHL_CHNNL_4136	184	1092	2292379.9271	6053348.2481	MH184,NRIM,INV-5.85	108.06	5.85	-102.57	5.49	39.44299	123.8000	0.0470	0.0820	0.7924	0.4294	0.6660	34	DT02-10-2TM09:57:40
MNHL_CHNNL_4137	260A	1288	2292579.7982	6054386.9976	MH260A,NRIM,INV-5.26	127.37	5.26	-102.52	24.86	39.44360	123.7964	0.0315	0.0483	0.9486	0.5618	0.7644	23	DT03-11-2TM13:59:01
MNHL_CHNNL_4138	258	1050	2292785.2452	6054309.3567	MH258,NRIM,INV-9.20'	123.98	9.20	-102.52	21.46	39.44416	123.7966	0.0231	0.0417	0.9638	0.5209	0.8109	28	DT01-21-2TM14:52:11
MNHL_CHNNL_4139	262	1059	2292774.2674	6054600.8623	MH262,NRIM,INV-2.82	119.08	2.82	-102.50	16.58	39.44414	123.7956	0.0433	0.0719	1.2503	0.5975	1.0983	25	DT01-24-2TM14:08:12
MNHL_CHNNL_4140	263	1289	2292550.1945	6055500.0561	MH263,NRIM,INV-3.12	127.14	3.12	-102.46	24.68	39.44357	123.7924	0.0799	0.1359	1.0726	0.6523	0.8515	19	DT03-11-2TM14:11:37
MNHL_CHNNL_4142	262A	1062	2292547.7438	6055639.4959	MH262A,NRIM,INV-3.85	129.16	3.85	-102.45	26.70	39.44358	123.7919	0.0640	0.0882	1.1233	0.5819	0.9609	18	DT01-24-2TM14:43:15
MNHL_CHNNL_4146	270	1113	2291885.7416	6055908.4073	MH270,NRIM,INV-8.32	142.69	8.32	-102.45	40.24	39.44177	123.7909	0.0354	0.0609	0.9954	0.5356	0.8390	32	DT02-10-2TM13:04:36
MNHL_CHNNL_4151	278	1111	2291874.0434	6055421.8298	MH278,NRIM,INV-5.85	140.47	5.85	-102.47	38.00	39.44171	123.7926	0.0361	0.0613	0.8152	0.4586	0.6740	33	DT02-10-2TM12:52:40
MNHL_CHNNL_4159	347	1074	2291828.3459	6057877.2195	MH347,NRIM,INV-7.52'	160.53	7.52	-102.35	58.18	39.44172	123.7839	0.0267	0.0379	0.9176	0.4780	0.7832	29	DT01-30-2TM13:03:54
MNHL_CHNNL_4160	346	1292	2292154.7930	6057893.2286	MH346,NRIM,INV-5.38	160.48	5.38	-102.34	58.13	39.44262	123.7839	0.0434	0.0646	0.8934	0.5310	0.7185	26	DT03-11-2TM14:30:36
MNHL_CHNNL_4162	334	1076	2291173.1546	6057698.4464	MH334,NRIM,INV-4.78'	160.29	4.78	-102.37	57.92	39.43991	123.7845	0.0295	0.0430	0.9996	0.5215	0.8527	28	DT01-30-2TM13:31:44
MNHL_CHNNL_4167	342	1070	2292484.0483	6057897.5414	MH342,NRIM,INV-5.77	162.69	5.77	-102.34	60.35	39.44352	123.7839	0.0303	0.0492	0.9230	0.5093	0.7698	30	DT01-30-2TM11:38:52
MNHL_CHNNL_4168	343	1071	2292482.5611	6058296.7266	MH343,NRIM,INV-5.97	172.76	5.97	-102.32	70.44	39.44354	123.7825	0.0464	0.0805	0.9261	0.5125	0.7714	28	DT01-30-2TM11:48:07
MNHL_CHNNL_4169	345	1073	2292483.8268	6058965.3478	MH345,NRIM,INV-5.68'	185.80	5.68	-102.28	83.52	39.44358	123.7801	0.0305	0.0652	1.0411	0.5987	0.8517	24	DT01-30-2TM12:05:07
MNHL_CHNNL_4170	**341**	**1116**	**2292914.5872**	**6057907.2267**	**CO341,NRIM,NO INV**	**166.70**	**-102.33**	**64.37**	**39.44471**	**123.7839**	**0.0543**	**0.0974**	**1.0133**	**0.5402**	**0.8574**	**21**	**DT02-10-2TM13:36:**	
MNHL_CHNNL_4178	175	1102	2291877.1559	6054086.1606	MH175,NRIM,INV-5.28	124.07	5.28	-102.54	21.53	39.44165	123.7974	0.0521	0.0816	0.8597	0.4551	0.7294	35	DT02-10-2TM11:19:33
MNHL_CHNNL_4180	271	1114	2291484.5546	6055908.3127	MH271,NRIM,INV-5.85	145.04	5.85	-102.45	42.59	39.44067	123.7909	0.0344	0.0589	0.9650	0.5215	0.8119	33	DT02-10-2TM13:11:49
MNHL_CHNNL_4182	174	1082	2291378.2610	6054086.7576	MH174,NRIM,INV-3.53'	125.67	3.53'	-102.55	23.12	39.44028	123.7973	0.0297	0.0540	0.9795	0.5428	0.8153	25	DT01-30-2TM14:34:03
MNHL_CHNNL_4183	197	1146	2290978.2178	6054077.8276	MH197,NRIM,INV-3.00	129.66	3.00	-102.55	27.10	39.43918	123.7973	0.0468	0.0772	0.8308	0.4518	0.6972	33	DT02-11-2TM11:19:12
MNHL_CHNNL_4185	194A	1160	2291136.0825	6052572.2711	MH194A,NRIM,INV-3.96	103.89	3.96	-102.63	1.26	39.43953	123.8027	0.0286	0.0502	1.0147	0.5155	0.8740	26	DT02-11-2TM13:22:00
MNHL_CHNNL_4187	189	1106	2291477.7618	6052950.4321	MH189,N-RIM,INV-2.96	105.43	2.96	-102.61	2.82	39.44049	123.8014	0.0548	0.0894	0.8875	0.4682	0.7539	32	DT02-10-2TM11:35:37
MNHL_CHNNL_4188	181	1104	2291473.5872	6053334.9550	MH181,NRIM,INV-3.40	115.08	3.40	-102.59	12.50	39.44050	123.8000	0.0337	0.0519	0.8581	0.4564	0.7266	35	DT02-10-2TM11:25:41
MNHL_CHNNL_4189	198	1149	2290942.0099	6053696.6247	MH198,NRIM,INV-4.35	129.37	4.35	-102.57	26.80	39.43906	123.7987	0.0282	0.0458	0.9103	0.4789	0.7742	33	DT02-11-2TM11:31:00
MNHL_CHNNL_4190	307	1084	2290701.2012	6054569.0586	MH307,NRIM,INV-5.19'	144.40	5.19	-102.53	41.87	39.43845	123.7956	0.0323	0.0563	0.9561	0.5841	0.7569	24	DT01-30-2TM15:04:29
MNHL_CHNNL_4193	302	1085	2289924.0675	6055373.6343	MH302,NRIM,INV-4.81'	147.44	4.81	-102.50	44.94	39.43636	123.7927	0.0283	0.0495	0.9840	0.6153	0.7679	23	DT01-30-2TM15:14:34
MNHL_CHNNL_4195	312	1271	2289304.3612	6055865.2681	MH312,NRIM,INV-2.15	155.93	2.15	-102.48	53.44	39.43468	123.7909	0.0294	0.0472	0.8305	0.4522	0.6966	31	DT03-11-2TM10:43:37
MNHL_CHNNL_4198	338	1119	2289902.4560	6056668.5250	MH338,NRIM,INV-6.55	161.79	6.55	-102.44	59.36	39.43637	123.7881	0.0401	0.0653	0.9960	0.5247	0.8466	29	DT02-10-2TM14:03:34
MNHL_CHNNL_4199	339	1118	2289630.9428	6056662.4365	MH339,NRIM,INV-4.03	161.04	4.03	-102.44	58.60	39.43562	123.7881	0.0402	0.0664	0.9314	0.5087	0.7802	29	DT02-10-2TM13:59:17
MNHL_CHNNL_4200	340	1117	2289362.6660	6056633.2071	MH340,NRIM,INV-4.95	164.57	4.95	-102.45	62.12	39.43489	123.7882	0.0398	0.0655	0.9599	0.5248	0.8037	29	DT02-10-2TM13:55:15
MNHL_CHNNL_4201	298	1078	2290521.7723	6055880.1653	MH298,NRIM,INV-5.76'	152.13	5.76	-102.47	49.66	39.43803	123.7909	0.0237	0.0356	0.9824	0.5077	0.8411	28	DT01-30-2TM13:54:54
MNHL_CHNNL_4206	**304**	**1080**	**2290613.7266**	**6055358.4214**	**MH304,NRIM,CLEANOUT-NO INV.**	**146.53**	**NO INV**	**-102.49**	**44.04**	**39.43825**	**123.7928**	**0.0248**	**0.0404**	**0.9982**	**0.5338**	**0.8435**	**26**	**DT01-30-2TM14:16:**
MNHL_CHNNL_4207	303	1079	2290234.6941	6055378.5386	MH303,NRIM,INV-4.37'	146.73	4.37	-102.50	44.24	39.43721	123.7927	0.0311	0.0478	0.9589	0.5049	0.8152	28	DT01-30-2TM14:02:56
MNHL_CHNNL_4209	**212**		**NOT LOCATED SEE NOTE**															**UNABLE TO LOCATE PAVED OVER**
MNHL_CHNNL_4210	213	1144	2289424.0858	6053722.0965	MH213,NRIM,INV-2.79	113.92	2.79	-102.59	11.33	39.43490	123.7985	0.0298	0.0505	0.8491	0.4682	0.7084	32	DT02-11-2TM11:05:24
MNHL_CHNNL_4213	204	1154	2289971.7895	6052711.9954	MH204,NRIM,INV-8.61	99.18	8.61	-102.64	-3.46	39.43635	123.8021	0.0344	0.0524	0.8628	0.4445	0.7394	32	DT02-11-2TM12:34:26
MNHL_CHNNL_4216	117	1138	2288647.1613	6051979.3736	MH117,NRIM,INV-7.89	109.16	7.89	-102.69	6.47	39.43267	123.8046	0.0306	0.0486	0.8482	0.4480	0.7203	33	DT02-11-2TM10:31:17
MNHL_CHNNL_4217	118	1130	2288222.8307	6051963.3012	MH118,NRIM,INV-7.55	116.96	7.55	-102.70	14.26	39.43150	123.8046	0.0416	0.0596	0.8957	0.4598	0.7687	29	DT02-11-2TM09:39:12
MNHL_CHNNL_4227	103	1236	2290566.5709	6051664.7342	MH103,NRIM,INV-6.59	69.99	6.59	-102.69	-32.69	39.43792	123.8058	0.0315	0.0528	0.8789	0.4509	0.7544	30	DT02-27-2TM10:57:20
MNHL_CHNNL_4239	135	1215	2285229.6408	6051014.8807	MH135,NRIM,INV-7.45	111.18	7.45	-102.78	8.40	39.42324	123.8078	0.0382	0.0612	0.9536	0.5489	0.7798	25	DT02-26-2TM13:34:45
MNHL_CHNNL_4242	1	1171	2290923.8338	6049499.4024	MH1,NRIM,INV-7.84	51.37	7.84	-102.79	-51.42	39.43878	123.8135	0.0328	0.0504	0.9879	0.5757	0.8029	26	DT02-11-2TM14:45:13
MNHL_CHNNL_4244	101	1156	2290622.1616	6052026.1287	MH101,NRIM,INV-7.54	74.13	7.54	-102.67	-28.54	39.43809	123.8046	0.0417	0.0728	1.0074	0.5059	0.8712	18	DT02-11-2TM13:02:04
MNHL_CHNNL_4248	101A	1155	2290353.5834	6052019.1076	MH101A,NRIM,INV-5.70	75.06	5.70	-102.67	-27.61	39.43736	123.8046	0.0398	0.0643	0.9525	0.4914	0.8160	29	DT02-11-2TM12:50:17
MNHL_CHNNL_4249	62	1018	2293772.6658	6051561.2954	MH62,NRIM,INV-5.22	81.17	5.22	-102.65	-21.48	39.44672	123.8064	0.027	0.041	0.902	0.465	0.773	28	DT01-14-2TM14:29:31
MNHL_CHNNL_4255	63	1017	2293781.8763	6051149.8375	MH63,NRIM,INV-3.51	76.80	3.51	-102.67	-25.87	39.44672	123.8079	0.025	0.037	0.901	0.458	0.775	30	DT01-14-2TM14:22:34
MNHL_CHNNL_4263	**144**		**NOT LOCATED SEE NOTE**															**UNABLE TO LOCATE PAVED OVER**
MNHL_CHNNL_4264	246	1303	2284717.3187	6052270.9750	MH246,NRIM,INV-6.43	31.27	6.43	-102.72	-71.45	39.42190	123.8033	0.0406	0.0864	1.0740	0.5777	0.9054	22	DT03-11-2TM16:26:46
MNHL_CHNNL_4264	**245**		**NOT LOCATED SEE NOTE**															**UNABLE TO LOCATE**
MNHL_CHNNL_4267	255	1121	2284691.7894	6053468.8511	MH255,NRIM,INV-6.16	145.02	6.16	-102.66	42.36	39.42189	123.7990	0.0574	0.0993	0.9683	0.5710	0.7820	19	DT02-10-2TM14:29:28
MNHL_CHNNL_4269	249	1120	2283926.6640	6052380.2912	MH249,NRIM,INV-9.50	96.43	9.50	-102.72	-6.30	39.41973	123.8028	0.0638	0.0985	0.8943	0.5125	0.7329	28	DT02-10-2TM14:20:21
MNHL_CHNNL_4276	226	1134	2288603.1887	6053692.1508	MH226,NRIM,INV-6.39	111.52	6.39	-102.60	8.91	39.43264	123.7985	0.0538	0.0733	0.7909	0.4259	0.6664	34	DT02-11-2TM10:05:20
MNHL_CHNNL_4277	225	1133	2288578.1132	6053744.1815	MH225,NRIM,INV-6.58	112.02	6.58	-102.60	9.42	39.43258	123.7983	0.0363	0.0528	0.7912	0.4257	0.6669	35	DT02-11-2TM10:02:09
MNHL_CHNNL_4278	229A	1135	2288465.7276	6052874.6427	MH229A,NRIM,INV-5.34	110.51	5.34	-102.65	7.87	39.43222	123.8014	0.0485	0.0875	0.8941	0.4716	0.7597	29	DT02-11-2TM10:12:33
MNHL_CHNNL_4283	219	1140	2289298.4235	6052975.4861	MH219,NRIM,INV-7.45	106.58	7.45	-102.63	3.94	39.43451	123.8011	0.0436	0.0775	0.8478	0.4562	0.7146	30	DT02-11-2TM10:46:23
MNHL_CHNNL_4288	208	1150	2290626.1781	6052729.8122	MH208,NRIM,INV-4.74	101.63	4.74	-102.63	-1.00	39.43814	123.8021	0.0398	0.0590	0.8472	0.4255	0.7326	34	DT02-11-2TM12:14:03
MNHL_CHNNL_4289	209	1297	2290770.8468	6052741.9672	MH209,NRIM,INV-4.97	103.30	4.97	-102.63	0.67	39.43854	123.8020	0.0274	0.0412	0.9381	0.5413	0.7663	27	DT03-11-2TM15:02:55
MNHL_CHNNL_4290	187	1099	2291930.2615	6052956.7366	MH187,NRIM,INV-5.19	101.73	5.19	-102.60	-0.87	39.44174	123.8014	0.0381	0.0594	0.8046	0.4271	0.6819	37	DT02-10-2TM11:00:42
MNHL_CHNNL_4294	69	1032	2293523.7055	6051554.9399	MH69,NRIM,INV-4.13	81.31	4.13	-102.65	-21.34	39.44603	123.8064	0.0187	0.0271	0.8405	0.4500	0.7099	30	DT01-21-2TM10:33:03
MNHL_CHNNL_4296	181A	1105	2291475.0780	6053158.4861	MH181A,N-RIM,INV-2.96	107.64	2.96	-102.60	5.04	39.44050	123.8006	0.0306	0.0472	0.8257	0.4384	0.6997	35	DT02-10-2TM11:30:51
MNHL_CHNNL_4297		**1281**	**2294930.1334**	**6052686.5391**	**ASSID?,TOP,C/O_NOINV**	**88.03**	**NO INV**	**-102.58**	**-14.55**	**39.44996**	**123.8025**	**0.0525**	**0.0963**	**1.0003**	**0.5560**	**0.8315**	**21**	**DT03-11-2TM13:13:**
MNHL_CHNNL_4318	35A	1005	2295709.7882	6050958.1522	MH35A,NRIM,INV-6.81	55.62	6.81	-102.66	-47.04	39.45200	123.8087	0.022	0.035	0.838	0.457	0.703	32	DT01-14-2TM11:57:08

MNHL_CHNNL_4321	37	1008	2295619.5758	6051578.1682	MH37,N-RIM,INV-6.86	63.64	6.86	-102.62	-38.98	39.45179	123.8065	0.022	0.036	0.851	0.448	0.724	33	DT01-14-2	TM13:16:21	
MNHL_CHNNL_4327	39	1023	2295167.6734	6051959.6228	MH39,NRIM,INV-5.57'	71.58	5.57	-102.61	-31.03	39.45057	123.8051	0.028	0.048	1.010	0.531	0.859	26	DT01-14-2	TM14:54:01	
MNHL_CHNNL_4328	41	1229	2295171.5381	6051787.9404	MH41,NRIM,INV-6.46	70.32	6.46	-102.62	-32.30	39.45057	123.8057	0.0407	0.0634	0.8514	0.4517	0.7217	32	DT02-27-2	TM09:49:58	
MNHL_CHNNL_4329	47	1009	2295208.6100	6050973.6401	MH47,N-RIM,INV-3.81	63.19	3.81	-102.66	-39.47	39.45063	123.8086	0.024	0.037	0.983	0.497	0.848	27	DT01-14-2	TM13:26:38	
MNHL_CHNNL_4330			NOT LOCATED SEE NOTE																	UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4331	51A	1277	2294720.5200	6051807.5875	MH51A,NWRIM,INV-5.98	75.16	5.98	-102.62	-27.46	39.44933	123.8056	0.0303	0.0479	0.9061	0.4862	0.7646	28	DT03-11-2	TM11:51:21	
MNHL_CHNNL_4335	49	1012	2294268.0466	6050966.0561	MH49,N-RIM,INV-7.13	71.76	7.13	-102.67	-30.92	39.44804	123.8086	0.027	0.039	0.843	0.421	0.731	34	DT01-14-2	TM13:58:01	
MNHL_CHNNL_4336	49A	1015	2294261.0742	6050954.1151	MH49A,NRIM,INV-5.91'	71.65	5.91	-102.68	-31.03	39.44802	123.8086	0.022	0.031	0.858	0.430	0.743	33	DT01-14-2	TM14:05:42	
MNHL_CHNNL_4337	53	1227	2294248.1036	6051706.4504	MH53,NRIM,INV-11.50	80.47	11.50	-102.64	-22.16	39.44803	123.8060	0.0338	0.0516	0.8578	0.4462	0.7327	33	DT02-27-2	TM09:40:54	
MNHL_CHNNL_4338	60	1197	2294706.4837	6052335.1026	MH60,NRIM,INV-6.76	80.09	6.76	-102.60	-22.51	39.44932	123.8038	0.0388	0.0819	0.9245	0.4971	0.7795	27	DT02-26-2	TM09:52:09	
MNHL_CHNNL_4339	59	1198	2294727.1716	6052353.1609	MH59,NRIM,INV-5.86	79.82	5.86	-102.60	-22.78	39.44938	123.8037	0.0315	0.0710	1.0621	0.5885	0.8842	23	DT02-26-2	TM09:56:23	
MNHL_CHNNL_4341	148	1210	2295285.5732	6052823.3760	MH148,NRIM,INV-3.90	87.65	3.90	-102.56	-14.92	39.45094	123.8021	0.0412	0.0579	0.9324	0.4699	0.8053	25	DT02-26-2	TM11:11:54	
MNHL_CHNNL_4342	147A	1211	2295334.4839	6053043.5145	MH147A,NRIM,INV-5.35	90.26	5.35	-102.55	-12.29	39.45108	123.8013	0.0355	0.0518	0.9178	0.4716	0.7874	26	DT02-26-2	TM11:17:44	
MNHL_CHNNL_4343	149	1207	2294905.3025	6052498.9495	MH149,NRIM,INV-4.69	84.15	4.69	-102.59	-18.44	39.44988	123.8032	0.0622	0.0851	0.9059	0.4910	0.7613	23	DT02-26-2	TM10:59:43	
MNHL_CHNNL_4345	145	1201	2294977.9867	6053549.4758	MH145F,NRIM,INV-6.54	99.31	6.54	-102.53	-3.22	39.45013	123.7995	0.0614	0.1657	0.8967	0.5088	0.7384	20	DT02-26-2	TM10:18:36	
MNHL_CHNNL_4346	146	1285	2295292.1388	6053250.8409	MH146A,NRIM,INV-3.58_TS	90.19	3.58	-102.54	-12.35	39.45098	123.8006	NA						DT03-11-2	TM13:38:02	
MNHL_CHNNL_4347	147	1246	2295296.6353	6053229.8493	MH146,NRIM,INV-4.27_TS	90.83	4.27	-102.54	-11.71	39.45099	123.8006	NA						DT02-27-2	TM14:24:	
MNHL_CHNNL_4351	153	1286	2294645.0557	6053384.4590	MH153,NRIM,INV-4.79	107.77	4.79	-102.54	5.23	39.44921	123.8000	0.0502	0.0788	1.0706	0.6246	0.8697	21	DT03-11-2	TM13:46:05	
MNHL_CHNNL_4353	153B	1026	2294663.5634	6052669.6035	MH153B,NRIM,INV-2.84	86.85	2.84	-102.58	-15.73	39.44922	123.8026	0.034	0.069	1.003	0.527	0.853	24	DT01-14-2	TM15:24:19	
MNHL_CHNNL_4356	153C	1279	2294701.4645	6052486.1636	MH153,NRIM,INV-6.73	81.44	6.73	-102.59	-21.15	39.44932	123.8032	0.0479	0.0833	0.9418	0.5187	0.7862	25	DT03-11-2	TM12:59:07	
MNHL_CHNNL_4357	153D	1027	2294360.6865	6052478.3188	MH153D,NRIM,INV-4.31	81.47	4.31	-102.59	-21.13	39.44838	123.8032	0.033	0.060	0.922	0.504	0.772	27	DT01-14-2	TM15:31:50	
MNHL_CHNNL_4358	163	1040	2293749.0214	6053009.3520	MH163,NRIM,INV-7.31,	94.85	7.31	-102.57	-7.72	39.44673	123.8013	0.0199	0.0301	0.8538	0.4409	0.7311	33	DT01-21-2	TM13:39:52	
MNHL_CHNNL_4360	162	1039	2293757.9113	6052639.6611	MH162,NRIM,INV-5.01,	90.20	5.01	-102.59	-12.40	39.44673	123.8026	0.0189	0.0285	0.8356	0.4340	0.7140	34	DT01-21-2	TM13:31:37	
MNHL_CHNNL_4364	168	1045	2293289.5418	6053748.3463	MH168,NRIM,INV-5.51'	109.88	5.51	-102.54	7.33	39.44551	123.7987	0.0219	0.0391	0.8410	0.4715	0.6964	31	DT01-21-2	TM14:17:02	
MNHL_CHNNL_4365	167	1044	2293251.9570	6054143.7285	MH167,NRIM,INV-5.83'	114.68	5.83	-102.52	12.16	39.44543	123.7973	0.0213	0.0353	0.7509	0.4271	0.6176	34	DT01-21-2	TM14:08:24	
MNHL_CHNNL_4366	167A	1287	2293250.1934	6054311.6025	MH167A,NRIM,INV-4.12	117.45	4.12	-102.51	14.94	39.44543	123.7967	0.0752	0.1177	0.9150	0.5530	0.7290	26	DT03-11-2	TM13:57:58	
MNHL_CHNNL_4372	172	1272	2292991.2609	6052982.8324	MH172,NRIM,INV-3.99	106.26	3.99	-102.59	3.67	39.44465	123.8014	0.0397	0.0605	0.8883	0.4536	0.7638	30	DT03-11-2	TM11:13:28	
MNHL_CHNNL_4373	173	1048	2293282.1560	6052613.6968	MH173,NRIM,INV-2.20'	98.80	2.20'	-102.60	-3.80	39.44543	123.8027	0.0237	0.0444	0.9127	0.5105	0.7566	28	DT01-21-2	TM14:33:29	
MNHL_CHNNL_4386	80	1226	2292408.2966	6051657.1372	MH80,NRIM,INV-7.53	71.89	7.53	-102.66	-30.77	39.44298	123.8060	0.0290	0.0439	0.8461	0.4455	0.7194	33	DT02-27-2	TM09:33:50	
MNHL_CHNNL_4387	72		NOT LOCATED SEE NOTE																	UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4388	91		NOT LOCATED SEE NOTE																	UNABLE TO LOCATE IN MENDO MILL
MNHL_CHNNL_4389	97	1157	2291011.4155	6051861.0719	MH97,NRIM,INV-7.45	69.38	7.45	-102.67	-33.29	39.43915	123.8052	0.0305	0.0528	0.9362	0.4817	0.8027	29	DT02-11-2	TM13:04:38	
MNHL_CHNNL_4390	94A	1244	2290869.4636	6050768.9948	MH94A,NRIM,INV-12.82	65.55	12.82	-102.73	-37.18	39.43870	123.8090	0.0458	0.0692	0.9280	0.5505	0.7471	27	DT02-27-2	TM13:58:24	
MNHL_CHNNL_4391	94	1243	2290866.8200	6050735.0626	MH94,NRIM,INV-13.98	66.25	13.98	-102.73	-36.48	39.43869	123.8092	0.0434	0.0683	1.0478	0.6031	0.8568	25	DT02-27-2	TM13:50:21	
MNHL_CHNNL_4392	87A	1161	2291492.1832	6052235.9483	MH87A,NRIM,INV-4.43	85.05	4.43	-102.64	-17.60	39.44049	123.8039	0.0327	0.0571	0.9519	0.4980	0.8113	26	DT02-11-2	TM13:28:06	
MNHL_CHNNL_4396	194	1107	2291493.0356	6052580.0590	MH194,N-RIM,INV-5.58	101.55	5.58	-102.63	-1.07	39.44051	123.8027	0.0504	0.0792	0.8585	0.4470	0.7330	34	DT02-10-2	TM11:40:13	
MNHL_CHNNL_4398	191A	1096	2292164.9470	6052527.4241	MH191A,NRIM,INV-3.67	91.55	3.67	-102.62	-11.07	39.44236	123.8029	0.0522	0.0978	0.9944	0.5363	0.8374	28	DT02-10-2	TM10:29:48	
MNHL_CHNNL_4401	260	1060	2292572.9384	6054687.0317	MH260,NRIM,INV-6.77	124.88	6.77	-102.50	22.38	39.44359	123.7953	0.0510	0.0898	0.9877	0.5005	0.8515	26	DT01-24-2	TM14:20:28	
MNHL_CHNNL_4402	261	1061	2292556.2692	6055273.3158	MH263,NRIM,INV-5.17	127.73	5.17	-102.47	25.26	39.44358	123.7932	0.0375	0.0662	1.0555	0.5397	0.9070	25	DT01-24-2	TM14:31:26	
MNHL_CHNNL_4413	274	1077	2291226.2923	6055894.2287	MH274,NRIM,INV-4.46'	146.32	4.46	-102.46	43.86	39.43996	123.7909	0.0253	0.0374	0.9704	0.5019	0.8305	30	DT01-30-2	TM13:43:22	
MNHL_CHNNL_4415	344	1072	2292481.7627	6058696.7081	MH344,NRIM,INV-5.96	180.86	5.96	-102.30	78.56	39.44356	123.7811	0.0415	0.0801	0.9352	0.5203	0.7770	27	DT01-30-2	TM11:57:05	
MNHL_CHNNL_4422	282	1081	2291241.5669	6055383.7682	MH282,NRIM,INV-6.11'	144.54	6.11	-102.48	42.06	39.43998	123.7927	0.0277	0.0467	1.0570	0.5638	0.8941	25	DT01-30-2	TM14:23:27	
MNHL_CHNNL_4428	180	1103	2291416.3835	6053709.4142	MH180,NRIM,INV-4.73	122.31	4.73	-102.57	19.74	39.44037	123.7987	0.0434	0.0676	0.8390	0.4468	0.7101	36	DT02-10-2	TM11:20:50	
MNHL_CHNNL_4429	308	1296	2290944.4095	6054254.9421	MH308,NRIM,INV-2.98	132.30	2.98	-102.55	29.76	39.43910	123.7967	0.0286	0.0425	0.9376	0.5447	0.7632	27	DT03-11-2	TM14:58:09	
MNHL_CHNNL_4430	309	1083	2290756.5903	6054251.5813	MH309,NRIM,INV-2.60'	132.66	2.60	-102.55	30.11	39.43858	123.7967	0.0315	0.0625	1.0073	0.5833	0.8212	24	DT01-30-2	TM14:50:30	
MNHL_CHNNL_4434	318A		NOT LOCATED SEE NOTE																	UNABLE TO LOCATE
MNHL_CHNNL_4451	214	1143	2289527.4055	6053722.1052	MH214,NRIM,INV-8.72	118.65	8.72	-102.59	16.06	39.43518	123.7985	0.0297	0.0518	0.8716	0.4793	0.7279	30	DT02-11-2	TM11:02:10	
MNHL_CHNNL_4452	215	1142	2289527.7301	6053400.6945	MH215,NRIM,INV-11.09	117.41	11.09	-102.61	14.80	39.43516	123.7996	0.0277	0.0472	0.8293	0.4593	0.6905	32	DT02-11-2	TM10:56:10	
MNHL_CHNNL_4455	111	1139	2289311.7407	6051994.7250	MH111,NRIM,INV-7.21	100.07	7.21	-102.68	-2.61	39.43449	123.8046	0.0545	0.0969	0.8938	0.4692	0.7607	30	DT02-11-2	TM10:39:34	
MNHL_CHNNL_4456	119	1131	2287909.8931	6052035.5994	MH119,NRIM,INV-5.40	119.15	5.40	-102.70	16.45	39.43065	123.8043	0.0360	0.0511	0.8932	0.4644	0.7630	31	DT02-11-2	TM09:44:16	
MNHL_CHNNL_4465	115	1237	2287537.3135	6051580.6926	MH115,NRIM,INV-10.61	119.57	10.61	-102.73	16.84	39.42960	123.8059	0.0285	0.0454	0.9193	0.4681	0.7912	30	DT02-27-2	TM11:08:48	
MNHL_CHNNL_4467	1A	1257	2290858.4367	6049377.9547	MH1A,NRIM,INV-NA	55.84	NA	-102.80	-46.96	39.43860	123.8140	0.0226	0.0387	0.8589	0.4478	0.7329	34	DT02-27-2	TM16:17:	SEALED SHUT
MNHL_CHNNL_4480	71	1033	2293313.8596	6051501.2084	MH71,NRIM,INV-4.07	83.20	4.07	-102.66	-19.46	39.44545	123.8066	0.0185	0.0291	0.8450	0.4479	0.7166	30	DT01-21-2	TM10:39:09	
MNHL_CHNNL_4490	206	1152	2290632.6160	6052380.1199	MH209(6),NRIM,INV-5.41	84.84	5.41	-102.65	-17.81	39.43814	123.8033	0.0470	0.0696	0.8496	0.4279	0.7340	33	DT02-11-2	TM12:22:10	
MNHL_CHNNL_4491	207	1151	2290635.1998	6052423.6986	MH207,NRIM,INV-3.82	85.99	3.82	-102.64	-16.65	39.43815	123.8032	0.0488	0.0737	0.8579	0.4301	0.7424	33	DT02-11-2	TM12:18:32	
MNHL_CHNNL_4496	229	1136	2288620.3214	6052665.9728	MH229,NRIM,INV-5.66	108.81	5.66	-102.66	6.15	39.43263	123.8022	0.0407	0.0626	0.8686	0.4580	0.7381	31	DT02-11-2	TM10:22:28	
MNHL_CHNNL_4498	217	1141	2289246.3347	6053224.3343	MH217,NRIM,INV-4.30	108.18	4.30	-102.62	5.56	39.43438	123.8002	0.0337	0.0580	0.8165	0.4460	0.6839	32	DT02-11-2	TM10:50:55	
MNHL_CHNNL_4515	258A		NOT LOCATED SEE NOTE																	UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4517	285	1108	2292096.8749	6054964.5861	MH285,N-RIM,INV-4.11	132.26	4.11	-102.49	29.76	39.44230	123.7943	0.0615	0.0960	0.8574	0.4467	0.7318	34	DT02-10-2	TM11:51:17	
MNHL_CHNNL_4531	205A	1153	2290173.3613	6052369.2115	MH205A,NRIM,INV-5.10	87.36	5.10	-102.65	-15.30	39.43688	123.8033	0.0496	0.0771	0.8143	0.4198	0.6978	34	DT02-11-2	TM12:29:08	
MNHL_CHNNL_4532		1283	2295006.0506	6052645.2108	ASSID,TOP,C/O,4",NOINV	86.66	NO INV	-102.58	-15.91	39.45016	123.8027	0.0483	0.0799	1.1309	0.6141	0.9498	22	DT03-11-2	TM13:16:	

MNHL_CHNNL_4533			NOT LOCATED SEE NOTE																
MNHL_CHNNL_4544			NOT LOCATED SEE NOTE																
MNHL_CHNNL_4545			NOT LOCATED SEE NOTE																NOT A MANHOLE, STORM DRAIN W/GRATE IN NORTHEASE CORNER OF PARKING LOT.
MNHL_CHNNL_4546	BY4	1217	2284801.8515	6051098.8262	MHBY4,NRIM,INV-6.79	113.90	6.79	-102.78	11.11	39.42207	123.8074	0.0339	0.0490	0.9723	0.5603	0.7946	23	DT02-26-2	TM13:45:22
MNHL_CHNNL_4547	BY1	1218	2284668.9685	6051110.4006	MHBY1,NRIM,INV-5.32	112.81	5.32	-102.78	10.03	39.42170	123.8074	0.0329	0.0473	1.0090	0.5726	0.8307	22	DT02-26-2	TM13:49:32
MNHL_CHNNL_4561	242	1301	2285065.6279	6052486.5956	MH242,NRIM,INV-5.09	10.53	5.09	-102.71	-92.18	39.42287	123.8026	0.0326	0.0557	0.8508	0.4789	0.7033	29	DT03-11-2	TM16:18:42
MNHL_CHNNL_4562	HD1	1123	2285069.9204	6052666.0858	MHHD1,NRIM,INV-8.90	14.38	8.90	-102.70	-88.32	39.42289	123.8019	0.0502	0.0827	0.9331	0.5476	0.7556	28	DT02-10-2	TM14:49:44
MNHL_CHNNL_4563	HD2	1122	2285131.0351	6052698.2911	MHHD2,NRIM,INV-6.64	12.22	6.64	-102.69	-90.48	39.42306	123.8018	0.0440	0.0736	0.9563	0.5543	0.7792	27	DT02-10-2	TM14:46:54
MNHL_CHNNL_4564	HD3	1124	2284988.5750	6052969.2337	MHHD3,NRIM,INV-7.18	14.91	7.18	-102.68	-87.77	39.42268	123.8008	0.0492	0.0936	1.3788	0.7340	1.1672	18	DT02-10-2	TM14:59:10
MNHL_CHNNL_4565	DI1	1125	2285101.5914	6053064.3918	MHDI1,N-RIM,INV-5.82	13.65	5.82	-102.67	-89.02	39.42300	123.8005	0.0487	0.0999	1.2959	0.7191	1.0781	17	DT02-10-2	TM15:09:56
MNHL_CHNNL_4566	DI2	1127	2285489.2465	6053035.1816	MHDI2,N-RIM,INV-3.57	11.96	3.57	-102.67	-90.71	39.42406	123.8006	0.0576	0.0936	0.9455	0.5775	0.7487	26	DT02-10-2	TM15:25:55
MNHL_CHNNL_4567	DI3	1126	2285688.2828	6053246.0777	MHDI3,N-RIM,INV-3.20	11.76	3.20	-102.66	-90.90	39.42462	123.7999	0.0496	0.0877	1.0439	0.5952	0.8576	24	DT02-10-2	TM15:20:49
MNHL_CHNNL_4568	224	1299	2288381.2694	6053824.5040	MH224,NRIM,INV-6.61	113.39	6.61	-102.60	10.79	39.43204	123.7980	0.0324	0.0520	0.9118	0.5280	0.7434	28	DT03-11-2	TM15:33:51
MNHL_CHNNL_4571	130	1300	2286275.1837	6051178.3965	MH130,NRIN,INV-6.45	110.35	6.45	-102.76	7.59	39.42612	123.8073	0.0363	0.0625	0.8523	0.4874	0.6992	29	DT03-11-2	TM16:00:00
MNHL_CHNNL_4599	SSMH	1269	2288856.9218	6055844.2594	MHSSMH?,NRIM,INV-3.85	150.08	3.85	-102.49	47.59	39.43346	123.7909	0.0280	0.0500	0.9506	0.5089	0.8029	28	DT03-11-2	TM10:36:49
MNHL_CHNNL_4600			NOT LOCATED SEE NOTE																UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4601			NOT LOCATED SEE NOTE																UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4621	267	1063	2292531.1393	6055943.8559	MH267,NRIM,INV-8.34	142.27	8.34	-102.44	39.84	39.44355	123.7908	0.0300	0.0561	0.9722	0.5495	0.8020	25	DT01-24-2	TM14:57:25
MNHL_CHNNL_4624	277	1112	2291863.7922	6055689.3511	MH277,NRIM,INV-3.83	145.17	3.83	-102.46	42.71	39.44170	123.7917	0.0372	0.0656	0.9508	0.5225	0.7943	31	DT02-10-2	TM12:57:27
MNHL_CHNNL_4635			NOT LOCATED SEE NOTE																UNABLE TO LOCATE, PER DEPT. OF
MNHL_CHNNL_4639			NOT LOCATED SEE NOTE																
MNHL_CHNNL_4640	45A	1011	2294803.4711	6050964.5866	MH45A,N-RIM,INV-3.72	67.81	3.72	-102.67	-34.85	39.44951	123.8086	0.023	0.033	0.882	0.436	0.767	33	DT01-14-2	TM13:48:29
MNHL-CHNNL-4495		1298	2288629.8095	6052408.2736	ASID4495,NRIM,C/O,NO-INV	107.71	NO INV	-102.67	5.04	39.43265	123.8031	0.0404	0.0632	0.9554	0.5485	0.7822	27	DT03-11-2	TM15:28:19
MNHL-CHNNL-4588		1266	2298292.1436	6051525.5655	ASSID_4588,INV-18.19,FLOOR_TS	20.22	18.19	-102.59	-82.37	39.45912	123.8069	NA						DT03-11-2	TM09:56:02
MNHL-CHNNL-4620		1290	2292500.3238	6056904.4866	ASSID4620,NRIM,C/O,NO-INV	154.45	NO INV	-102.39	52.06	39.44351	123.7874	0.0845	0.1398	1.1239	0.6639	0.9069	20	DT03-11-2	TM14:23:11
MNHL-CHNNL-4629		1294	2291011.8402	6057694.6670	ASSID4629,NRIM,INV-5.20	161.69	5.20	-102.37	59.32	39.43947	123.7845	0.0598	0.0926	0.9591	0.5537	0.7831	25	DT03-11-2	TM14:56:16
MNHL-CHNNL-4641		1273	2293309.5609	6052989.9319	ASSID4641,NRIM,INV-5.45	100.81	5.45	-102.58	-1.77	39.44552	123.8013	0.0513	0.0756	0.8857	0.4528	0.7612	28	DT03-11-2	TM11:19:00
		1	2290983.9318	6049364.5548	OPUS_BASE_CORRECTION	SUM=48.956595-.10		-102.80	-53.84	39.43894	123.814069								
		1000	2290983.9318	6049364.5548	CP_5/8''RB_GPS_BASE	48.96		-102.80	-53.84	39.43894	123.814069								
		1002	2290362.4621	6048422.2288	CP_MAGW/SHINER-NRUNWAY	49.45		-102.86	-53.41	39.43718	123.8173	0.021	0.028	0.820	0.439	0.693	32	DT01-14-2	TM11:10:3
		1003	2289061.3873	6049236.5819	CP_MAGW/SHINER-SRUNWAY	74.32		-102.83	-28.51	39.43366	123.8143	0.022	0.030	0.851	0.451	0.722	31	DT01-14-2	TM11:21:2
		1028	2289061.4980	6049236.5757	CHK_CP_MAG1003	74.31		-102.83	-28.52	39.43366	123.8143	0.027	0.047	0.892	0.500	0.739	27	DT01-14-2	TM15:41:49
		1029	2290362.4941	6048422.3155	CHK_CP_MAG1002	49.75		-102.86	-53.11	39.43718	123.8173	0.024	0.042	0.888	0.500	0.734	27	DT01-21-2	TM09:54:41
		1030	2290362.3854	6048422.2357	CHK-CP_MAG1002	49.77		-102.86	-53.09	39.43718	123.8173	0.0185	0.0268	0.8255	0.4649	0.6822	30	DT01-21-2	TM10:15:15
		1031	2289061.4049	6049236.5762	CHK-CP_MAG1003	74.32		-102.83	-28.51	39.43366	123.8143	0.0214	0.0310	0.8600	0.4743	0.7174	29	DT01-21-2	TM10:20:56
		1053	2289061.4160	6049236.5749	CHK_CP_MAG1003	74.31		-102.83	-28.52	39.43366	123.8143	0.0234	0.0364	0.8809	0.5141	0.7154	29	DT01-21-2	TM15:45:59
		1054	2290362.3856	6048422.2278	CHK_CP_MAG1003	49.76		-102.86	-53.10	39.43718	123.8173	0.0241	0.0377	0.9562	0.5415	0.7881	27	DT01-21-2	TM15:50:00
		1055	2290983.9412	6049364.5550	CHK_BASE2025.01.24	48.96		-102.80	-53.84	39.43894	123.814069							DT01-24-2	TM10:52:31
		1056	2290362.3700	6048422.2989	CHK-CP_MAG1002	49.75		-102.86	-53.11	39.43718	123.8173	0.0395	0.0597	0.8664	0.4738	0.7253	31	DT01-24-2	TM12:34:54
		1057	2289061.4503	6049236.5803	CHK-CP_MAG1002	74.29		-102.83	-28.54	39.43366	123.8143	0.0369	0.0563	0.8681	0.4753	0.7264	31	DT01-24-2	TM12:43:55
		1058	2284870.4159	6050970.9140	CP_BRTOP,MEN-59.95	110.10		-102.79	7.31	39.42225	123.8079	0.0359	0.0563	0.9115	0.4795	0.7753	29	DT01-24-2	TM12:57:5
		1064	2289061.4034	6049236.6013	CHK_CP_MAG1003	74.33		-102.83	-28.50	39.43366	123.8143	0.0528	0.0943	0.8575	0.5070	0.6918	26	DT01-24-2	TM15:18:01
		1065	2290362.4016	6048422.2854	CHK_CP_MAG1002	49.77		-102.86	-53.09	39.43718	123.8173	0.0470	0.0814	0.8732	0.5265	0.6966	26	DT01-24-2	TM15:28:12
		1066	2290983.9412	6049364.5550	CHK_BASE1.30.2025	48.96		-102.80	-53.84	39.43894	123.814069						30	DT01-30-2	TM10:14:37
		1067	2290362.4319	6048422.3371	CHK-CP_MAG1002	49.76		-102.86	-53.10	39.43718	123.8173	0.0346	0.0491	0.9090	0.4711	0.7774	31	DT01-30-2	TM11:03:48
		1068	2289061.4392	6049236.6836	CHK-CP_MAG1003	74.33		-102.83	-28.50	39.43366	123.8143	0.0594	0.0841	0.8772	0.4692	0.7412	32	DT01-30-2	TM11:10:28
		1086	2289061.4141	6049236.6737	CHK-CP_MAG1003	74.34		-102.83	-28.49	39.43366	123.8143	0.0368	0.0605	0.9624	0.6048	0.7487	24	DT01-30-2	TM15:27:42
		1087	2290362.2897	6048422.3648	CHK_CP_MAG1002	49.80		-102.86	-53.06	39.43718	123.8173	0.0604	0.0981	1.0455	0.6212	0.8412	24	DT01-30-2	TM15:37:15
		1088	2290362.4184	6048422.3548	CHK_CP_MAG1002	49.72		-102.86	-53.13	39.43718	123.8173	0.0546	0.0807	0.8223	0.4289	0.7018	27	DT02-10-2	TM09:16:47
		1089	2289061.4850	6049236.6704	CHK_CP_MAG1003	74.24		-102.83	-28.59	39.43366	123.8143	0.0636	0.0966	0.8013	0.4189	0.6832	36	DT02-10-2	TM09:25:49
		1128	2290362.3819	6048422.2607	CHK-CP_MAG1002	49.72		-102.86	-53.14	39.43718	123.8173	0.0605	0.0817	0.8643	0.4511	0.7373	32	DT02-11-2	TM09:21:48
		1129	2289061.4231	6049236.5742	CHK-CP_MAG1003	74.28		-102.83	-28.55	39.43366	123.8143	0.0755	0.0995	0.8699	0.4483	0.7456	26	DT02-11-2	TM09:29:30
		1169	2289061.3955	6049236.5902	CHK-CP_MAG1003	74.30		-102.83	-28.53	39.43366	123.8143	0.0328	0.0506	0.8718	0.5386	0.6854	28	DT02-11-2	TM14:35:25
		1170	2290362.4312	6048422.2751	CHK-CP_MAG1002	49.74		-102.86	-53.12	39.43718	123.8173	0.0256	0.0401	0.9781	0.5756	0.7909	26	DT02-11-2	TM14:39:12
		1172	2290362.4385	6048422.3647	CHK-CP_MAG1002	49.73		-102.86	-53.12	39.43718	123.8173	0.0450	0.0724	0.8664	0.4461	0.7428	32	DT02-21-2	TM11:10:52
		1173	2289061.4783	6049236.6483	CHK-CP_MAG1003	74.31		-102.83	-28.52	39.43366	123.8143	0.0242	0.0387	0.8710	0.4455	0.7484	33	DT02-21-2	TM11:17:49
		1174	2296877.3156	6050889.7248	CHK_1004	56.83		-102.64	-45.81	39.45520	123.8090	0.0221	0.0355	0.9336	0.4675	0.8081	30	DT02-21-2	TM11:37:31
		1175	2295728.8903	6050852.6095	CHK_1007	54.31		-102.66	-48.35	39.45205	123.8091	0.0321	0.0511	0.8912	0.4552	0.7662	31	DT02-21-2	TM11:45:08
		1177	2295709.8574	6050958.1965	CHK_1005	55.66		-102.66	-46.99	39.45200	123.8087	0.0567	0.0924	0.8634	0.4521	0.7355	32	DT02-21-2	TM11:59:01
		1178	2295619.5831	6051578.2068	CHK_1008	63.58		-102.62	-39.05	39.45179	123.8065	0.0433	0.0705	0.8474	0.4437	0.7220	31	DT02-21-2	TM12:02:51
		1179	2295167.6715	6051959.6706	CHK_1023	71.56		-102.61	-31.05	39.45057	123.8051	0.0250	0.0405	1.0302	0.5133	0.8932	27	DT02-21-2	TM12:06:46

1180	2295208.6093	6050973.6746	CHK_1009	63.17	-102.66	-39.49	39.45063	123.8086	0.0312	0.0533	1.0714	0.5202	0.9367	27	DT02-21-2	TM12:10:32
1181	2295111.2127	6050986.0287	CHK_1010	66.62	-102.66	-36.05	39.45036	123.8086	0.0234	0.0384	1.0033	0.4965	0.8719	29	DT02-21-2	TM12:11:45
1182	2294803.4760	6050964.6440	CHK_1011	67.76	-102.67	-34.91	39.44951	123.8086	0.0258	0.0460	0.9545	0.5147	0.8039	27	DT02-21-2	TM12:57:17
1183	2294261.0154	6050954.1186	CHK_1015	71.60	-102.68	-31.08	39.44802	123.8086	0.0314	0.0562	0.9375	0.5157	0.7829	27	DT02-21-2	TM13:01:05
1184	2294267.9998	6050966.0685	CHK_1012	71.69	-102.67	-30.98	39.44804	123.8086	0.0232	0.0420	0.9332	0.5160	0.7776	27	DT02-21-2	TM13:02:03
1185	2294260.4416	6051149.5822	CHK_1016	73.16	-102.67	-29.51	39.44803	123.8079	0.0242	0.0434	0.9250	0.5165	0.7674	27	DT02-21-2	TM13:03:54
1186	2294255.4730	6051543.9866	CHK_1020	77.73	-102.64	-24.91	39.44804	123.8065	0.0325	0.0609	0.9585	0.5481	0.7864	25	DT02-21-2	TM13:07:07
1187	2293772.6297	6051561.3323	CHK_1018	81.11	-102.65	-21.54	39.44672	123.8064	0.0298	0.0538	0.9352	0.5397	0.7638	25	DT02-21-2	TM13:10:31
1188	2293781.8626	6051149.9196	CHK_1017	76.83	-102.67	-25.84	39.44672	123.8079	0.0305	0.0543	0.8813	0.5295	0.7045	25	DT02-21-2	TM13:15:23
1189	2294710.9220	6052159.8306	CHK_1025	78.17	-102.61	-24.44	39.44932	123.8044	0.0321	0.0666	0.9340	0.5616	0.7463	21	DT02-21-2	TM13:21:02
1190	2294663.5501	6052669.6581	CHK_1026	86.88	-102.58	-15.70	39.44922	123.8026	0.0377	0.0714	0.9226	0.5627	0.7312	23	DT02-21-2	TM13:24:37
1191	2294360.6517	6052478.3903	CHK_1027	81.51	-102.59	-21.09	39.44838	123.8032	0.0261	0.0513	0.9106	0.5640	0.7150	24	DT02-21-2	TM13:28:14
1192	2292774.1856	6054600.8065	CHK_1059	119.01	-102.50	16.50	39.44414	123.7956	0.0311	0.0807	1.0326	0.6162	0.8285	19	DT02-21-2	TM13:35:05
1193	2289061.4433	6049236.6798	CHK_CP_MAG1003	74.31	-102.83	-28.52	39.43366	123.8143	0.0497	0.0776	0.8835	0.5479	0.6931	24	DT02-21-2	TM13:53:15
1194	2290362.4626	6048422.3243	CHK_CP_MAG1002	49.77	-102.86	-53.08	39.43718	123.8173	0.0287	0.0445	0.9948	0.6083	0.7872	22	DT02-21-2	TM13:58:56
1195	2290362.4319	6048422.2366	CHK_CP_MAG1002	49.75	-102.86	-53.11	39.43718	123.8173	0.0347	0.0544	0.9227	0.4773	0.7897	30	DT02-26-2	TM09:14:48
1196	2289061.4355	6049236.5635	CHK_CP_MAG1003	74.31	-102.83	-28.52	39.43366	123.8143	0.0237	0.0379	0.9282	0.4819	0.7933	30	DT02-26-2	TM09:18:38
1219	2295244.8807	6053244.8166	CP_MAG,MH146	91.60	-102.54	-10.94	39.45085	123.8006	0.0366	0.0493	1.0195	0.5803	0.8382	23	DT02-26-2	TM14:08:
1220	2294992.5931	6053211.8088	CP_MAG,MH146	96.57	-102.55	-5.97	39.45016	123.8007	0.0365	0.0481	0.9920	0.5735	0.8094	23	DT02-26-2	TM14:10:
1221	2289061.4551	6049236.5961	CHK_CP_MAG1003	74.32	-102.83	-28.51	39.43366	123.8143	0.0225	0.0326	0.9806	0.5616	0.8039	24	DT02-26-2	TM14:37:05
1222	2290362.4307	6048422.2452	CHK-CP_MAG1002	49.80	-102.86	-53.06	39.43718	123.8173	0.0341	0.0518	1.0253	0.5853	0.8418	23	DT02-26-2	TM14:44:16
1223	2290362.4782	6048422.3027	CHK-CP_MAG1002	49.76	-102.86	-53.09	39.43718	123.8173	0.0308	0.0456	0.8390	0.4492	0.7086	31	DT02-27-2	TM09:11:00
1224	2289061.4910	6049236.6227	CHK-CP_MAG1003	74.30	-102.83	-28.53	39.43366	123.8143	0.0291	0.0432	0.8525	0.4530	0.7222	31	DT02-27-2	TM09:15:46
1231	2298301.2521	6051541.8531	CP_MAG,LFT	20.21	-102.59	-82.38	39.45915	123.8068	0.0412	0.0716	0.8428	0.4550	0.7095	32	DT02-27-2	TM10:21:
1232	2298268.9925	6051606.5859	CP_MAG,LFT	21.76	-102.59	-80.83	39.45906	123.8066	0.0312	0.0521	0.8620	0.4671	0.7244	32	DT02-27-2	TM10:23:
1233	2298268.9937	6051606.5827	BS_CHK1232,CP_MAG,LFT_TS	21.74	-102.59	-80.84	39.45906	123.806645							DT02-27-2	TM10:28:
1245	2294992.5915	6053211.8061	BS_CHK,CP_MAG1220_TS	96.57	-102.55	-5.97	39.45016	123.800731							DT02-27-2	TM14:21:
1247	2289061.4497	6049236.6117	CHK-CP_MAG1003	74.34	-102.83	-28.49	39.43366	123.8143	0.0500	0.0730	0.9032	0.5327	0.7295	28	DT02-27-2	TM14:46:22
1248	2290362.4338	6048422.2955	CHK-CP_MAG1002	49.76	-102.86	-53.10	39.43718	123.8173	0.0275	0.0407	0.8218	0.5000	0.6523	30	DT02-27-2	TM14:58:24
1261	2290362.4412	6048422.2807	CHK-CP_MAG1002	49.73	-102.86	-53.13	39.43718	123.8173	0.0486	0.0725	0.8420	0.4510	0.7110	29	DT03-11-2	TM09:13:55
1262	2289061.4342	6049236.5792	CHK-CP_MAG1003	74.29	-102.83	-28.54	39.43366	123.8143	0.0332	0.0474	0.8480	0.4522	0.7174	31	DT03-11-2	TM09:17:43
1263	2298301.2643	6051541.8264	BS_CHK,1231_TS	20.20	-102.59	-82.39	39.45915	123.806877							DT03-11-2	TM09:44:
1264	2298281.4945	6051521.2855	CP_SCRIBE,CC_TS	20.16	-102.59	-82.43	39.45909	123.806948							DT03-11-2	TM09:47:
1265	2298268.9896	6051606.6026	BS_CHK1232_TS	21.76	-102.59	-80.83	39.45906	123.806645							DT03-11-2	TM09:52:
1284	2294992.5473	6053211.8016	BS_CHK1220_TS	96.60	-102.55	-5.95	39.45016	123.800731							DT03-11-2	TM13:34:
1304	2289061.4382	6049236.5808	CHK-CP_MAG1003	74.33	-102.83	-28.50	39.43366	123.8143	0.0475	0.0782	0.8353	0.4650	0.6939	30	DT03-11-2	TM16:39:
1305	2290362.4333	6048422.2712	CHK-CP_MAG1002	49.77	-102.86	-53.09	39.43718	123.8173	0.0634	0.1024	0.8378	0.4643	0.6974	30	DT03-11-2	TM16:42:
5000	2290983.9318	6049364.5548	CP_SPK-BASE	48.96	-102.80	-53.84	39.43894	123.814069							DT01-07-2	TM10:43:

Appendix B. Flow Monitoring

Fort Bragg Wastewater Collection System Master Plan

Wet Weather Open Channel Flow Monitoring

Prepared for:

HDR
2365 Iron Point Road, Suite 300
Folsom, CA 95630

Original Report Date: July 26, 2024
Revised Report Date: September 9, 2024

Prepared by:

V&A consulting engineers

V&A Project No. 23-0169, Rev01

Table of Contents

Table of Contents i
Tables ii
Figures ii
Photo Log iii
Abbreviations and Acronyms iv
Terms and Definitions v
Executive Summary 1
Scope and Purpose 1
Monitoring Sites and Basins 1
Findings 2
Recommendations 4
1 Introduction 1
1.1 Scope and Purpose 1
1.2 Flow Monitoring Sites and Isolated Sewerage Basins 1
2 Methods and Procedures 4
2.1 Confined Space Entry 4
2.2 Flow Meter Installation 5
2.3 Flow Calculation 6
2.4 Measurement Error and Uncertainty 7
2.4.1 Flow Addition versus Flow Subtraction 7
2.5 Average Dry Weather Flow Determination 9
2.6 Flow Attenuation 10
3 Results and Analysis 11
3.1 Rainfall Monitoring 11
3.1.1 Rain Gauge Locations 11
3.1.2 Regional Rainfall Event Classification 15
3.1.3 Rain Gauge Triangulation Distribution 19
3.2 Flow Monitoring 21
3.2.1 Average Flow Analysis 21
3.2.2 Peak Measured Flows and Pipeline Capacity Analysis 23
4 Recommendations 27
Appendix A Flow Monitoring Sites: Data, Graphs, Information A-1

Tables

Table ES-1. List of Monitoring Sites 1
Table ES-2. List of Rain Gauge Sites 2
Table 1-1. List of Monitoring Locations 1
Table 1-2. Isolated Flow Monitoring Basin Characteristics 2
Table 3-1. Recorded Rainfall 11
Table 3-2. Summary of Rainfall Data 12
Table 3-3. Rainfall Event Classification Summary 19
Table 3-4. Rain Gauge Distribution per Monitoring Site 20
Table 3-5. Dry Weather Flow 21
Table 3-6. Capacity Analysis Summary 24

Figures

Figure ES-1. Map of Monitoring Sites and Basin (provided by HDR) 3
Figure 1-1. Map of Flow Monitoring Sites and Basins (provided by HDR) 3
Figure 2-1. Typical Installation for Flow Meter with Submerged Sensor 5
Figure 2-2. Sample ADWF Diurnal Flow Patterns 9
Figure 2-3. Attenuation Illustration 10
Figure 3-1. Location of Rain Gauges 13
Figure 3-2. Rainfall Monitoring (triangulated to the geographic center of the monitoring area) 14
Figure 3-3. Rainfall Accumulation Plot 15
Figure 3-4. NOAA Northern California Rainfall Frequency Map 16
Figure 3-5. Rainfall Event Classification – 24-Hour Period (RG Central) 17
Figure 3-6. Rainfall Event Classification – 24-Hour Period (RG NE) 17
Figure 3-7. Rainfall Event Classification – 24-Hour Period (RG East) 18
Figure 3-8. Rainfall Event Classification – 24-Hour Period (RG South) 18
Figure 3-9. Rainfall Event Classification - 24-Hour (RG North) 19
Figure 3-10. Rainfall Inverse Distance Weighting Method 20
Figure 3-11 Average Dry Weather Flow (Flow Schematic) 22
Figure 3-12. Peaking Factors 24
Figure 3-13. Capacity Summary: Max d/D Ratios 25
Figure 3-14. Peak Measured Flow (Flow Schematic) 26

Photo Log

Photo 2-1. Confined Space Entry 4
Photo 2-2. Typical Personal Four-Gas Monitor 4

Abbreviations and Acronyms

Abbreviations/Acronyms	Definition
ADWF	Average Dry Weather Flow
CCTV	Closed-Circuit Television
CIP	Capital Improvement Plan
CO	Carbon Monoxide
d/D	Depth/Diameter Ratio
FT.	Feet
FM	Flow Monitor
GPD	Gallons per Day
GWI	Groundwater Infiltration
H2S	Hydrogen Sulfide
IN.	Inch
I/I	Inflow and Infiltration
IDM	Inch-Diameter Mile
IDW	Inverse Distance Weighting
LEL	Lower Explosive Limit
MAX.	Maximum
MGD	Million Gallons per Day
MIN.	Minimum
NOAA	National Oceanic and Atmospheric Administration
N/A	Not applicable
PF	Peaking Factor
PWS	Personal Weather Station
Q	Flow Rate
RDI	Rainfall-Dependent Infiltration
RG	Rain Gauge
V&A	V&A Consulting Engineers, Inc.
WEF	Water Environment Federation
WRCC	Western Regional Climate Center
WU	Weather Underground

Terms and Definitions

Term	Definition
Average dry weather flow (ADWF)	The average flow rate or pattern from days without noticeable inflow or infiltration response. ADWF usage patterns for weekdays and weekends differ and must be computed separately. ADWF is expressed as a numeric average and may include the influence of normal groundwater infiltration (not related to a rain event).
Basin	Sanitary sewer collection systems upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances, also refer to the ground surface area near and enclosed by pipelines. A basin may refer to the entire collection system upstream from a flow meter or exclude separately monitored basins upstream.
Depth/diameter (*d*/*D*) ratio	The depth of water in a pipe is a fraction of the pipe's diameter. A measure of the fullness of the pipe used in the capacity analysis.
Infiltration and inflow	**Infiltration and inflow (I/I)** rates are calculated by subtracting the ADWF flow curve from the instantaneous flow measurements taken during and after a storm event. Flow in excess of the baseline consists of inflow, rainfall-responsive infiltration, and rainfall-dependent infiltration. **Combined I/I** is the total sum in gallons of additional flow attributable to a storm event.
Infiltration, groundwater	**Groundwater infiltration (GWI)** is groundwater that enters the collection system through pipe defects. GWI depends on the depth of the groundwater table above the pipelines as well as the percentage of the system that is submerged. The variation of groundwater levels and subsequent groundwater infiltration rates are seasonal by nature. On a day-to-day basis, groundwater infiltration rates are relatively steady and will not fluctuate greatly.
Infiltration, rainfall-dependent	**Rainfall-dependent infiltration (RDI)** is similar to groundwater infiltration but occurs as a result of stormwater. The stormwater percolates into the soil submerges more of the pipe system, and enters through pipe defects. RDI is the slowest component of storm-related infiltration and inflow, beginning gradually and often lasting 24 hours or longer. The response time depends on the soil permeability and saturation levels.
Inflow	Inflow is defined as water discharged into the sewer system, including private sewer laterals, from direct connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections from storm drains, or catch basins. Inflow creates a peak flow problem in the sewer system and often dictates the required capacity of downstream pipes and transport facilities to carry these peak instantaneous flows. Overflows are often attributable to high inflow rates.
Peak Wet Weather Flow	The highest daily flow during and immediately after a significant storm event includes sanitary flow, infiltration, and inflow.
Peaking factor (PF)	PF is the ratio of peak measured flow to average dry weather flow. This ratio expresses the degree of fluctuation in flow rate over the monitoring period and is used in the capacity analysis.
Surcharge	When the flow level is higher than the crown of the pipe, then the pipeline is said to be in a **surcharged** condition. The pipeline is surcharged when the *d*/*D* ratio is greater than 1.0.

Executive Summary

Scope and Purpose

This executive summary is a general overview of V&A Consulting Engineers' (V&A) findings, conclusions, and recommendations of the temporary flow performed on portions of the City of Fort Bragg's (City) sanitary sewer collection system. V&A Consulting Engineers (V&A) was retained by HDR to perform sanitary sewer flow monitoring for eight (8) weeks from January 3rd to March 2nd, 2024. Open-channel flow monitoring was conducted at seven (7) scoped flow monitoring locations. There were two general purposes of this study:

1. Establish the baseline sanitary sewer flows at the flow monitoring sites
2. Establish the peak flow condition during the rainfall events and indicate the relative available sewer capacity at the flow monitoring nodes.

Monitoring Sites and Basins

The flow monitoring site locations were selected and approved by HDR and the City and are listed in Table ES-1.

Table ES-1. List of Monitoring Sites

Monitoring Site	Manhole No.	Monitored Pipe	Measured Pipe Diameter (in)	Location
FM-01	4588	West Outlet	12	Next to the Pump Station off of 1184 N Main St
FM-02	4058	East Outlet	24	Within Pump Station off of 398 W Elm St
FM-03	4112	East Inlet	20	Chief Celeri Dr x E Alder St
FM-04	4125	East Inlet	10	E Oak St x W Whipple St
FM-05	4117	South Inlet	6	246 Maple St
FM-06	4284	East Inlet	6	Walnut St x Dubois Ln
FM-07	4264	West Outlet	12	19498 Coast Rd (Pump Station)

The rainfall monitoring site locations were selected by V&A and are listed in Table ES-2.

Table ES-2. List of Rain Gauge Sites

Rain Gauge	Source	X (Longitude)	Y (Latitude)	Total Rain (in)
RG Central	(WU) KCAFORTB86	-123.79300	39.46400	27.05
RG NE	(WU) KCAFORTB45	-123.77891	39.42668	30.25
RG East	(WU) KCAFORTB54	-123.76166	39.41316	34.21
RG South	(WU) KCAFORTB103	-123.77500	39.38800	25.79
RG North	(WU) KCAFORTB79	-123.79700	39.48300	26.08

Findings

The following briefly discusses the findings of V&A's evaluation of the wastewater collection system flow data within the Study Area.

- A total of 128,290 linear feet of sanitary sewer was flow monitored as part of the project.
- The maximum pipe diameter within the metered collection system was 24 inches.
- The minimum pipe diameter within the metered collection system was 6 inches.
- The metered collection system comprises various pipe materials, including PVC, RCP, VCP (clay), concrete, and undocumented pipe material. The most common documented material in the metered areas was PVC.
- A triangulated total of 28.87 inches of rainfall was recorded during the flow metering period. Four events from this period were analyzed: Rain Event 1 (January 19th –25th, Rain Event 2 (Jan 30th – February 8th), Rain Event 3 (Feb 16th – 22nd), and Rain Event 3 (Feb 29th – March 4th). Rain Event 1 had a triangulated average of 4.02 inches, Rain Event 2 had a triangulated average of 9.23 inches, Rain Event 3 had a triangulated average of 5.01 inches, and Rain Event 4 had a triangulated average of 2.55 inches. The East rain gauge (RG East) saw the highest intensity rainfall during the monitoring period, with Event 1 being classified as a <1-year, 6-day storm and Event 2 as a 6-year, 9-day storm, Event 3 as a 2-year, 4-day storm, and Event 4 as a <1year, 4-day storm.
- All sites appear to have adequate dry weather flow capacity with d/D ratios ranging from 0.10 to 0.32.
- Sites FM-01 and FM-02 were flow meters installed upstream from a pump station.
- Sites FM-04, FM-06, and FM-07 had peaking factors of 10.6, 11.2, and 10.3 calculated for this monitoring period, respectively.
- Sites FM-03 and FM-04 were the only sites to have max d/D > 0.75. Both sites surcharged during Rain Event 2 (Jan 30th – February 8th). The level for both sites returned to baseline before the next rain event.

Figure ES-1 shows the location of all monitoring devices utilized as part of this study and their basins.

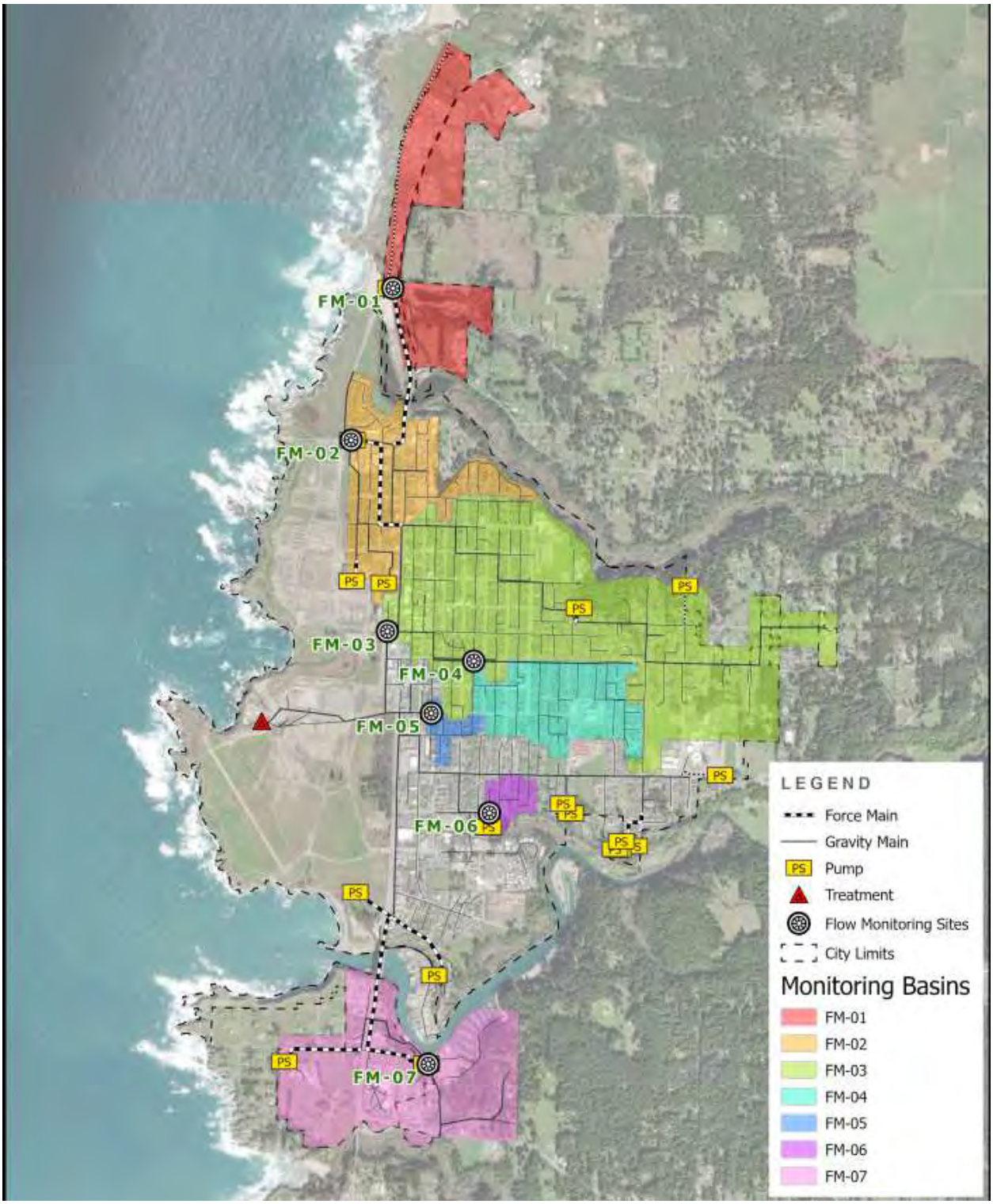


Figure ES-1. Map of Monitoring Sites and Basin (provided by HDR)

Recommendations

V&A advises that future I/I reduction plans consider the following recommendations:

1. **Master Plan and Model Implementation**: This study focuses on inflow and infiltration generation; the study results can be used to update the master plan and compare with previous model assumptions and flow monitoring results.
2. **Capacity Analysis**: Two sites (FM-03 and FM-04) surcharged during the monitoring period, approximately 2 feet above the pipe crown for FM-03 and 0.3 feet for FM-04. The following possible capacity concerns are noted:
    a. **Dry weather**: No site showed an average flow level greater than 50% full pipe conditions (greater than 0.5 d/D).
    b. **Wet Weather**: With the exception of sites FM-04, FM-06, and FM-07, wet weather peaking factors ranged from 2.7 to 6.8. This is typically considered to be within acceptable limits and no further action is recommended unless the City wishes to pursue I/I identification. It should be noted that while these limits may be within normally acceptable limits, higher intensity storms than those that occurred during the monitoring period could cause higher wet weather responses.
        i. It should be noted that FM-02 and FM-03 had peaking factors > 5, which may be considered above the standard for some municipalities.
        ii. Sites FM-04, FM-06, and FM-07 had peaking factors > 7; These PFs appear to be due to a wet-weather response. An investigation of I/I sources, and source disconnect / rehabilitation program, would be recommended in these basins.
3. **I/I Investigation Methods**: Potential I/I investigation methods include the following:
    a. Smoke testing.
    b. Manhole Inspection.
    c. Private I/I and Building Evaluations
    d. Mini-basin flow monitoring.
    e. Night-time reconnaissance work is done to (1) investigate and determine direct point sources of inflow and (2) determine the areas and/or pipe reaches responsible for high levels of infiltration contribution.
    f. CCTV inspection.
4. **I/I Reduction Cost Effective Analysis**: Follow I/I investigation, an evaluation can be conducted to determine which is more cost-effective: (1) elimination of priority sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines or (2) continued treatment of the additional rainfall-dependent I/I flow.

1 Introduction

1.1 Scope and Purpose

V&A Consulting Engineers (V&A) was retained by HDR to perform sanitary sewer flow monitoring and rainfall monitoring within the City of Fort Bragg' (City) collection system. Flow and rainfall monitoring were performed over the period of eight weeks from January 3rd to March 2nd, 2024. Open-channel flow monitoring was conducted at seven scoped flow monitoring locations. There were two general purposes of this study:

1. Establish the baseline sanitary sewer flows at the flow monitoring sites
2. Establish the peak flow condition during the rainfall events and indicate the relative available sewer capacity at the flow monitoring nodes.

1.2 Flow Monitoring Sites and Isolated Sewerage Basins

Flow monitoring sites are defined as the manholes where flow monitors are secured and the pipelines in which flow sensors are placed. Capacity analysis and flow rate information are presented on a site-by-site basis. The flow monitoring sites were selected and approved by HDR and the City of Fort Bragg. Information regarding the flow monitoring locations is listed in Table 1-1 and illustrated in

Flow monitoring site data may include the flows of one or many drainage basins. Flow monitoring basins are localized areas of a sanitary sewer collection system upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances. The basin refers to the ground surface area near and enclosed by the pipelines. A basin may refer to the entire collection system upstream from a flow meter or may exclude separately monitored basins upstream, requiring basin isolation (subtraction of upstream flows). The basins, basin attributes, and basin isolation equations are listed in Table 1-2.

Table 1-1. List of Monitoring Locations

Monitoring Site	Manhole No.	Monitored Pipe	Expected Pipe Diameter (in)	Measured Pipe Diameter (in)	Location
FM-01	4588	West Outlet	12	12	Next to Pump Station off of 1184 N Main St
FM-02	4058	East Outlet	24	24	Within Pump Station off of 398 W Elm St
FM-03	4112	East Inlet	18	20	Chief Celeri Dr x E Alder St
FM-04	4125	East Inlet	6	10	E Oak St x W Whipple St
FM-05	4117	South Inlet	6	6	246 Maple St
FM-06	4284	East Inlet	6	6	Walnut St x Dubois Ln
FM-07	4264	West Outlet	10	12	19498 Coast Rd (Pump Station)

Table 1-2. Isolated Flow Monitoring Basin Characteristics

Isolated Basin	Flow Meter	Flow Isolation Calculation	Iso Area (Acres)	IDM[1]	Pipe Length (miles)
Basin 01	FM-01	$Q_1 = Q_1$	138	13.01	2.02
Basin 02	FM-02	$Q_2 = Q_2 - Q1$	115	89.42	11.65
Basin 03	FM-03	$Q_3 = Q_3 - Q_2 - Q_1$	398	40.55	4.83
Basin 04	FM-04	$Q_4 = Q_4$	86	14.76	2.46
Basin 05	FM-05	$Q_5 = Q_5$	12	2.78	0.46
Basin 06	FM-06	$Q_6 = Q_6$	17	2.42	0.40
Basin 07	FM-07	$Q_7 = Q_7$	196	20.34	2.47

(1) Inch-diameter miles (IDM) are the total miles of sewer multiplied by the diameter (in inches) of sewer pipe.

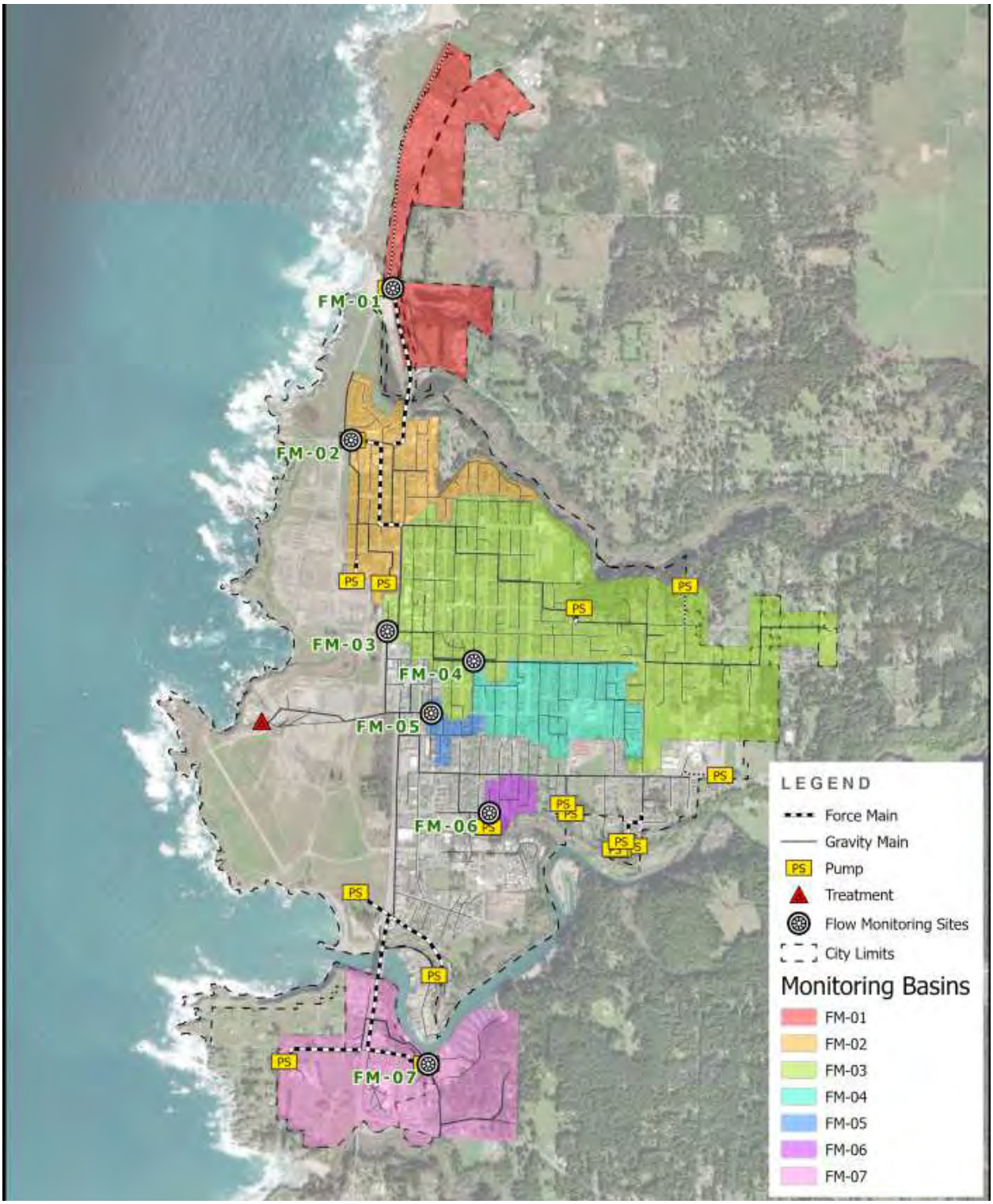


Figure 1-1. Map of Flow Monitoring Sites and Basins (provided by HDR)

2 Methods and Procedures

2.1 Confined Space Entry

A confined space (Photo 2-1) is defined as any space that is large enough and so configured that a person can bodily enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous employee occupancy. In general, the atmosphere must be constantly monitored for sufficient levels of oxygen (19.5% to 23.5%), the presence of hydrogen sulfide (H_2S) gas, carbon monoxide (CO) gas, and lower explosive limit (LEL) levels. A typical confined space entry crew has members with OSHA-defined responsibilities of Entrant, Attendant, and Supervisor. The Entrant is the individual performing the work. They are equipped with the necessary personal protective equipment to perform the job safely, including a personal four-gas monitor (Photo 2-2). If it is not possible to maintain line-of-sight with the Entrant, then more Entrants are required until line-of-sight can be maintained. The Attendant is responsible for maintaining contact with the Entrants to monitor the atmosphere using another four-gas monitor and maintaining records of all Entrants if there is more than one. The Supervisor is responsible for developing the safe work plan for the job at hand before entering.

Photo 2-1. Confined Space Entry

Photo 2-2. Typical Personal Four-Gas Monitor

2.2 Flow Meter Installation

V&A installed 7 area-velocity flow meters for temporary monitoring within the collection system using Hach FL900 flow meters. Hach FL900 flow meters use submerged sensors with a pressure transducer to collect depth readings and an ultrasonic Doppler sensor to determine the average fluid velocity. The ultrasonic sensor emits high-frequency sound waves, which are reflected by air bubbles and suspended particles in the flow. The sensor receives the reflected signal and determines the Doppler frequency shift, which indicates the estimated average flow velocity. The sensor is typically mounted at a manhole inlet to take advantage of smoother upstream flow conditions. The sensor may be offset to one side of the pipe to lessen the chances of fouling and sedimentation where these problems are expected to occur. Manual level and velocity measurements were taken during the installation of the flow meters, and again, when they were removed, they were compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. Figure 2-1 shows a typical installation for a flow meter with a submerged sensor.

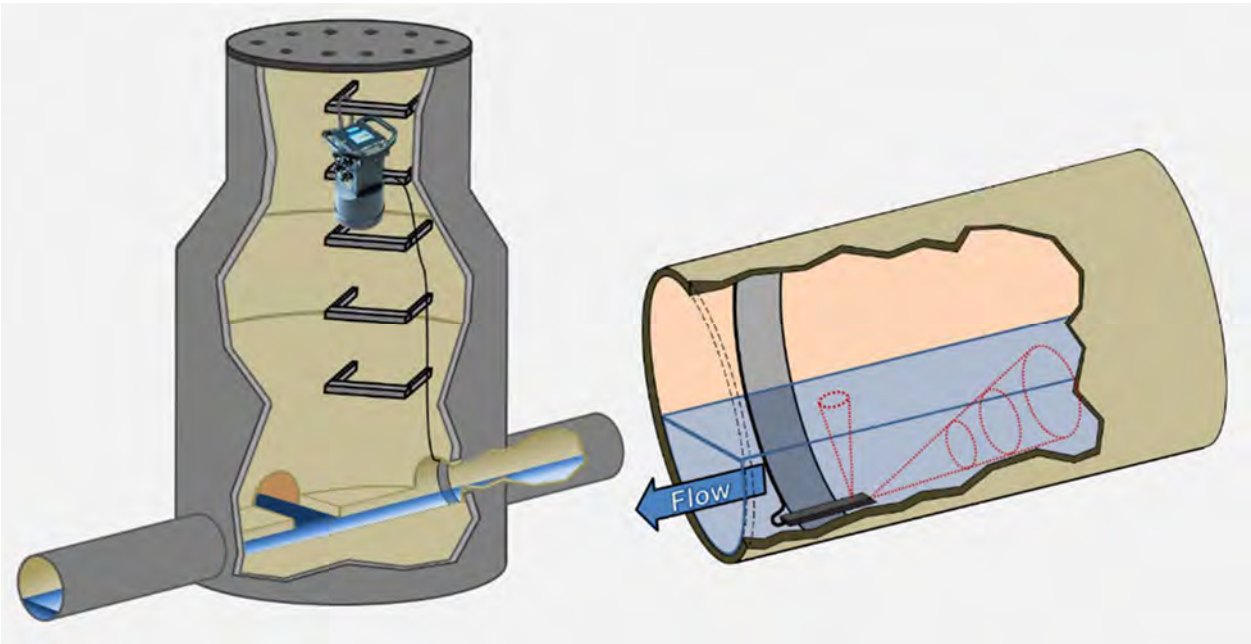


Figure 2-1. Typical Installation for Flow Meter with Submerged Sensor

2.3 Flow Calculation

Data retrieved from the flow meters is placed into a spreadsheet program for analysis. Data analysis includes comparison to field calibration measurements as well as necessary geometric adjustments as required for sediment (sediment reduces the pipe's wetted cross-sectional area available to carry flow). Area-velocity flow metering uses the continuity equation,

$$Q = v \cdot A = v \cdot (A_T - A_S)$$

where Q: volume flow rate

v: average velocity as determined by the ultrasonic sensor

A: cross-sectional area available to carry the flow

A_T: total cross-sectional area with both wastewater and sediment

A_S: cross-sectional area of sediment

For circular pipe,

$$A_T = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right] - \left[\left(\frac{D}{2}-d_W\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_W}{D}\right)\right)\right]$$

$$A_S = \left[\frac{D^2}{4}\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right] - \left[\left(\frac{D}{2}-d_S\right)\left(\frac{D}{2}\right)\sin\left(\cos^{-1}\left(1-\frac{2d_S}{D}\right)\right)\right]$$

where d_W: distance between wastewater level and pipe invert

d_S: depth of sediment

D: pipe diameter

2.4 Measurement Error and Uncertainty

For traditional engineering applications, measurement "error" is a difference between a computed, estimated, or measured value and the generally accepted true or theoretically correct value. It can also be considered a difference between the desired and the actual performance of equipment. For equipment, an error is usually expressed as a percentage relative to accuracy (i.e., "...the velocity sensor has an accuracy of ±2% of the reading...").

However, for this study and flow monitoring applications, the cause of the measurement difference is important, and a distinction will be made between the equipment not performing to industry standards ("error") and expected inaccuracies ("uncertainty") associated with monitoring technology limitations.

Gauging **"error"** occurs when the equipment does not meet industry standards. This can occur as a result of the following common categories of conditions that can be encountered at a wastewater monitoring site.

- Malfunctioning equipment (i.e., a sensor is damaged, battery life ends, or a desiccant canister becomes saturated)
- Improper equipment choice or maintenance (i.e., the selected gauging equipment technologies are incompatible with hydraulic conditions within the sewer, or excessive gravel deposits are allowed to accumulate around the sensors without being removed)
- Improper equipment calibration (i.e., depth and/or velocity measurements are incorrectly taken within the sewer, or equipment is allowed to drift out of calibration)
- Field conditions within the sewer (i.e., foaming at the water surface that "blinds" an ultrasonic depth sensor or toilet paper catching and accumulating on a combination sensor, blinding the acoustic Doppler velocity meter)

For flow monitoring applications, gauging **"uncertainty"** is used to describe and quantify the expected inaccuracies that result from the limitations of the technologies that utilize indirect measurements to quantify wastewater flow.

It is important to try to install flow meters in "ideal" flow conditions. Ideal flow conditions are generally defined as laminar flow in a straight-through, constant-slope pipeline with no disturbances (elbows, tees, hydraulic shifts, etc.) 10 diameters upstream and 5 diameters downstream from the flow monitoring location. If ideal flow conditions are met, then an expected uncertainty of final flow calculation from an open-channel flow meter may be approximately ±5%. In many situations, ideal flow conditions cannot be met, and uncertainties increase.

2.4.1 Flow Addition versus Flow Subtraction

Due to the uncertainties involved in subtracting flows of similar magnitudes, adding flows at multiple monitoring sites is usually preferred over subtracting flows. Subtraction becomes an issue, especially when the flow difference from the subtraction falls within the measurement uncertainty range of the two larger flow data sets (i.e., subtracting a large flow from another large flow to obtain a small difference).

The following example best demonstrates this concept:

1. Meter A measures 2.00 MGD of flow and has an expected uncertainty of ±5%; thus, the uncertainty range of the flow measurement is ±0.10 MGD.

2. Meter B measures 2.50 MGD of flow and has an expected uncertainty of ±6%; thus, the uncertainty range of the flow measurement is ±0.15 MGD.
3. Meter C measures 0.50 MGD of flow and has an expected uncertainty of ±8%; thus, the uncertainty range of the flow measurement is ±0.04 MGD.

Scenario 1 – Flow Addition

- Meter A + Meter B = 2.00 MGD (±0.10) + 2.50 MGD (±0.15) = 4.50 MGD (±0.25)
- Overall uncertainty = ±0.25 / 4.50 = ±5.6%
- The final uncertainty is essentially a weighted average of the component uncertainties for flow addition.

Scenario 2 – Flow Subtraction, Large Flow less Small Flow

- Meter B - Meter C = 2.50 MGD (±0.15) - 0.50 MGD (±0.04) = 2.00 MGD (±0.19)
- Overall uncertainty = ±0.19 / 2.00 = ±9.5%
- The final uncertainty will always be greater than the component uncertainties for flow subtraction.
- When subtracting a small flow from a large flow, the resulting uncertainties can still be manageable.

Scenario 3 – Flow Subtraction, Large Flow less a similarly Large Flow

- Meter B - Meter A = 2.50 MGD (±0.15) – 2.00 MGD (±0.10) = 0.50 MGD (±0.25)
- Overall uncertainty = ±0.25 / 0.50 = ±50%
- The resulting uncertainties may not be manageable when subtracting similarly sized flow rates. In this example, an uncertainty of ±50% may be considered unacceptable for confident analyses.

Scenario 3 is a very "real-world" situation. The uncertainties for Meter A and Meter B are extremely reasonable (indeed, most flow monitoring service providers would be extremely pleased with true meter uncertainties of ±5% to ±6%). However, the reality of the math is clear, and the above example demonstrates the concept of flow subtraction and compounding or inflating uncertainty ranges.

The following points are emphasized in relation to the items of this section:

- For subtraction of flows, the overall uncertainty can be an inflated value that far exceeds the component uncertainties.
- The smaller the resultant flow from the subtraction equation, the larger the percentage uncertainty.
- Whenever possible, basin flows should be directly measured rather than calculated as a subtraction of two or more flow meters.
- If flow subtraction cannot be avoided, it is better to have the magnitudes of the component flows be as dissimilar as possible.

2.5 Average Dry Weather Flow Determination

For this study, four distinct average dry weather flow curves were established for each site location:

- Mondays – Thursdays
- Fridays
- Saturdays
- Sundays

Flows for many sites differ on Friday evenings compared to Mondays through Thursdays. Starting around 7 p.m., the flows often decrease (compared to Monday through Thursday). Similarly, flow patterns for Saturday and Sunday were also separated due to their unique evening flow pattern. This type of differentiation can be important when determining I/I response, especially if a rain event occurs on a Friday, Saturday, or Sunday evening.

Figure 2-2 illustrates a sample of varying flow patterns within a typical dry week[1].

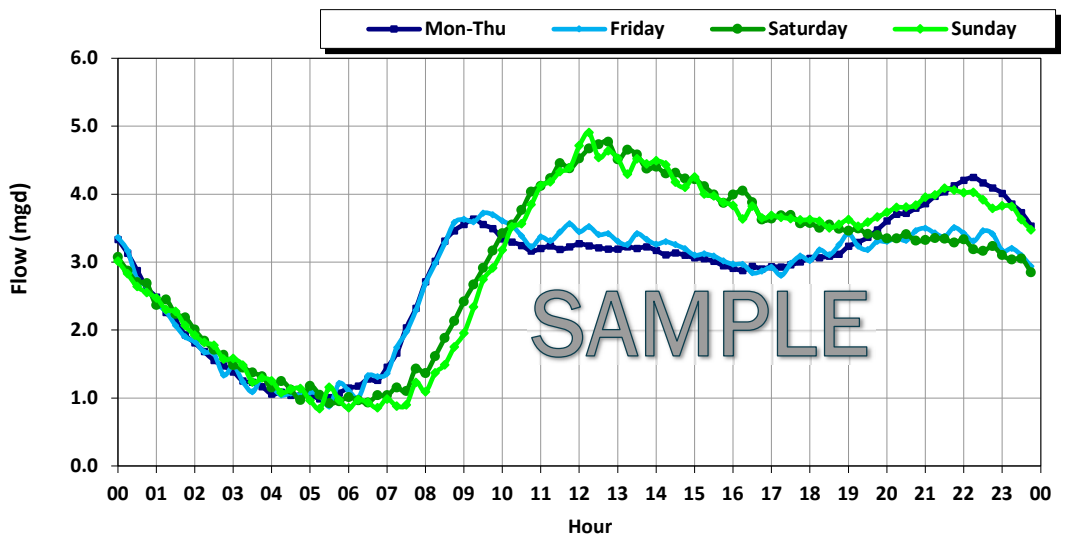


Figure 2-2. Sample ADWF Diurnal Flow Patterns

ADWF curves are taken from "Dry Days" when RDI had the least impact on the baseline flow. The overall average dry weather flow (ADWF) is calculated using the following equation:

$$ADWF = \left(ADWF_{Mon-Thu} \times \frac{4}{7}\right) + \left(ADWF_{Fri} \times \frac{1}{7}\right) + \left(ADWF_{Sat} \times \frac{1}{7}\right) + \left(ADWF_{Sun} \times \frac{1}{7}\right)$$

[1] Holiday flows can be extremely variable. Christmas flows are different from Thanksgiving flows and different from MLK Day flows. See Section **Error! Reference source not found.** for details on whether holiday ADWF curves were established for this project's I/I analysis.

2.6 Flow Attenuation

Flow attenuation in a sewer collection system is the natural process of reducing the peak flow rate through redistribution of the same flow volume over a longer period of time. This occurs as a result of friction (resistance), internal storage, and diffusion along the sewer pipes. Fluids are constantly working towards equilibrium. For example, a volume of fluid poured into a static vessel with no outside turbulence will eventually stabilize to a static state with a smooth fluid surface without peaks and valleys. Attenuation within a sanitary sewer collection system is based upon this concept. A flow profile with a strong peak will tend to stabilize towards equilibrium, as shown in Figure 2-3.

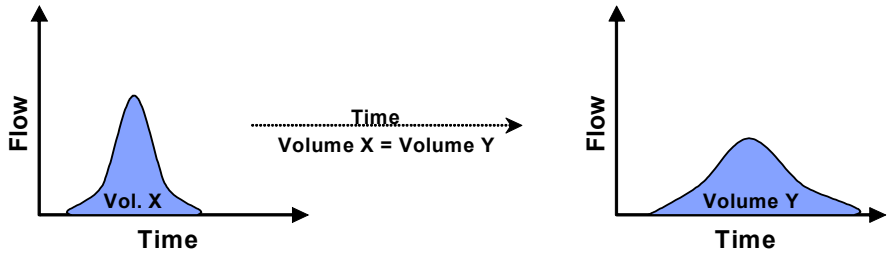


Figure 2-3. Attenuation Illustration

Each basin will have a specific flow profile within a sanitary sewer collection system. As the flows from the basins combine within the trunk sewer lines, the peaks from each basin will not necessarily coincide at the same time, and peak flows may attenuate prior to reaching the treatment facility due to the length and time of travel through the trunk sewers. The sum of the peak flows of the individual basins within a collection system will usually be greater than the peak flows observed at the treatment facility.

3 Results and Analysis

3.1 Rainfall Monitoring

3.1.1 Rain Gauge Locations

V&A analyzed rainfall data from six (6) publicly available private weather stations (PWS) on Weather Underground[2], choosing the best five (5) locations, allowing for solid coverage over the collection system, which has a diverse range of topographical features. Table 3-1 lists the recorded rainfall over the monitoring period at each site. Figure 3-1 illustrates the locations and labeling convention used for the five rain gauges as well as the location of the metered basins.

Table 3-1. Recorded Rainfall

Rain Gauge	Source	X (Longitude)	Y (Latitude)	Total Rain (in)
RG Central	(WU) KCAFORTB86	-123.79300	39.46400	27.06
RG NE	(WU) KCAFORTB45	-123.77891	39.42668	30.25
RG East	(WU) KCAFORTB54	-123.76166	39.41316	34.21
RG South	(WU) KCAFORTB103	-123.77500	39.38800	25.79
RG North	(WU) KCAFORTB79	-123.79700	39.48300	26.08

Four rainfall events elicited significant I/I responses during the flow monitoring periods. These events were of varying intensity and duration. These selected events are summarized in **Error! Reference source not found.** and illustrated in Figure 3-2 to provide context.

- Event 1 was a multi-day event from January 19th through January 25th, which resulted in an I/I response. On average, 4.02 inches of rainfall was recorded over the period. This event was classified as approximately a <1-year, 6-day event.
- Event 2 was a multi-day event from January 30th through February 8th, which resulted in an I/I response. On average, 9.23 inches of rainfall was recorded over the period. This event was classified as approximately a 4-year, 8-day event.
- Event 3 was a multi-day event from February 16th through February 22nd, which resulted in an I/I response. On average, 5.01 inches of rainfall was recorded over the period. This event was classified as approximately a 2-year, 4-day event.
- Event 4 was a multi-day event from February 29th through March 4th, which resulted in an I/I response. On average, 2.55 inches of rainfall was recorded over the period. This event was classified as approximately a <1-year, 4-day event.

[2] Weather Underground (wunderground.com) collects data from 180,000+ weather stations across the country, including Automated Surface Observation System (ASOS) at airports, personal weather stations (PWS), and Meteorological Assimilation Data Ingest System (MADIS) managed by the National Oceanic and Atmospheric Administration (NOAA). While V&A has no direct control over the rain gauges, V&A performs additional QA/QC on the data to assure its suitability for use.

Table 3-2. Summary of Rainfall Data

Rain Gauge	Rain Event 1 Jan 19 – Jan 25, 2024 (in)	Rain Event 2 Jan 30 – Feb 8, 2024 (in)	Rain Event 3 Feb 16 – Jan 22, 2024 (in)	Rain Event 4 Feb 29 – Mar 4, 2024 (in)
RG Central	3.77	8.74	4.96	2.25
RG NE	4.23	9.30	4.94	3.1
RG East	4.72	11.76	6.34	1.7
RG South	3.71	8.23	4.37	2.59
RG North	3.56	8.48	4.35	2.35
Triangulated to Geographic Center of Monitoring Area	**4.02**	**9.23**	**5.01**	**2.55**

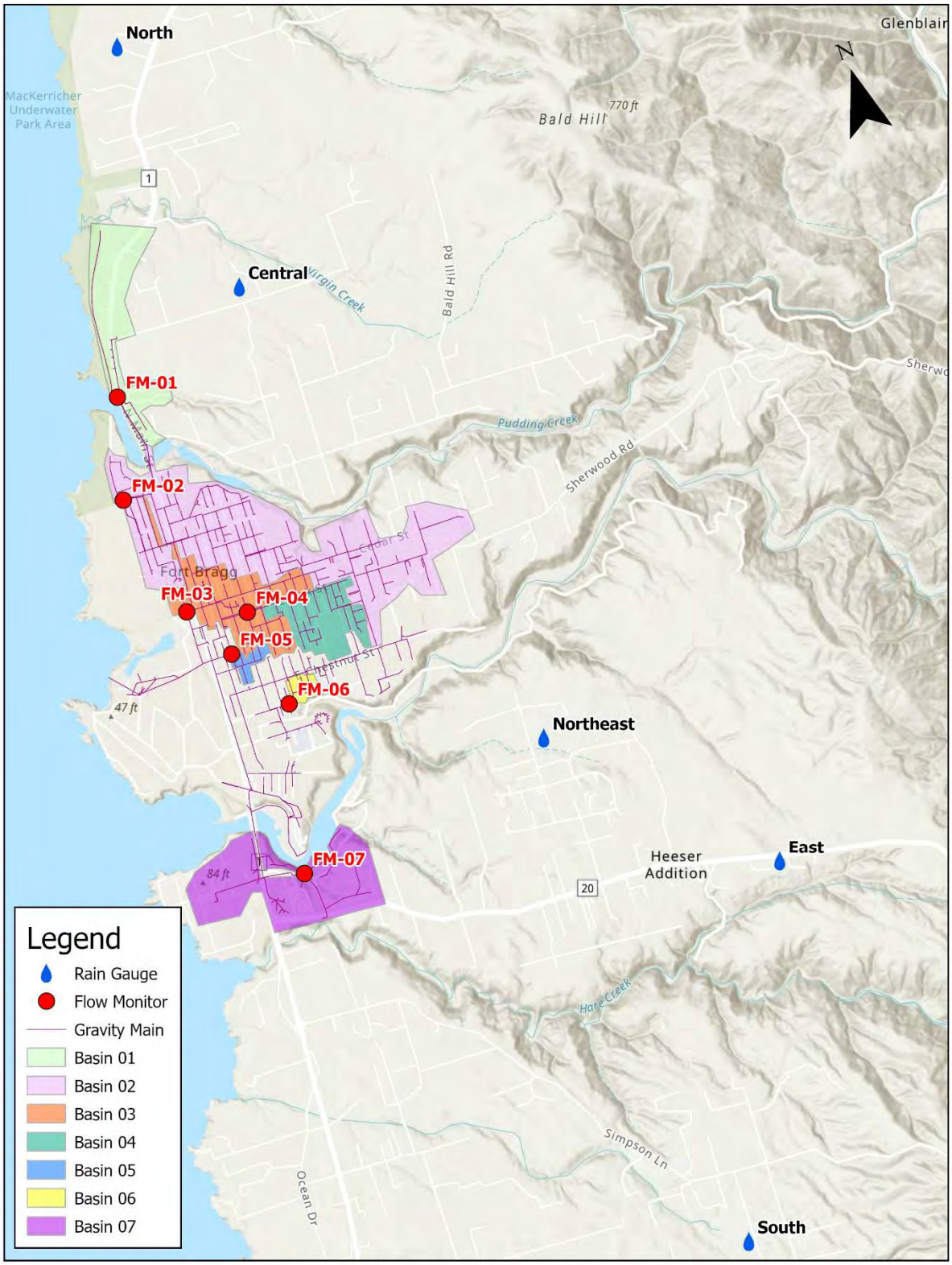


Figure 3-1. Location of Rain Gauges

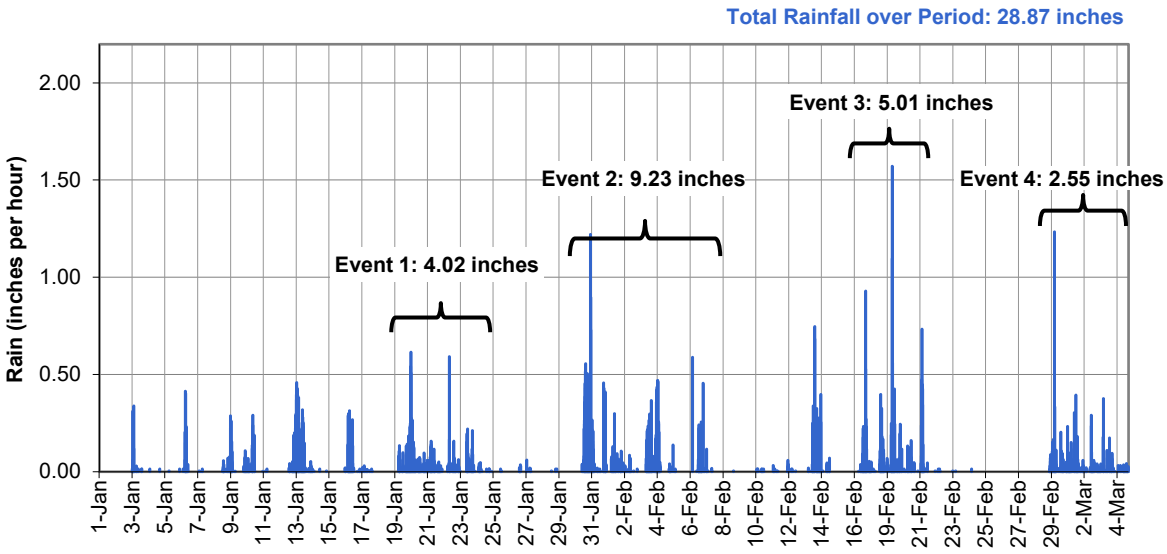


Figure 3-2. Rainfall Monitoring (triangulated to the geographic center of the monitoring area)

Figure 3-3 shows the rain accumulation plot of the period rainfall, as well as the historical average rainfall[3] (triangulated to the geographic center of Fort Bragg), which was approximately 190% of the historical precipitation averages over the same period.

[3] Historical data taken from the WRCC (Station 047769 at San Fransico WSO AP): http://www.wrcc.dri.edu/summary/climsmnca.html

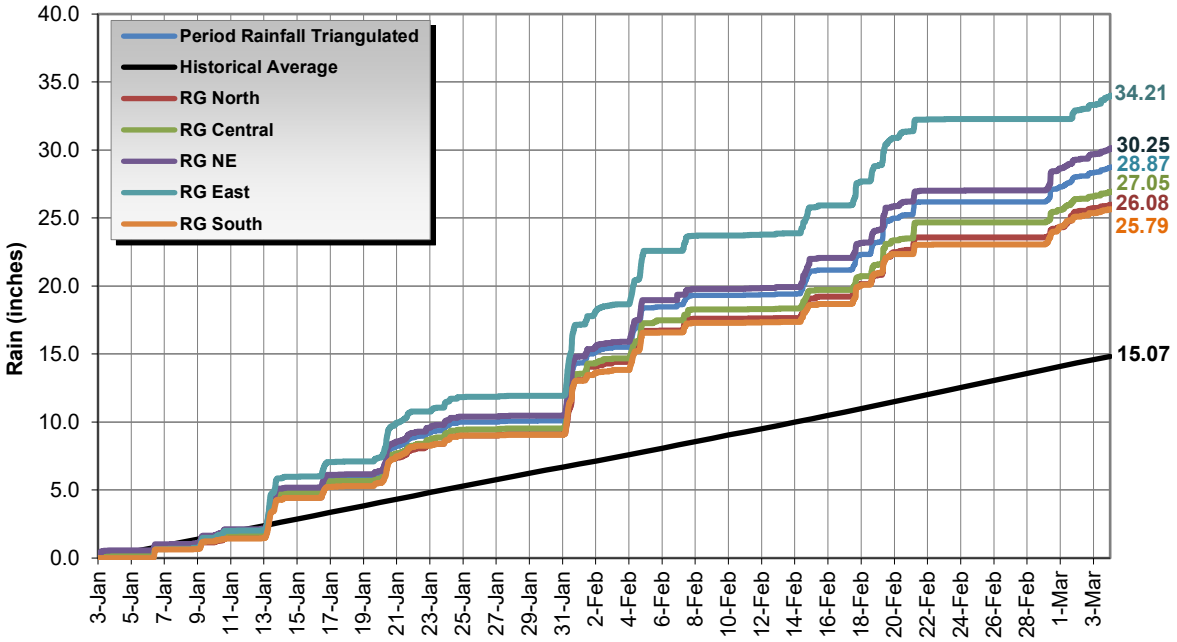


Figure 3-3. Rainfall Accumulation Plot

3.1.2 Regional Rainfall Event Classification

It is important to classify the relative size of a major storm event that occurs over the course of a flow monitoring period[4]. Rainfall events are classified by intensity and duration. Based on historical data, the NOAA has developed frequency contour maps for storm events of given intensity and duration for all areas within the continental United States (Figure 3-4).

For example, the NOAA Rainfall Frequency Atlas[5] classifies a 10-year, 24-hour storm event at the East rain gauge as 5.65 inches. This means that in any given year, at this specific location, there is a 10% chance that 5.65 inches of rain will fall in any 24-hour period.

[4] Sanitary sewers are often designed to withstand I/I contribution to sanitary flows for specific-sized "design" storm events.

[5] NOAA Western U.S. Precipitation Frequency Maps Atlas 14, Volume 6, 2011: ftp://hdsc.nws.noaa.gov/pub/hdsc/data/sw/ca10y24h.pdf

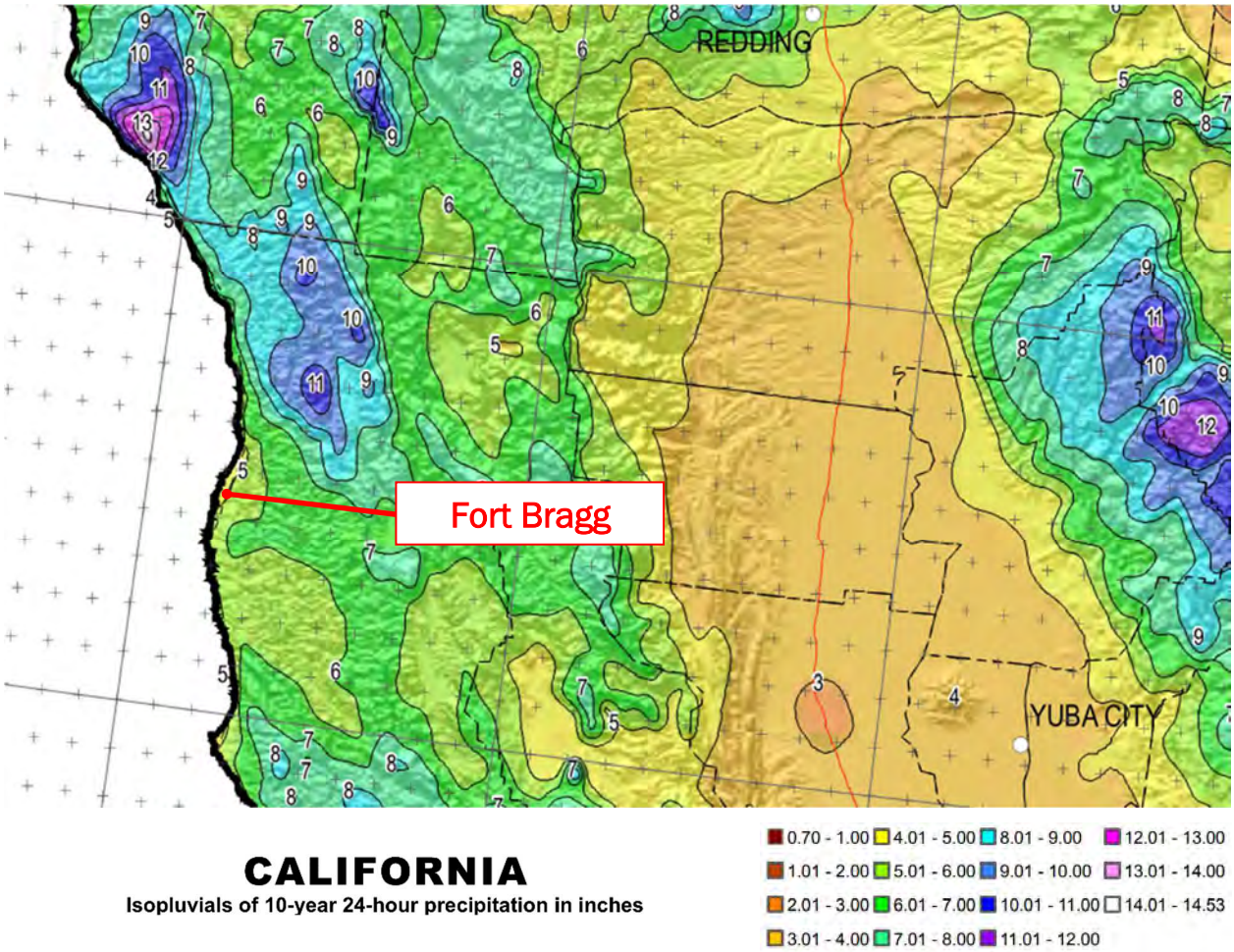


Figure 3-4. NOAA Northern California Rainfall Frequency Map

From the NOAA frequency maps, for a specific latitude and longitude, the rainfall densities for period durations ranging from 1 hour to 20 days are known for rain events ranging from 1-year to 10-year intensities. These are plotted to develop a rain event frequency map specific to each rainfall monitoring site. Superimposing the peak measured densities for the rainfall events on the rain event frequency plot determines the classification of the rainfall event.

Figure 3-5 through Figure 3-9 show the classification plots for the four events from each rain gauge over the course of the flow monitoring period. The following items are noted:

- RG East saw the highest intensity rainfall during the monitoring period, with Event 1 being classified as a <1-year, 6-day storm, Event 2 as a 6-year, 9-day storm, Event 3 as a 2-year, 4-day storm, and Event 3 as a <1-year, 4-day storm.

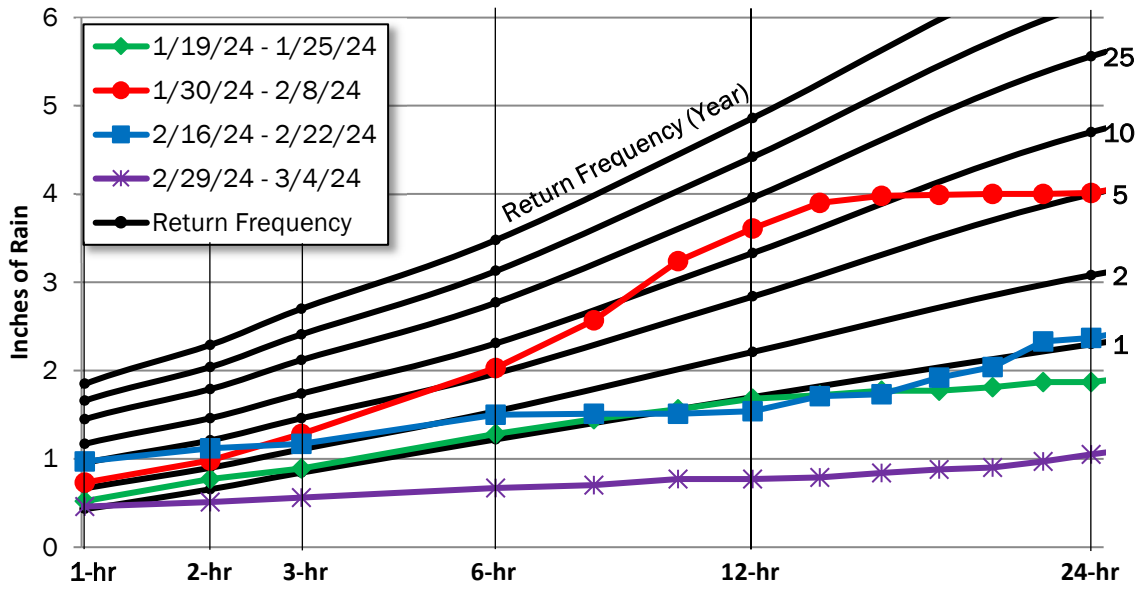


Figure 3-5. Rainfall Event Classification – 24-Hour Period (RG Central)

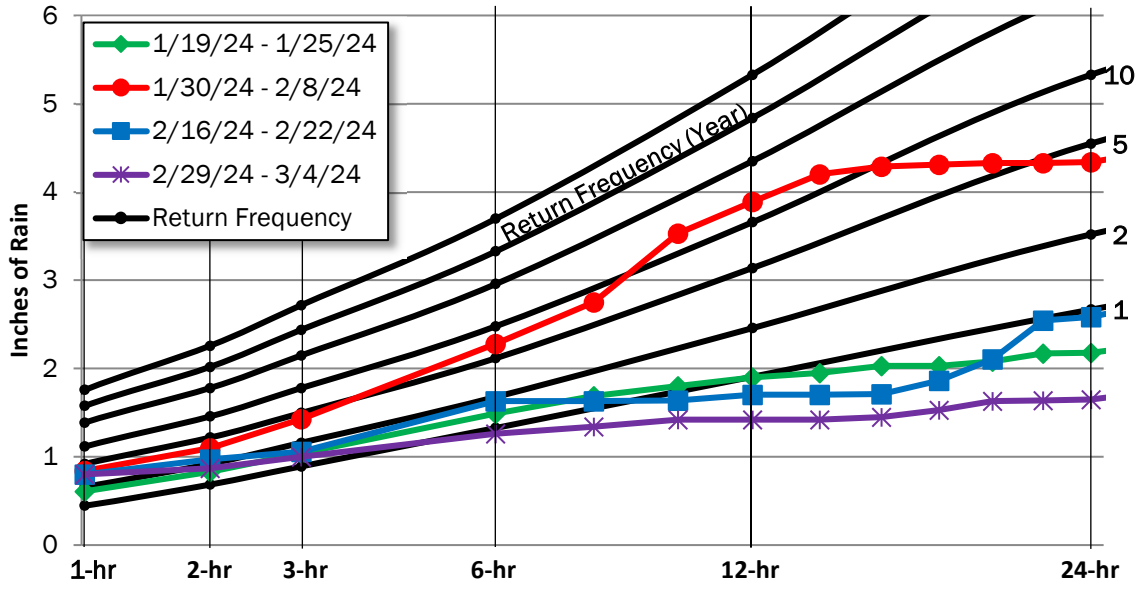


Figure 3-6. Rainfall Event Classification – 24-Hour Period (RG NE)

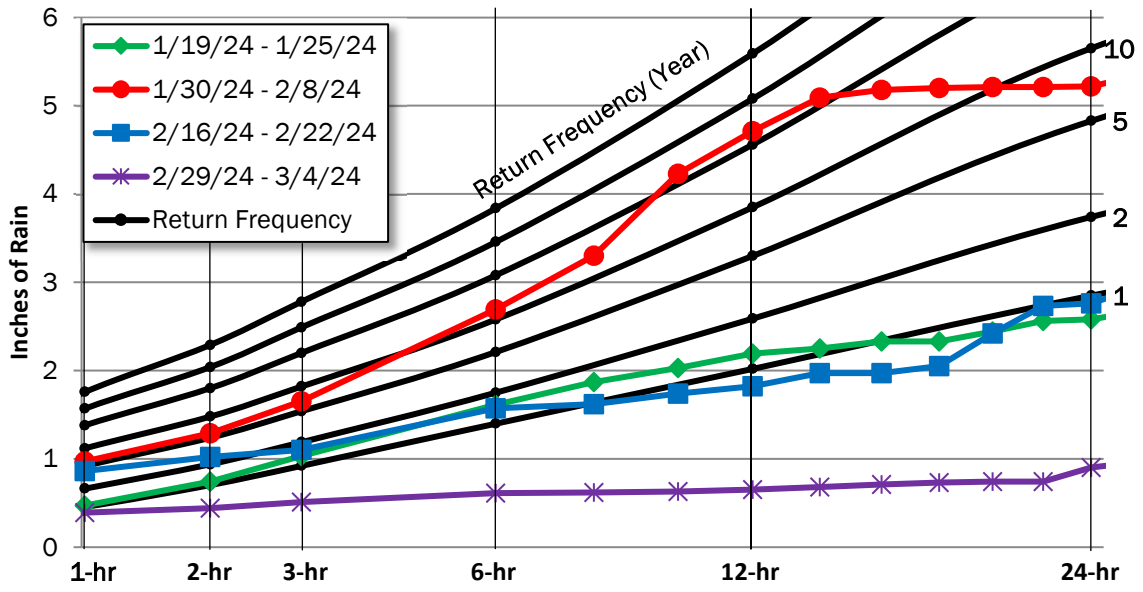


Figure 3-7. Rainfall Event Classification – 24-Hour Period (RG East)

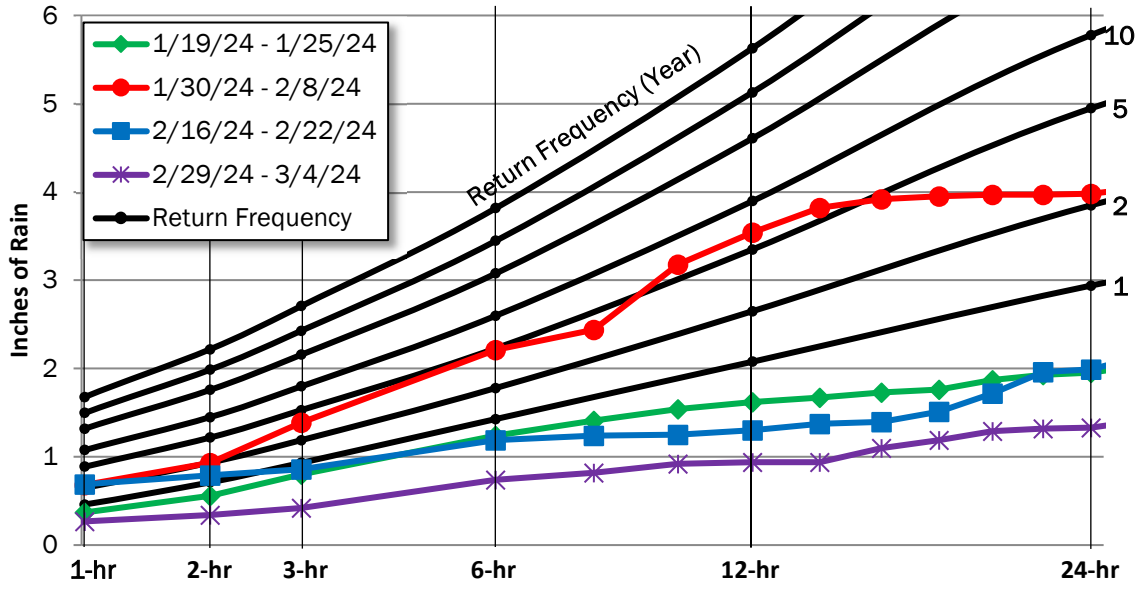


Figure 3-8. Rainfall Event Classification – 24-Hour Period (RG South)

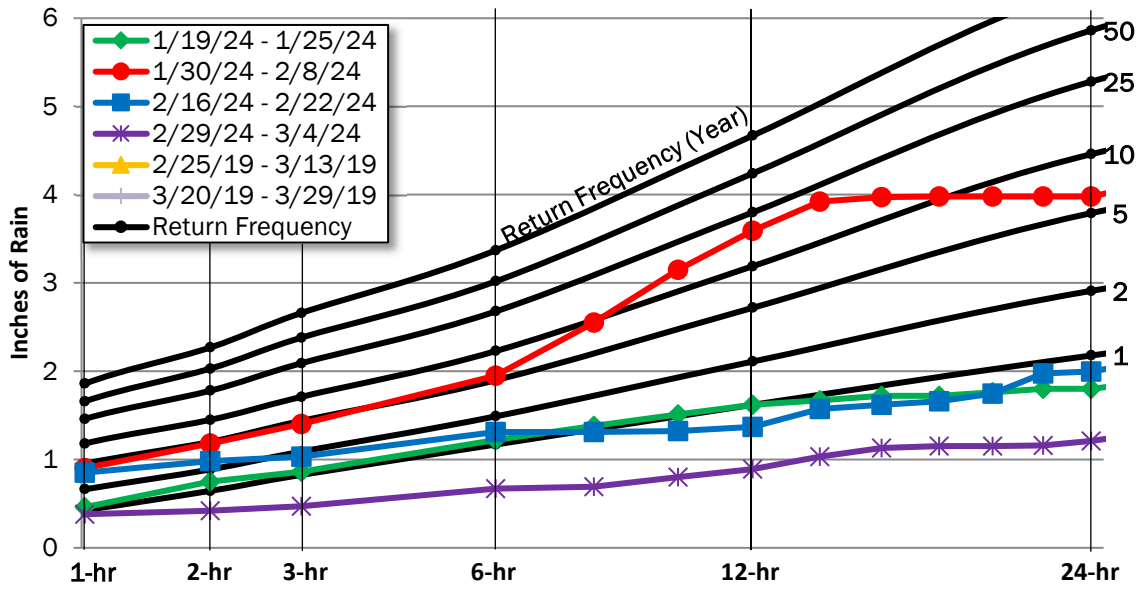


Figure 3-9. Rainfall Event Classification - 24-Hour (RG North)

Table 3-3. Rainfall Event Classification Summary

Rain Gauge	Rain Event #1 Classification	Rain Event #2 Classification	Rain Event #3 Classification	Rain Event #4 Classification
RG Central (WU) KCAFORTB86	<1-Yr, 6-Day	4-Yr, 8-Day	2-Yr, 4-Day	<1-Yr, 4-Day
RG NE (WU) KCAFORTB45	<1-Yr, 6-Day	4-Yr, 8-Day	<1-Yr, 4-Day	<1-Yr, 4-Day
RG East (WU) KCAFORTB54	<1-Yr, 6-Day	6-Yr, 9-Day	2-Yr, 4-Day	<1-Yr, 4-Day
RG South (WU) KCAFORTB103	<1-Yr, 6-Day	1.5-Yr, 9-Day	<1-Yr, 4-Day	<1-Yr, 4-Day
RG North (WU) KCAFORTB79	<1-Yr, 6-Day	5-Yr, 9-Day	1.5-Yr, 4-Day	<1-Yr, 4-Day

3.1.3 Rain Gauge Triangulation Distribution

The rainfall affecting the sanitary sewer collection system basins must be calculated based on their proximity to the rain gauge locations. The mean precipitation for each site's upstream basin was calculated by taking data from the rain gauges and using the inverse distance weighting (IDW) method. IDW is an interpolation method that assumes the influence of each rain gauge location diminishes with distance. The center of an upstream basin[6] is identified, and a weighted triangulated average of the precipitation data from nearby rain gauge locations is taken.

[6] Note that the full basin upstream of the site was used instead of the isolated basins as the rain data will be compared to the flow at each site

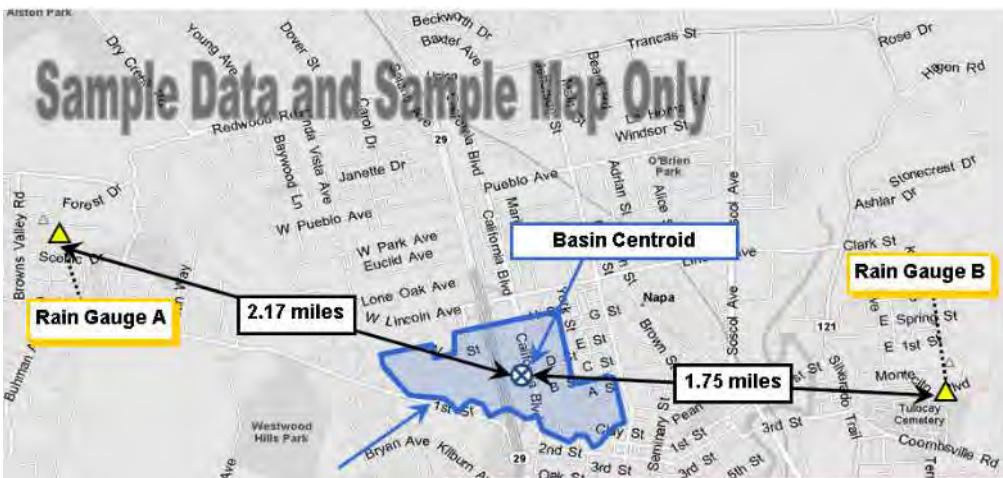
The IDW function is as follows:

$$weight(d) = \frac{1/d^p}{\sum 1/d^p},$$

where: d = distance
p = power ($p > 0$)

The value of p is user-defined. The most common choice for hydrological studies of watershed areas is $p = 2$.

Figure 3-10 illustrates the IDW method with sample data. The rain gauge distribution, as calculated for each flow monitoring site, is shown in Table 3-4.



Rain Gauge	Distance (miles)	$1/d^2$	Weight (%)
Rain Gauge A	2.17	0.2124	39.4%
Rain Gauge B	1.75	0.3265	60.6%
Totals		**0.5389**	**100%**

Figure 3-10. Rainfall Inverse Distance Weighting Method

Table 3-4. Rain Gauge Distribution per Monitoring Site

Site	RG Central	RG NE	RG East	RG South	RG North
FM-01	79.2%	3.3%	1.6%	0.0%	15.9%
FM-02	47.3%	28.2%	8.7%	4.3%	11.5%
FM-03	51.9%	23.9%	7.7%	3.8%	12.6%
FM-04	35.5%	36.5%	11.0%	5.8%	11.2%
FM-05	30.6%	39.7%	12.1%	6.8%	10.8%
FM-06	19.6%	52.8%	13.1%	6.9%	7.5%
FM-07	12.2%	50.8%	18.1%	12.9%	6.0%

3.2 Flow Monitoring

3.2.1 Average Flow Analysis

Average dry weather flow (ADWF) curves were established during dry days when I/I had the least impact on the baseline flow. Table 3-5 summarizes the dry weather flow data measured for this study. ADWF curves for each site can be found in Appendix A. Figure 3-11 shows a flow schematic of the average daily flows and levels. The following ADWF analysis results are noted:

- No site showed an average dry weather flow level greater than 50% pipe full conditions (greater than 0.5 d/D).

Table 3-5. Dry Weather Flow

Monitored Site	Sediment (in.)	Average d/D Ratio	Mon-Thu ADWF (MGD)	Friday AWDF (MGD)	Saturday ADWF (MGD)	Sunday ADWF (MGD)	Overall ADWF (MGD)
FM01	none	0.15	0.03	0.03	0.04	0.04	0.03
FM02	none	0.10	0.21	0.18	0.17	0.14	0.19
FM03	none	0.29	0.73	0.72	0.78	0.71	0.73
FM04	none	0.32	0.32	0.30	0.32	0.30	0.31
FM05	none	0.32	0.03	0.03	0.03	0.03	0.03
FM06	none	0.26	0.011	0.011	0.012	0.009	0.01
FM07	none	0.13	0.04	0.04	0.03	0.04	0.04

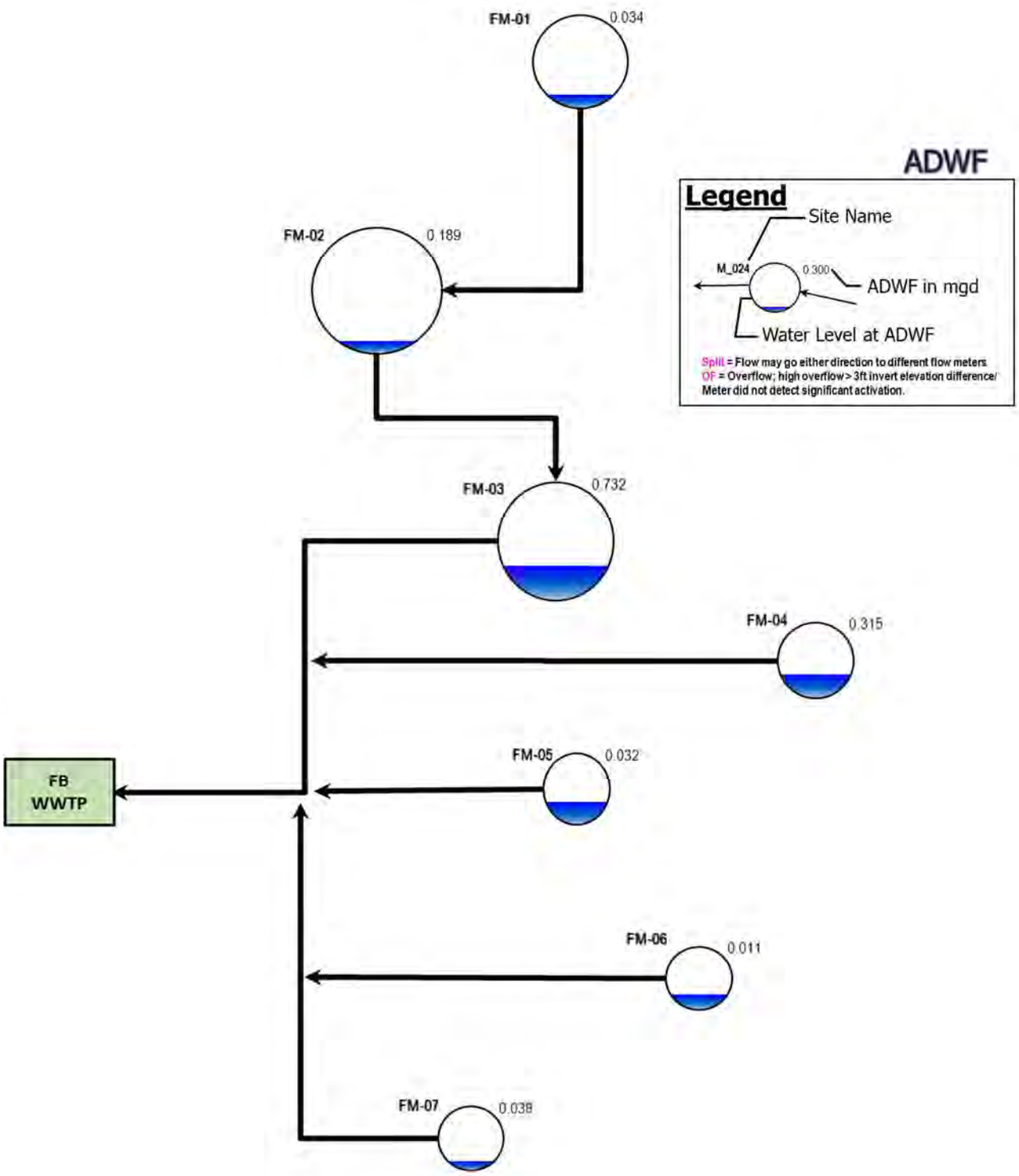


Figure 3-11 Average Dry Weather Flow (Flow Schematic)

3.2.2 Peak Measured Flows and Pipeline Capacity Analysis

Peak measured flows and the hydraulic grade line data (flow depths) are important to understanding the capacity limitations of a collection system. The peak flows and flow levels are the peak measurements taken across the entirety of the flow monitoring period. For this study, peak flows and peak levels correspond to rainfall events. The following capacity analysis definitions will be used:

- **The Peaking Factor (PF)** is defined as the peak measured flow divided by the average dry weather flow (ADWF). Peaking factors are influenced by many factors, including size and topography of the tributary area, flow attenuation, flow restrictions, characteristics of I/I entering the collection system, and hydraulic features such as pump stations.
  - For this report, PF > 7 is highlighted in RED[7]; however, the City should refer to City standards when evaluating peaking factors. Peaking factor data should be used at the discretion of the City Engineer.
- **d/D Ratio** is the peak measured depth of flow (d) divided by the pipe diameter (D). The d/D ratio for each site is computed based on the maximum depth of flow for the study. Standards for d/D ratio vary from agency to agency but typically range between d/D ≤ 0.5 and d/D ≤ 0.75
  - For this report, d/D ratios > 0.75 are highlighted in RED; however, the City should refer to City standards when evaluating d/D ratios, to be used at the discretion of the City Engineer.

Table 3-6 summarizes the peak recorded flows, depths, *d/D* ratios, and peaking factors per site during the flow monitoring period. Capacity analysis data are presented on a site-by-site basis and represent the hydraulic conditions only at the site locations; hydraulic conditions in other areas of the collection system will differ. Figure 3-12 and Figure 3-13 show bar graph summaries of the peaking factors and d/D ratios, respectively. Figure 3-14 shows the schematic diagram of the peak measured flows in each section with peak flow levels.

The following capacity analysis results are noted:

- Peaking Factors
  - Site FM-04, FM-06, and FM-07 had peaking factors > 7; These PFs appear to be due to wet-weather response.
  - It should be noted that FM-02 and FM-03 had peaking factors > 5, which may be considered above the standard for some collection systems and cities.
- d/D Ratio:
  - d/D > 0.75: No sites had a dry weather d/D > 0.75. However, sites FM-03 and FM-04 both had d/D > 0.75 over the monitoring period due to Rain Event 2. Levels returned to baseline before the next rain event.

[7] WEF Manual of Practice FD-6 and ASCE Manual No. 62 suggests typical peaking factor ratios range between 3 and 4, with higher values possibly indicative of pronounced I/I flows.

Table 3-6. Capacity Analysis Summary

Site	ADWF (MGD)	Peak Measured Flow (MGD)	Peaking Factor	Pipe Diameter, *D* (IN)	Max Depth, *d* (IN)	Max d/D Ratio	Surcharge above pipe crown (FT)
FM-01	0.034	0.16	4.6	12	2.81	0.23	n/a
FM-02	0.189	1.30	6.8	24	5.05	0.21	n/a
FM-03	0.732	4.39	6.0	20	44.08	2.20	2.01
FM-04	0.315	3.34	10.6	10	13.70	1.37	0.31
FM-05	0.032	0.09	2.7	6	2.68	0.45	n/a
FM-06	0.011	0.12	11.2	6	3.33	0.55	n/a
FM-07	0.038	0.39	10.3	12	4.05	0.34	n/a

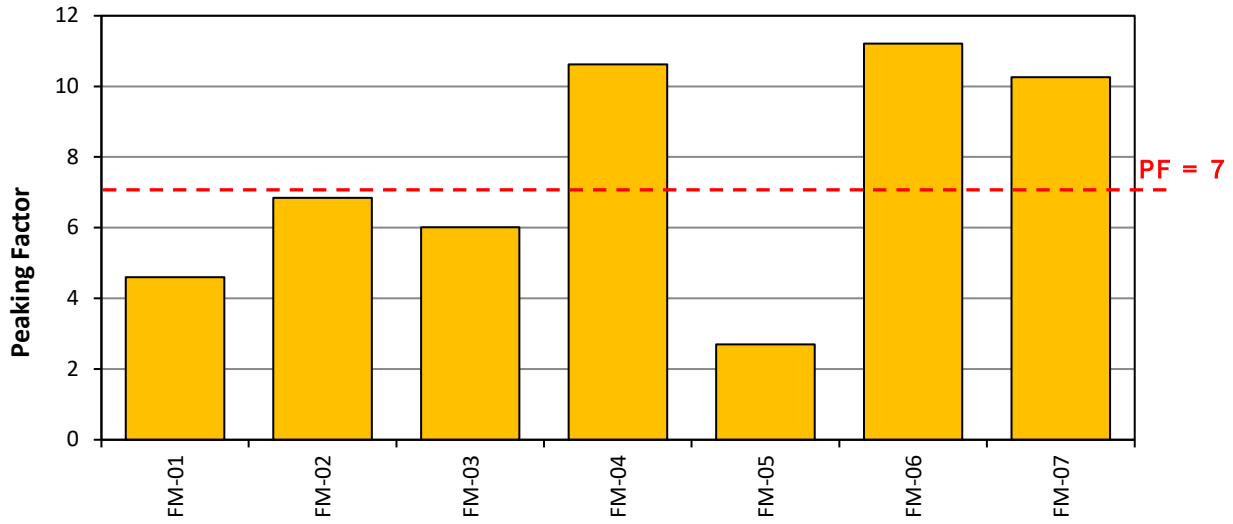


Figure 3-12. Peaking Factors

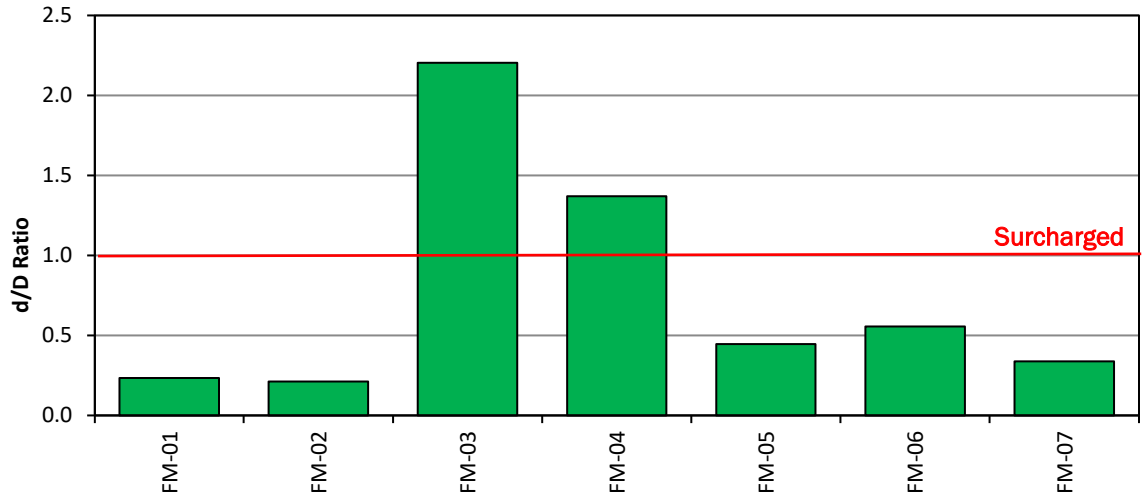


Figure 3-13. Capacity Summary: Max d/D Ratios

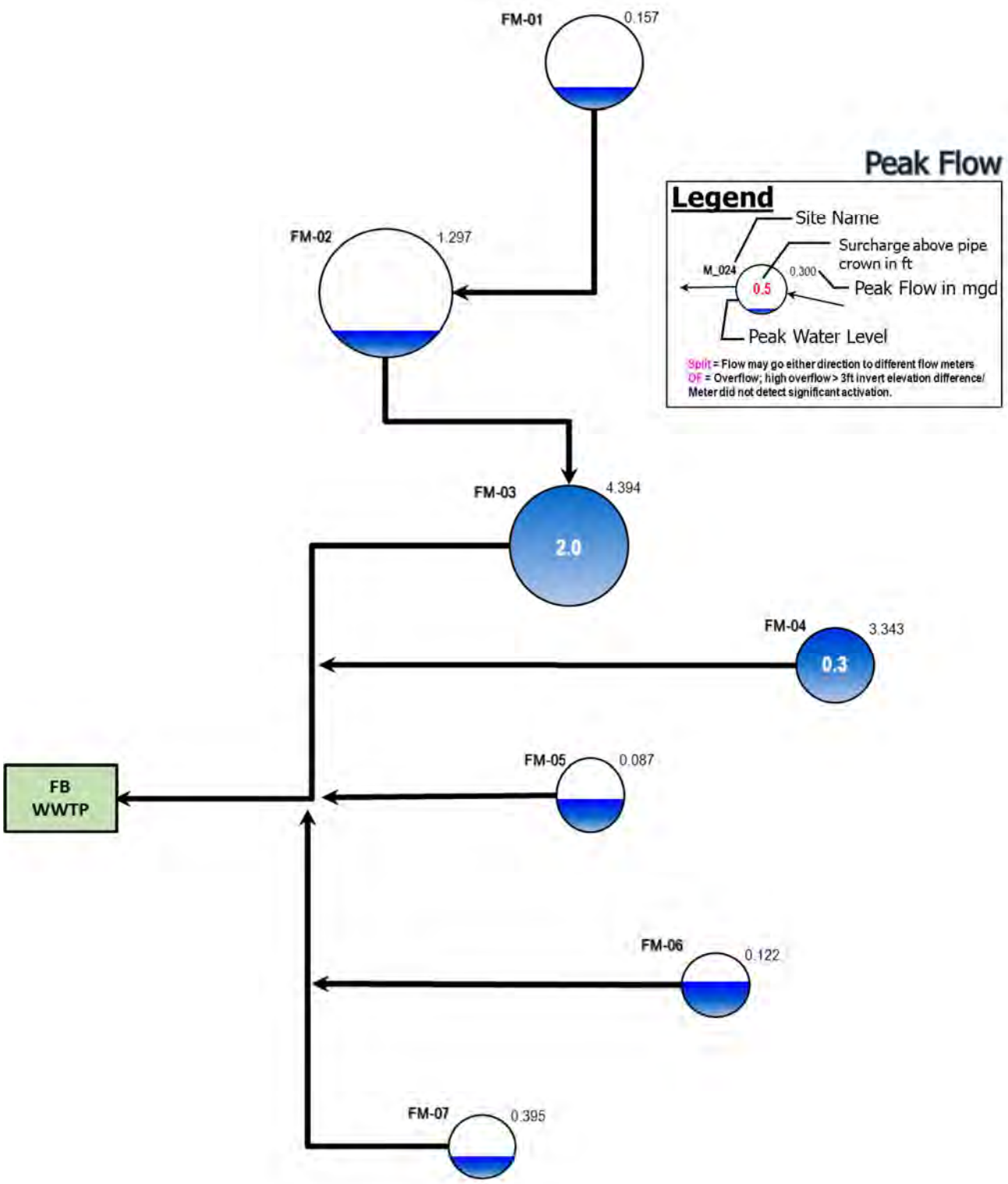


Figure 3-14. Peak Measured Flow (Flow Schematic)

4 Recommendations

V&A advises that future I/I reduction plans consider the following recommendations:

1. **Master Plan and Model Implementation**: This study focuses on inflow and infiltration generation; the study results can be used to update the master plan and compare with previous model assumptions and flow monitoring results.
2. **Capacity Analysis**: Two sites (FM-03 and FM-04) were surcharged during the monitoring period, approximately 2 feet above the pipe crown for FM-03 and 0.3 feet for FM-04. The following possible capacity concerns are noted:
    a. **Dry weather**: No site showed an average flow level greater than 50% full pipe conditions (greater than 0.5 d/D).
    b. **Wet Weather**: With the exception of sites FM-04, FM-06, and FM-07, wet weather peaking factors ranged from 2.7 to 6.8. This is typically considered to be within acceptable limits and no further action is recommended unless the City wishes to pursue I/I identification. It should be noted that while these limits may be within normally acceptable limits, higher intensity storms than those that occurred during the monitoring period could cause higher wet weather responses.
        i. It should be noted that FM-02 and FM-03 had peaking factors > 5, which may be considered above the standard for some municipalities.
        ii. Sites FM-04, FM-06, and FM-07 had peaking factors > 7; These PFs appear to be due to a wet-weather response. An investigation of I/I sources, and source disconnect / rehabilitation program, would be recommended in these basins.
3. **I/I Investigation Methods**: Potential I/I investigation methods include the following:
    a. Smoke testing.
    b. Manhole Inspection.
    c. Private I/I and Building Evaluations
    d. Mini-basin flow monitoring.
    e. Night-time reconnaissance work is done to (1) investigate and determine direct point sources of inflow and (2) determine the areas and/or pipe reaches responsible for high levels of infiltration contribution.
    f. CCTV inspection.
4. **I/I Reduction Cost Effective Analysis**: Follow I/I investigation, an evaluation can be conducted to determine which is more cost-effective: (1) elimination of priority sources of inflow/infiltration and systematically rehabilitating or replacing the faulty pipelines or (2) continued treatment of the additional rainfall-dependent I/I flow.

Appendix A
Flow Monitoring Sites: Data, Graphs, Information

Monitoring Site: FM-01

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: Next to Pump Station off of 1184 N Main St

Data Summary Report

Vicinity Map: FM-01

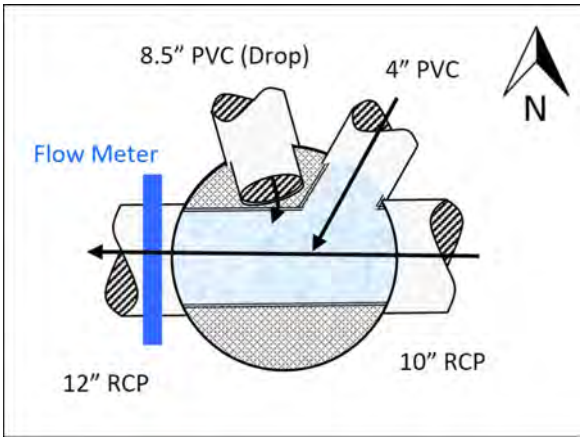
FM-01

Site Information MH ID: Mnhl-Chnnl-4588

Location:	Next to Pump Station off of 1184 N Main St
Coordinates:	123.8068° W, 39.4592° N
Rim Elevation:	23 feet
Expected Pipe Diameter:	12 inches
Measured Pipe Diameter:	12 inches
ADWF:	0.034 mgd
Peak Measured Flow:	0.157 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

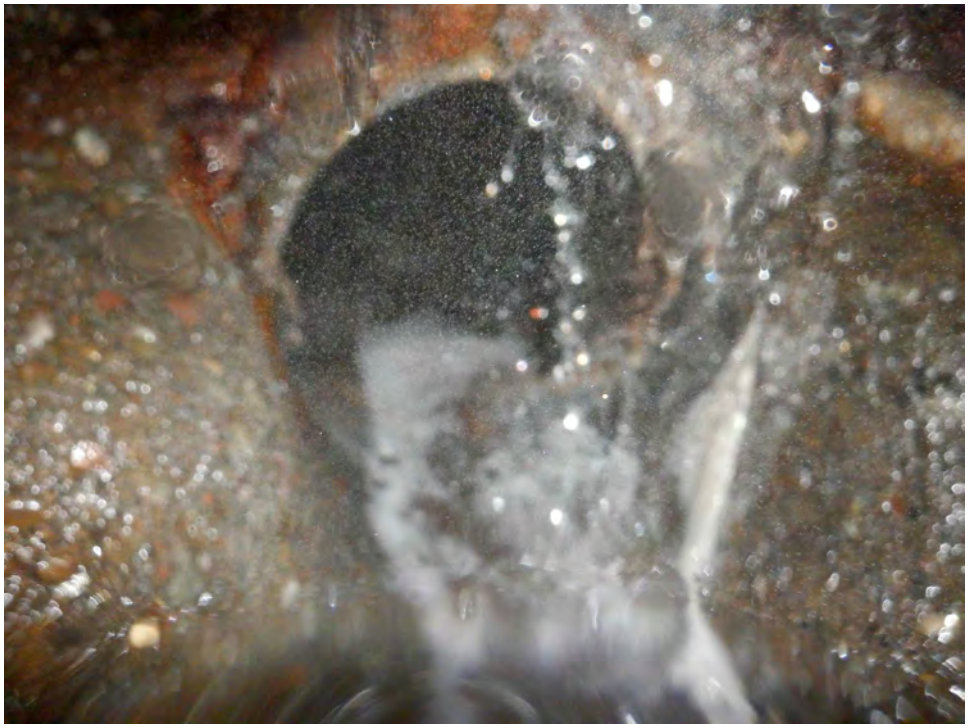
Plan View

FM-01

Additional Site Photos

Monitored West Outlet Pipe

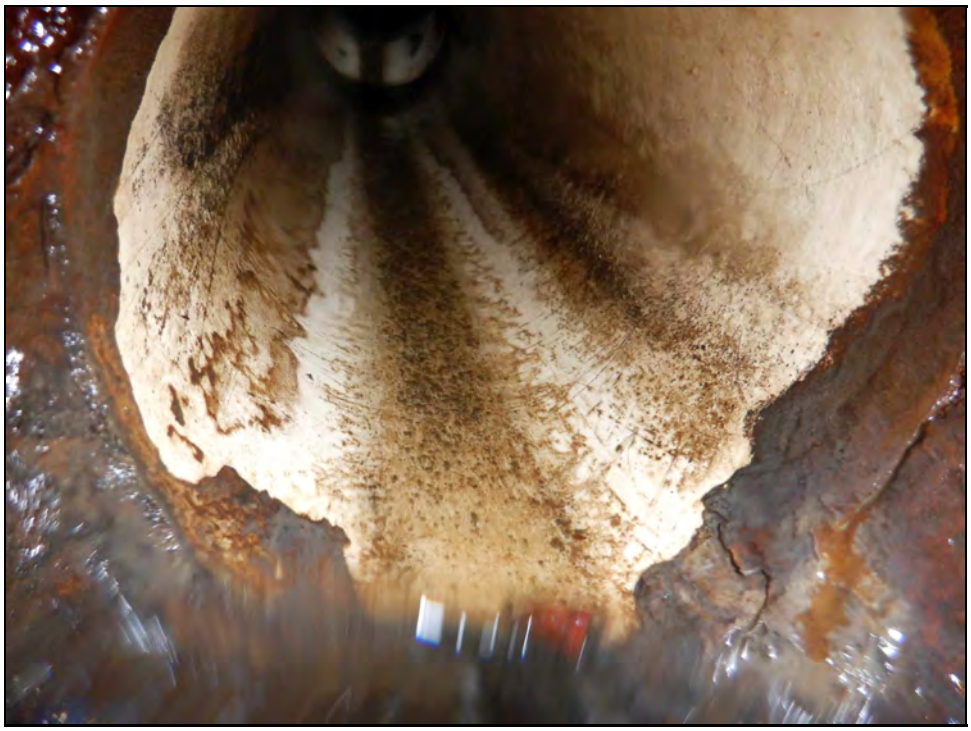
North Inlet Pipe



FM-01

Additional Site Photos

Northeast Inlet Pipe



East Inlet Pipe

FM-01

Additional Site Photos

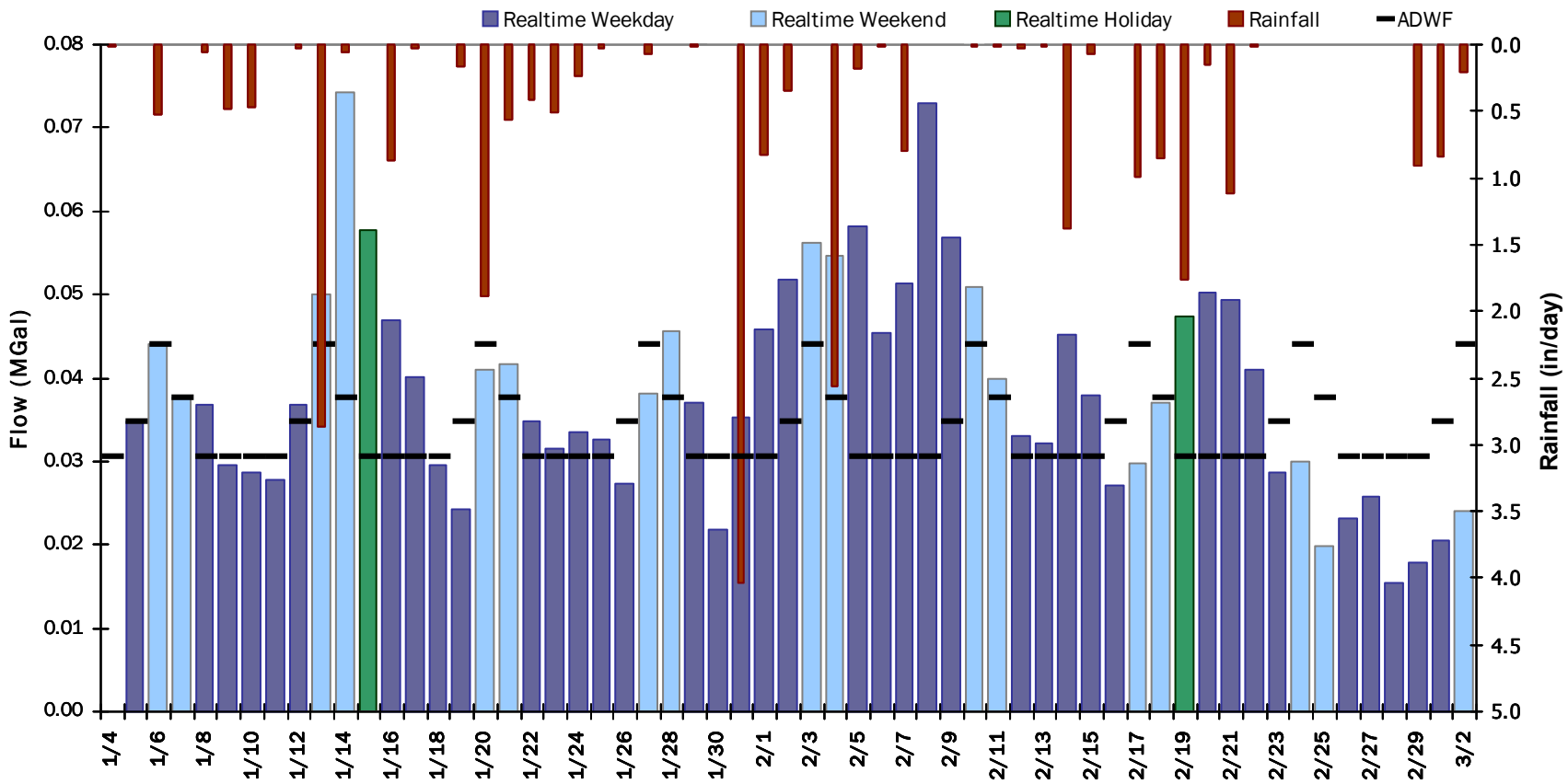
North Inside Drop

FM-01

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.039 MGal Peak Daily Flow: 0.074 MGal Min Daily Flow: 0.015 MGal

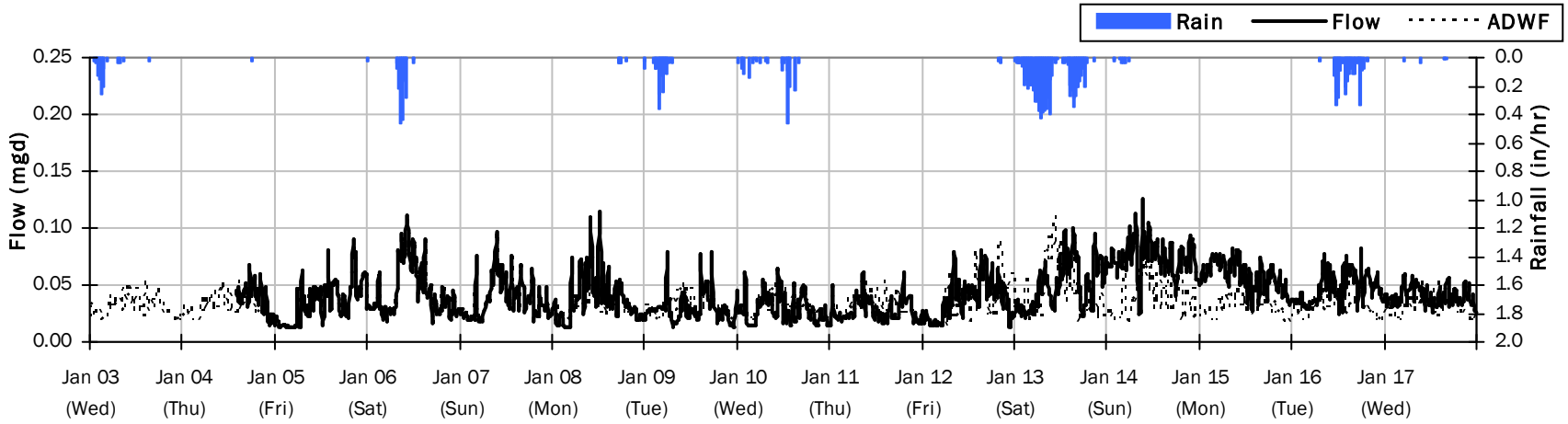
Total Rainfall: 26.36 inches

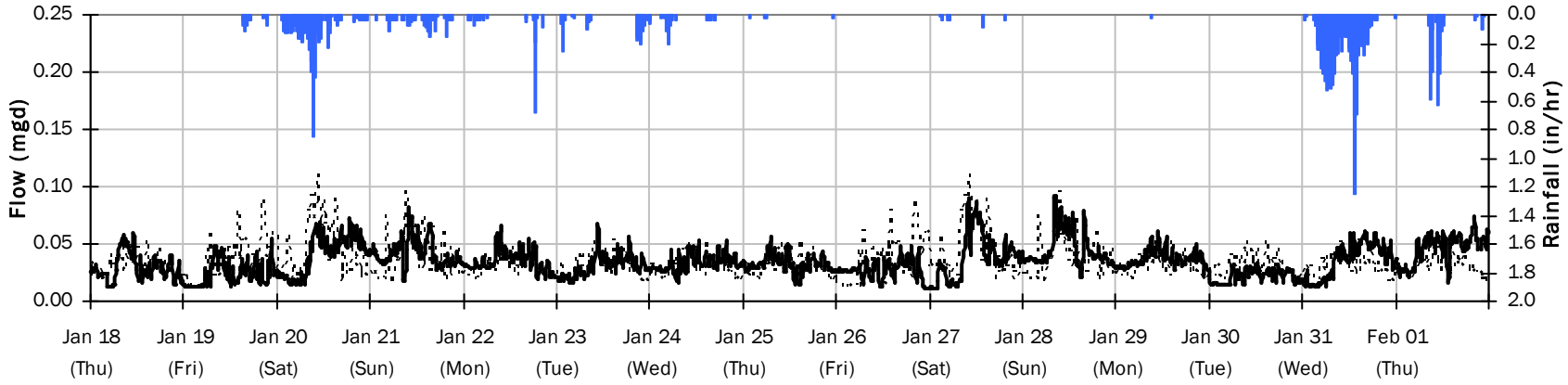


FM-01

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 14.41 inches Period Avg Flow: 0.038 mgd Period Peak Flow: 0.125 mgd Period Min Flow: 0.011 mgd

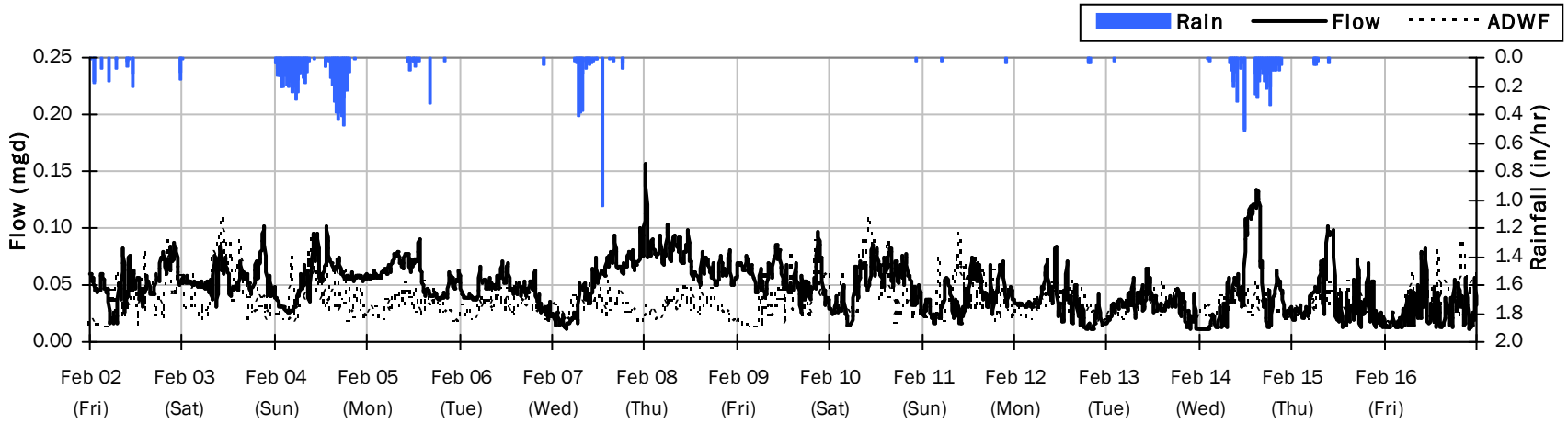


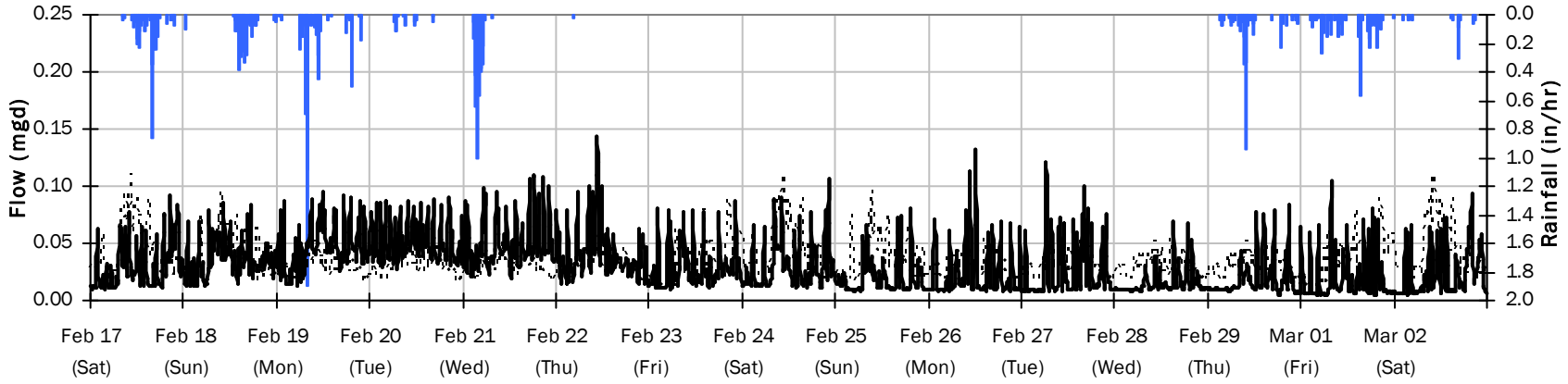


FM-01

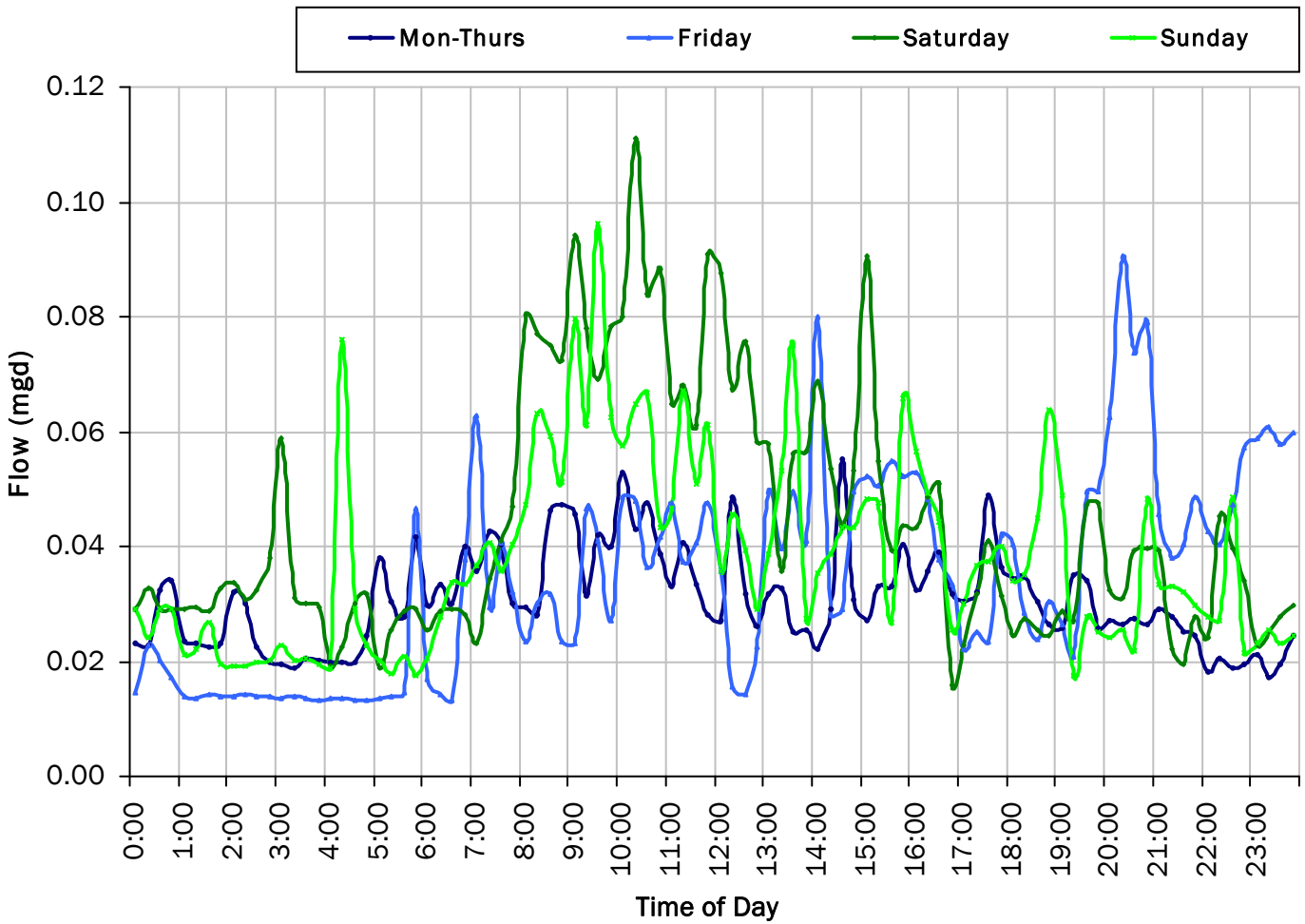
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 12.25 inches Period Avg Flow: 0.039 mgd Period Peak Flow: 0.157 mgd Period Min Flow: 0.004 mgd



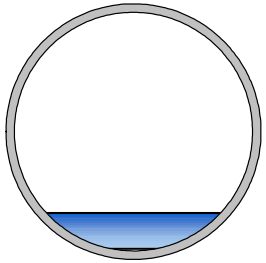


FM-01
Average Dry Weather Flow Hydrographs



ADWF:

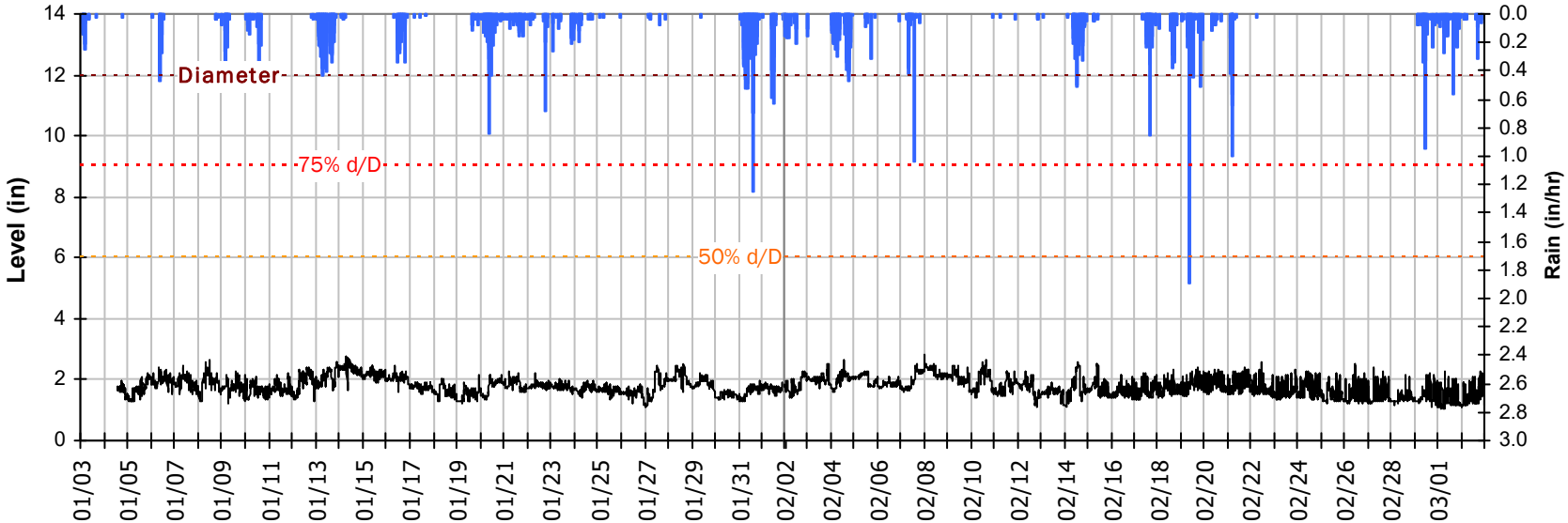
0.034 *mgd*

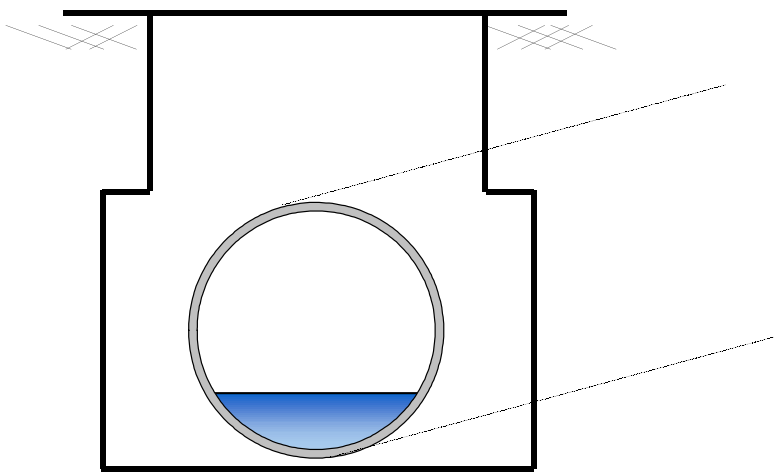


FM-01

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period

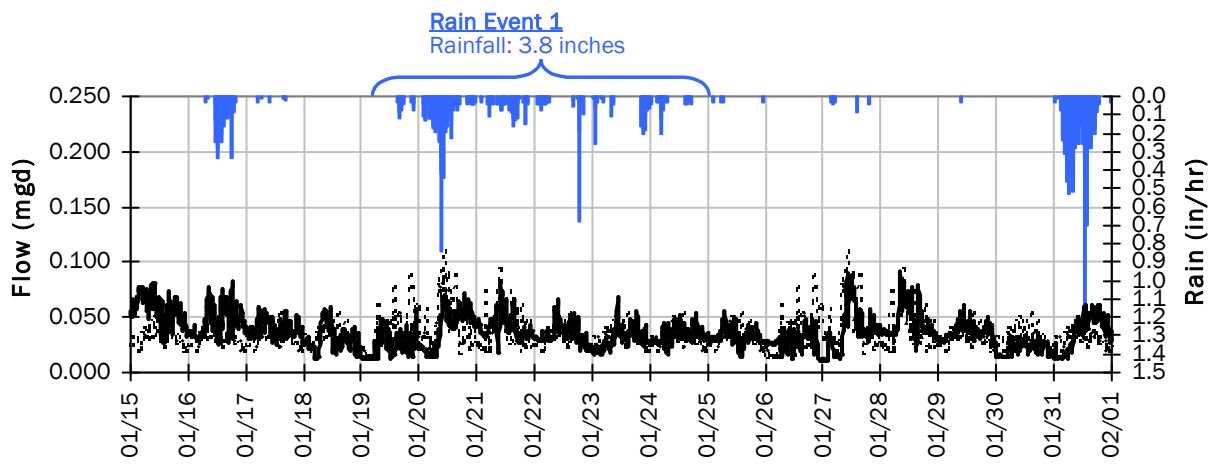




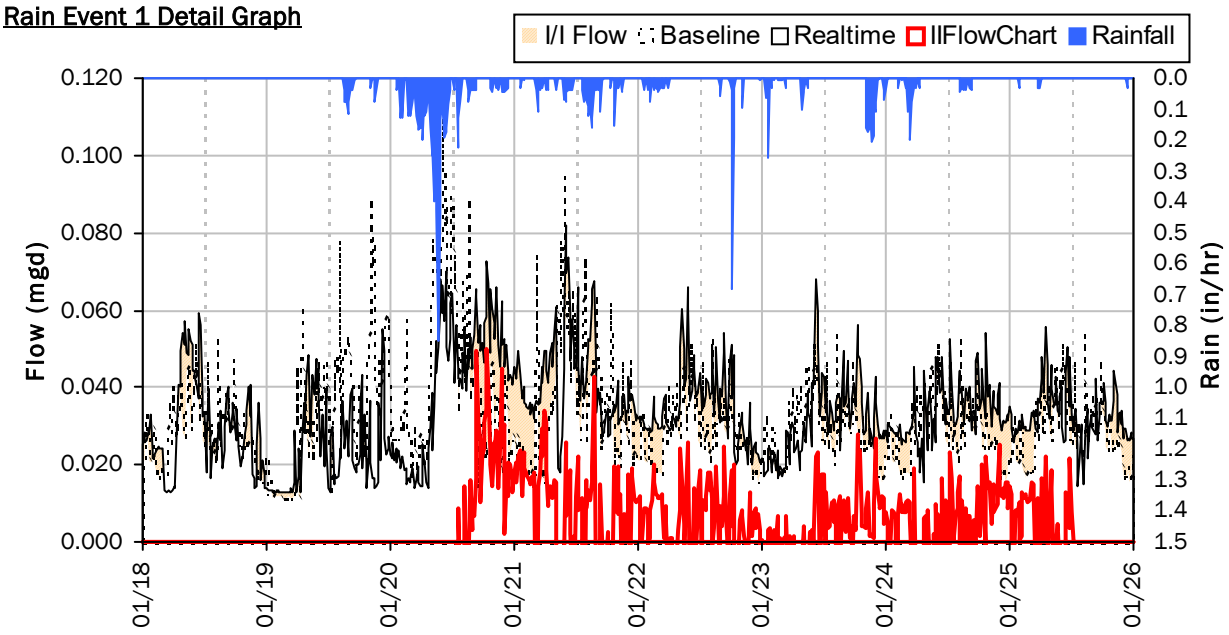
Pipe Diameter:	12	*inches*
Peak Measured Level:	2.81	*inches*
Peak d/D Ratio:	0.23	

FM-01
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

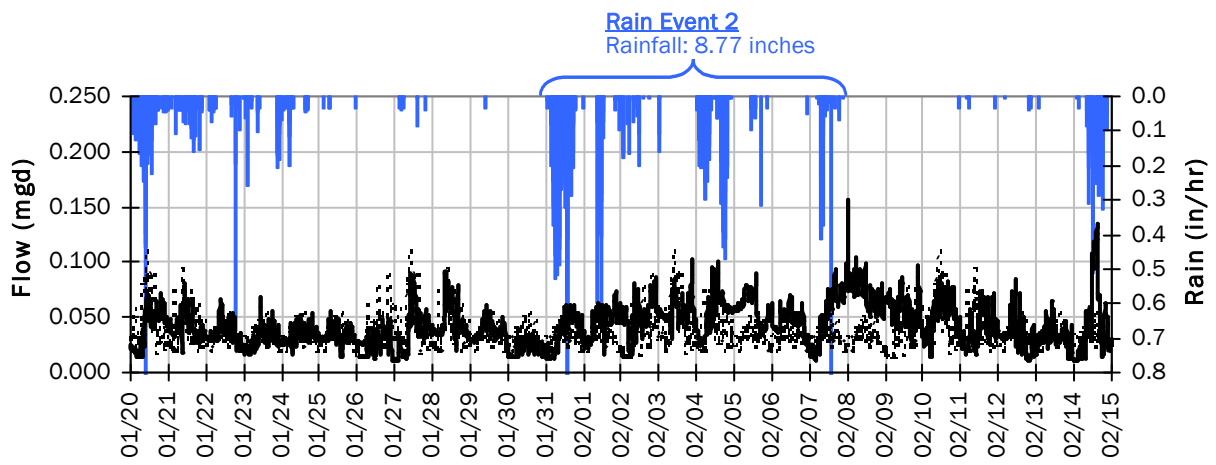


Storm Event I/I Analysis (Rain = 3.80 inches)

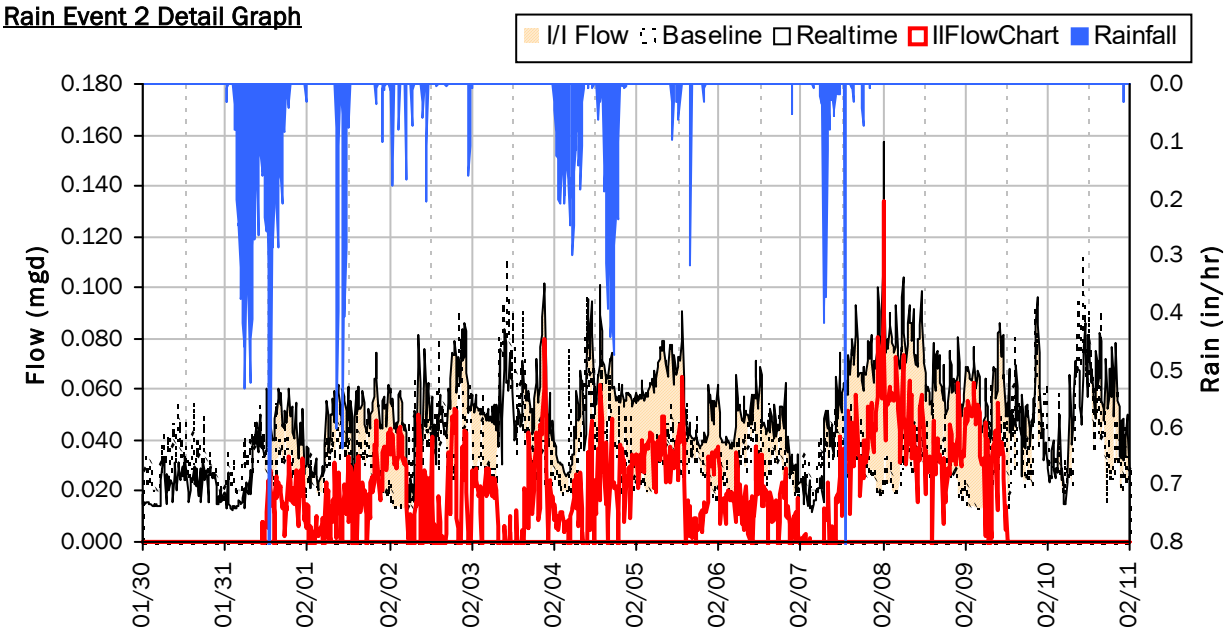
Capacity		Inflow / Infiltration	
Peak Flow:	0.082 *mgd*	**Peak I/I Rate:**	0.050 *mgd*
PF:	2.39	**Total I/I:**	29,000 *gallons*
Peak Level:	2.24 *in*		
d/D Ratio:	0.19		

FM-01
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

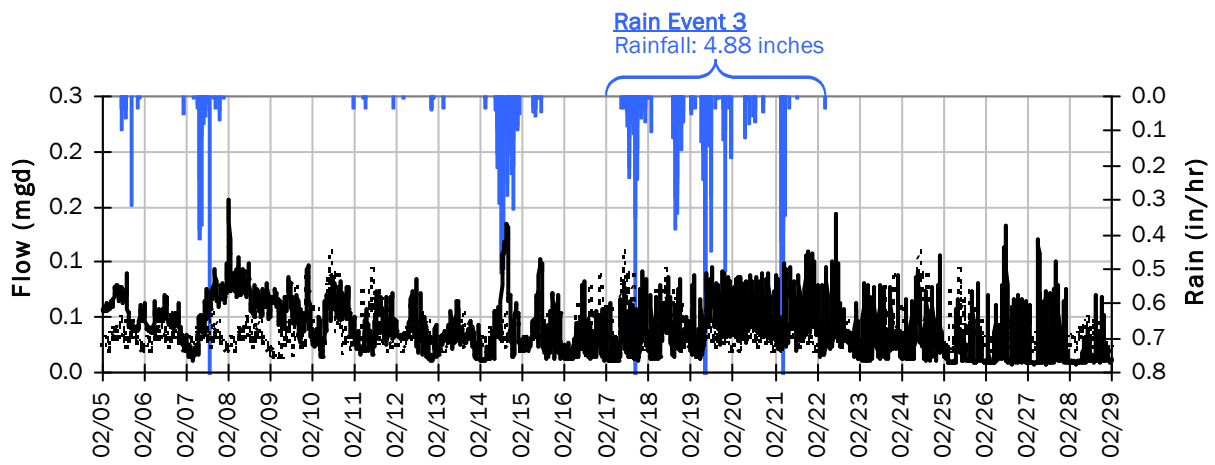


Storm Event I/I Analysis (Rain = 8.77 inches)

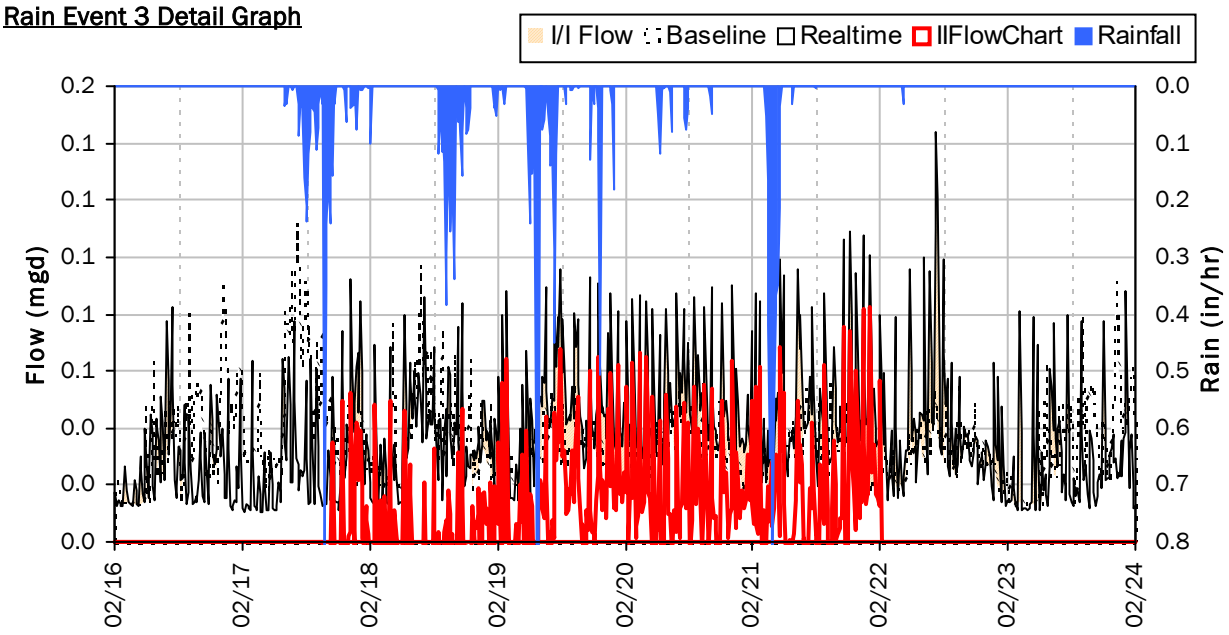
Capacity		Inflow / Infiltration	
Peak Flow:	0.157 *mgd*	**Peak I/I Rate:**	0.134 *mgd*
PF:	4.60	**Total I/I:**	193,000 *gallons*
Peak Level:	2.81 *in*		
d/D Ratio:	0.23		

FM-01
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

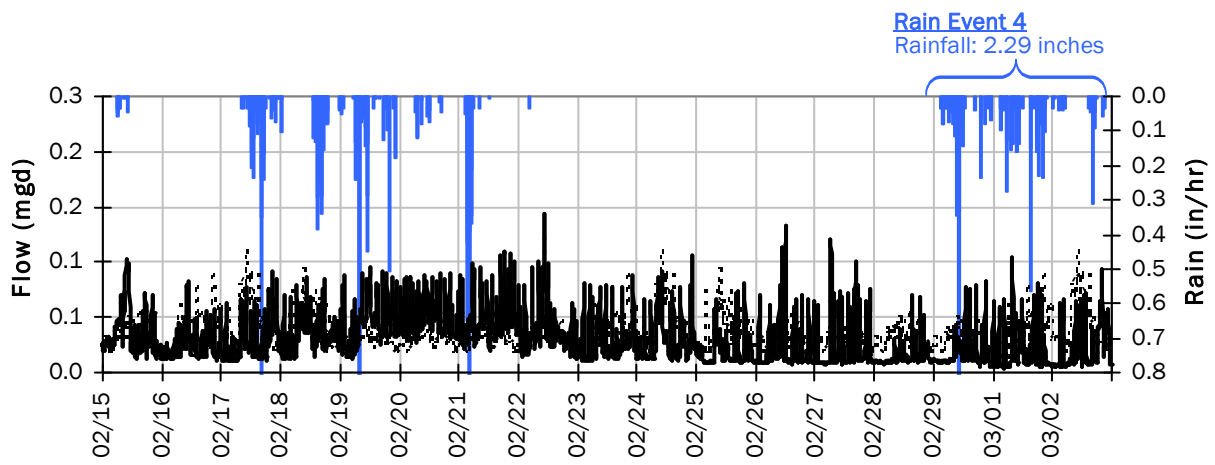


Storm Event I/I Analysis (Rain = 4.88 inches)

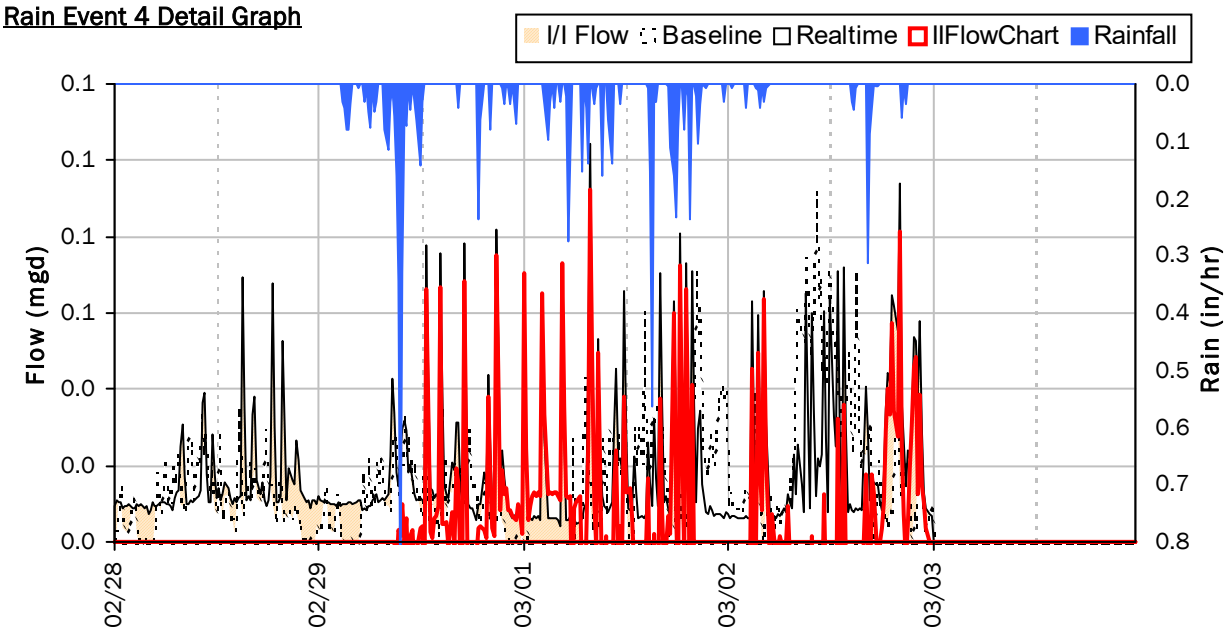
Capacity		Inflow / Infiltration	
Peak Flow:	0.11 *mgd*	**Peak I/I Rate:**	0.08 *mgd*
PF:	3.18	**Total I/I:**	56,000 *gallons*
Peak Level:	2.38 *in*		
d/D Ratio:	0.20		

FM-01
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



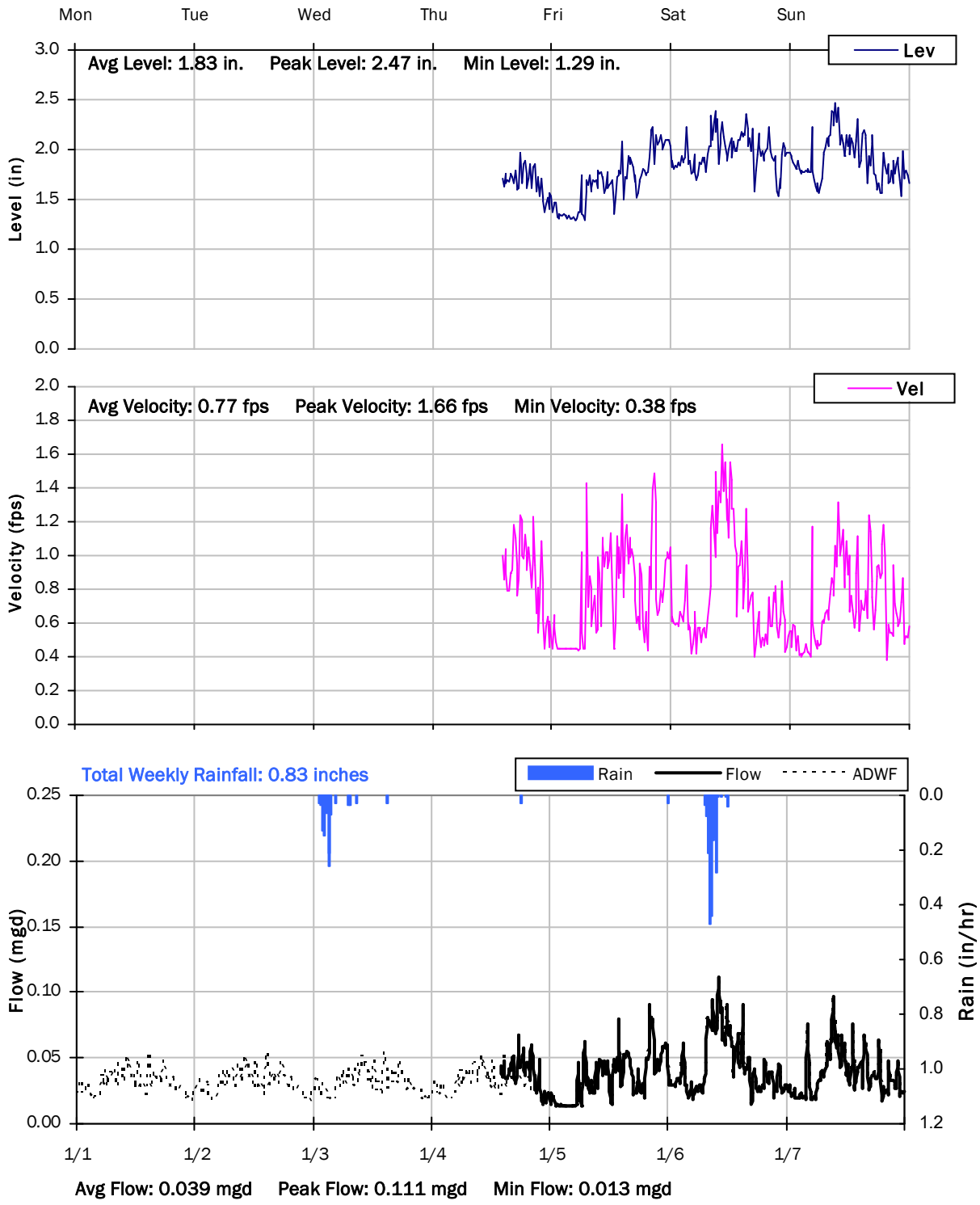
Storm Event I/I Analysis (Rain = 2.29 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.10 *mgd*	**Peak I/I Rate:**	0.09 *mgd*
PF:	3.05	**Total I/I:**	12,000 *gallons*
Peak Level:	2.29 *in*		
d/D Ratio:	0.19		

FM-01

Weekly Level, Velocity and Flow Hydrographs

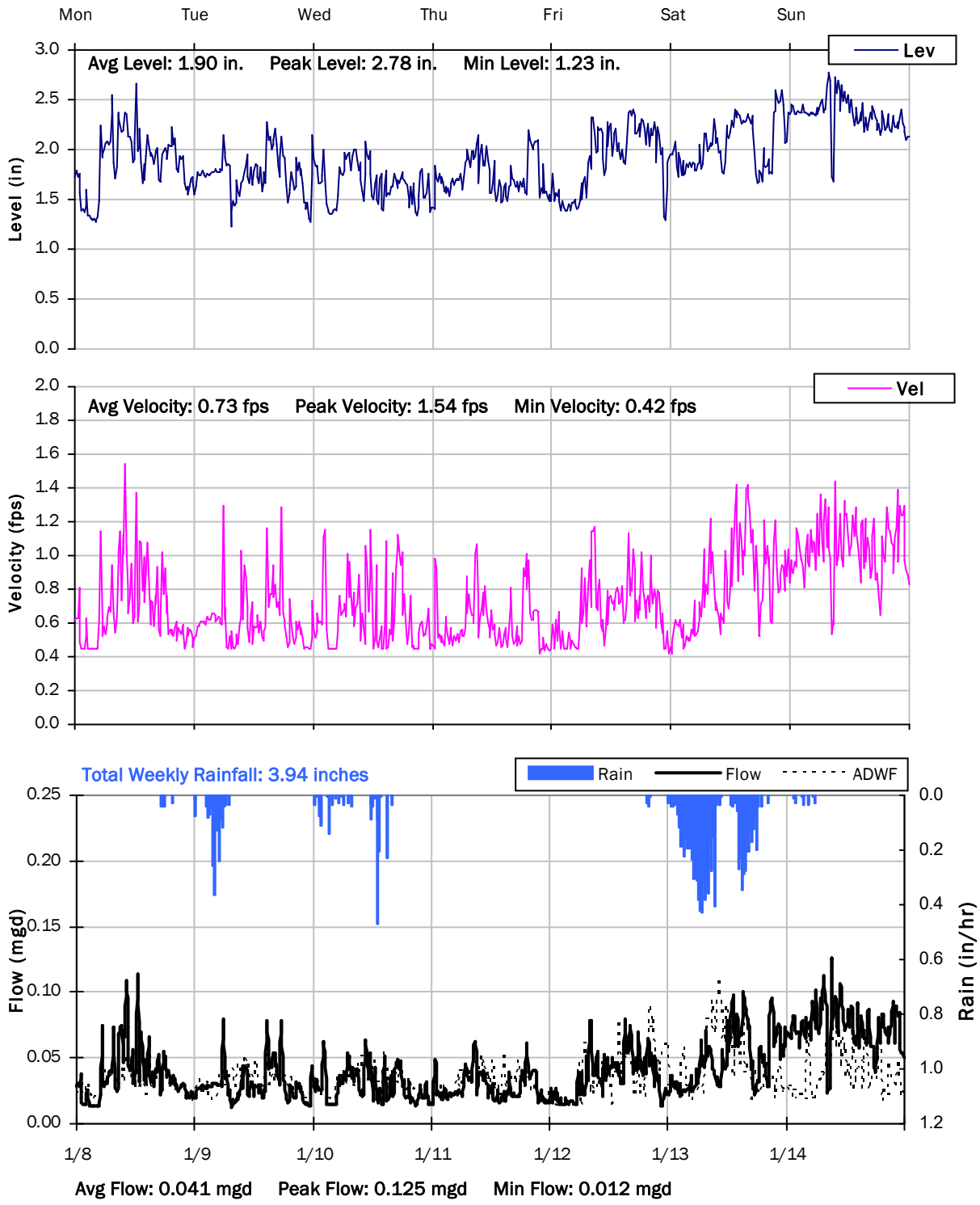
1/1/2024 to 1/8/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

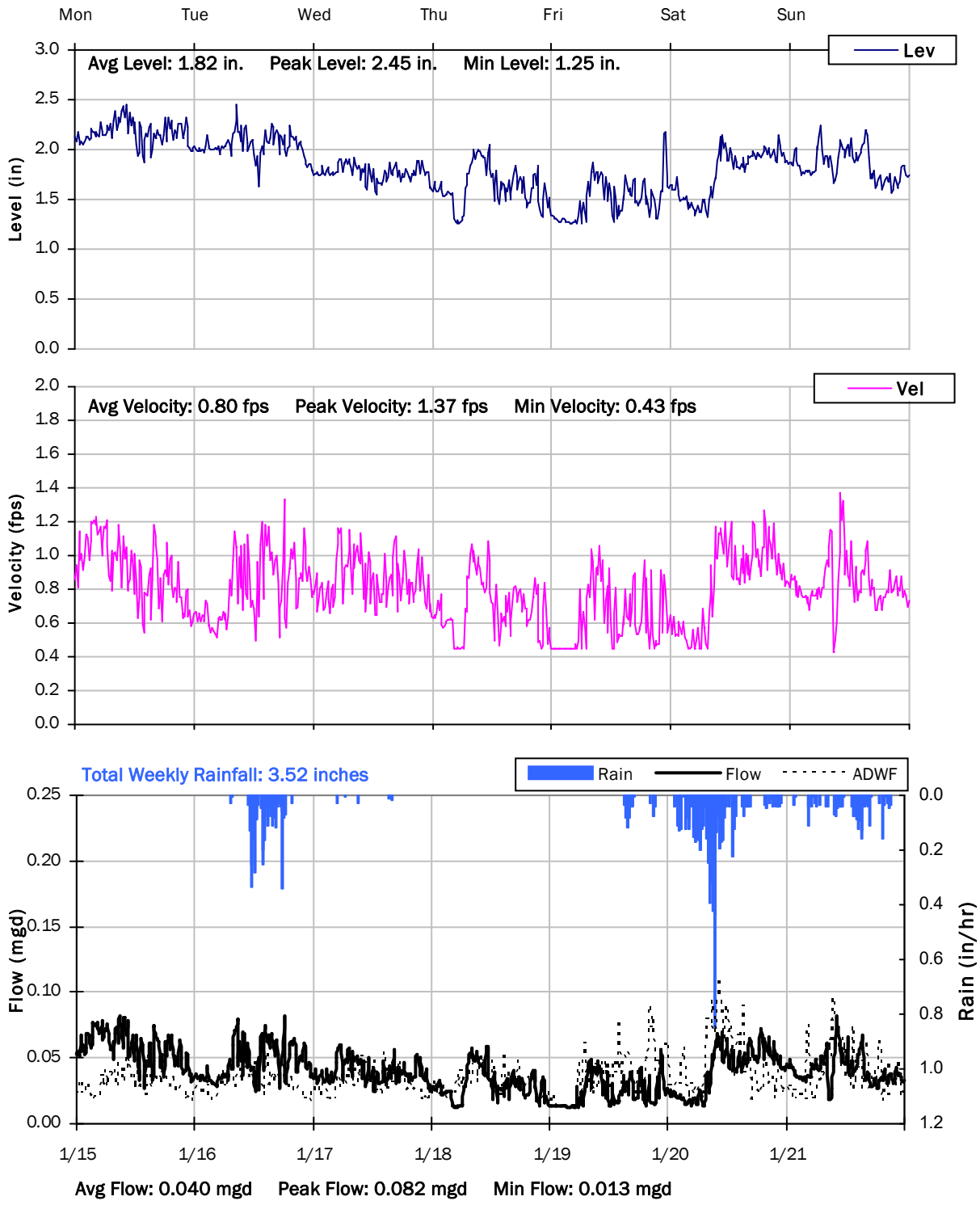
1/8/2024 to 1/15/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

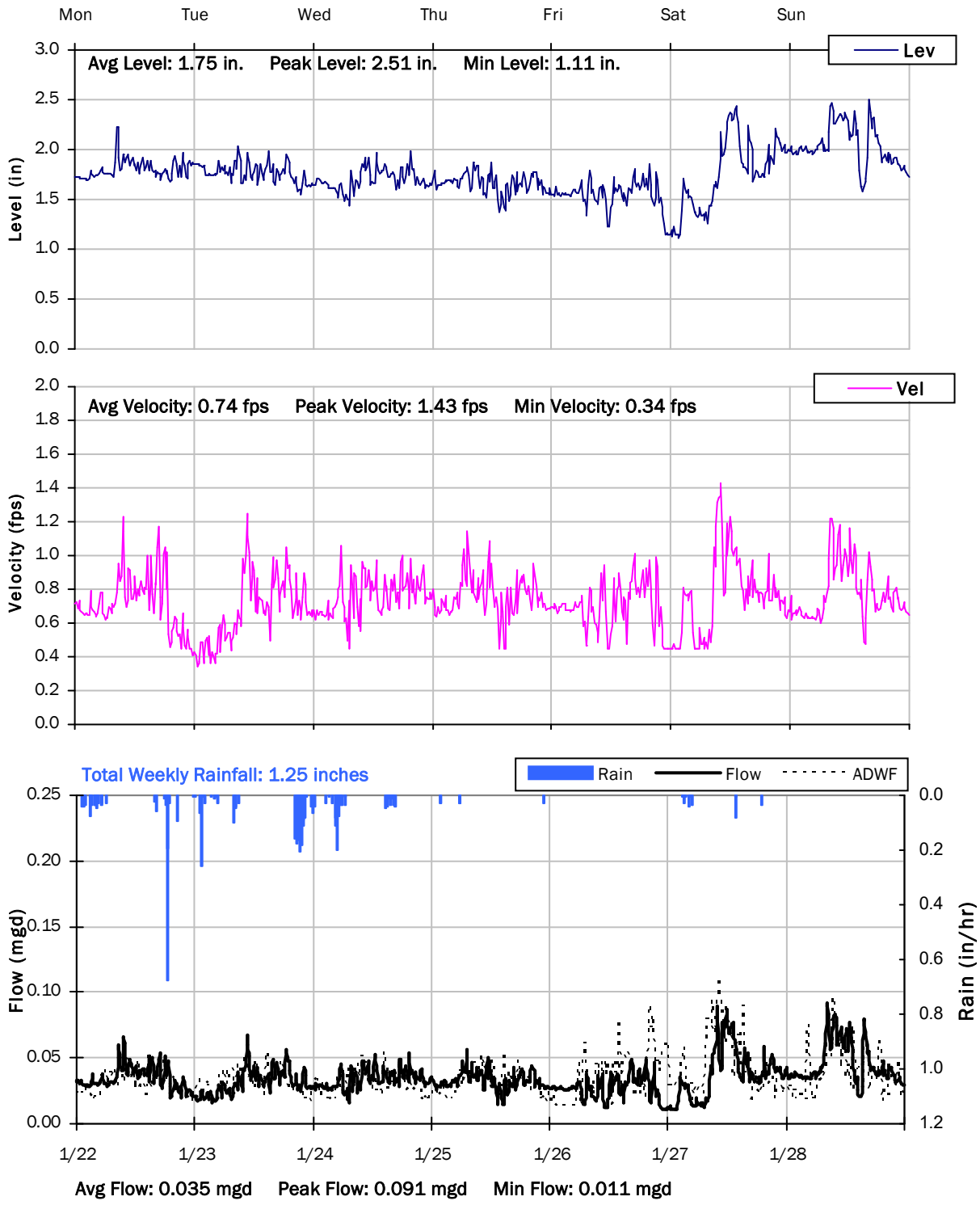
1/15/2024 to 1/22/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

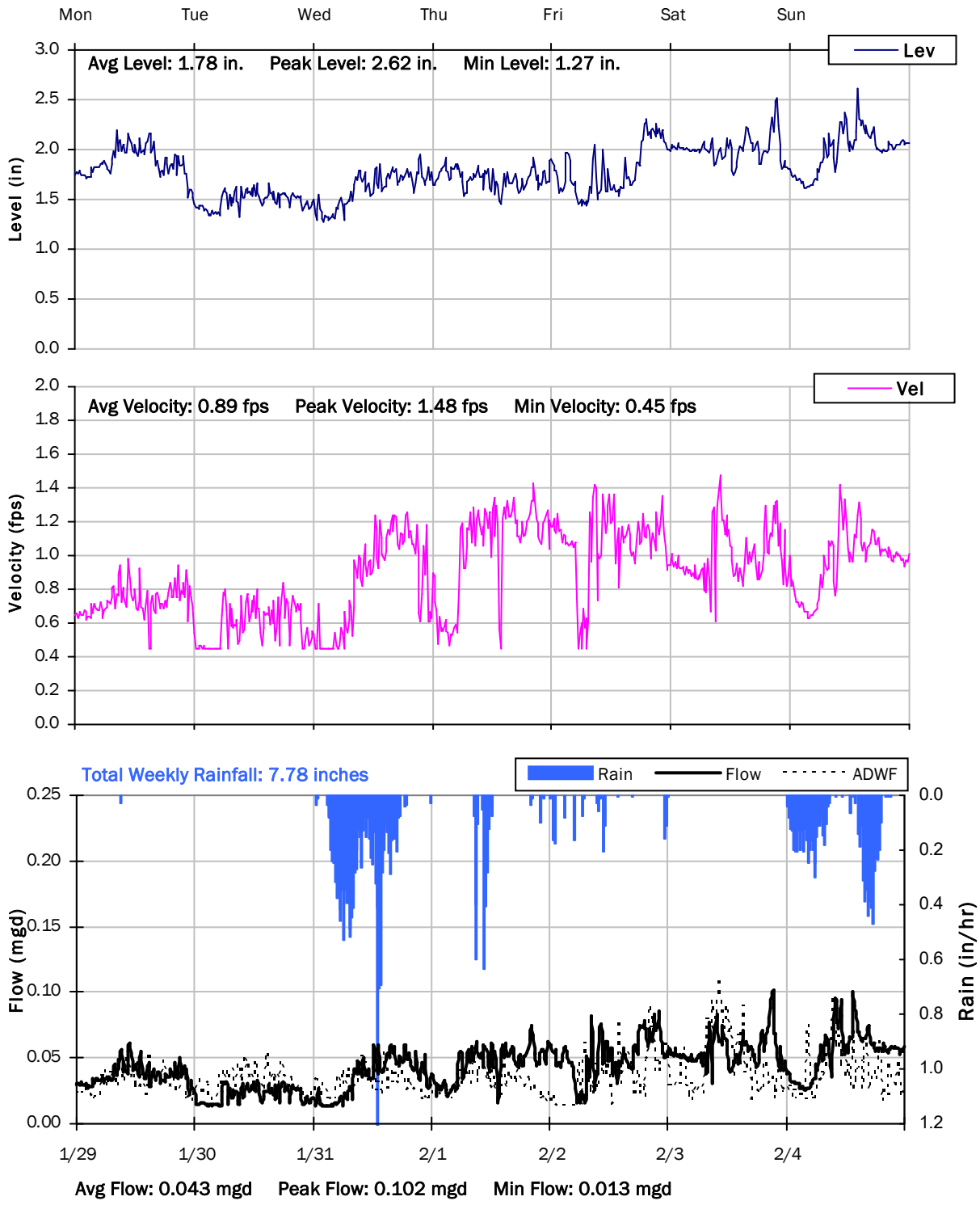
1/22/2024 to 1/29/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

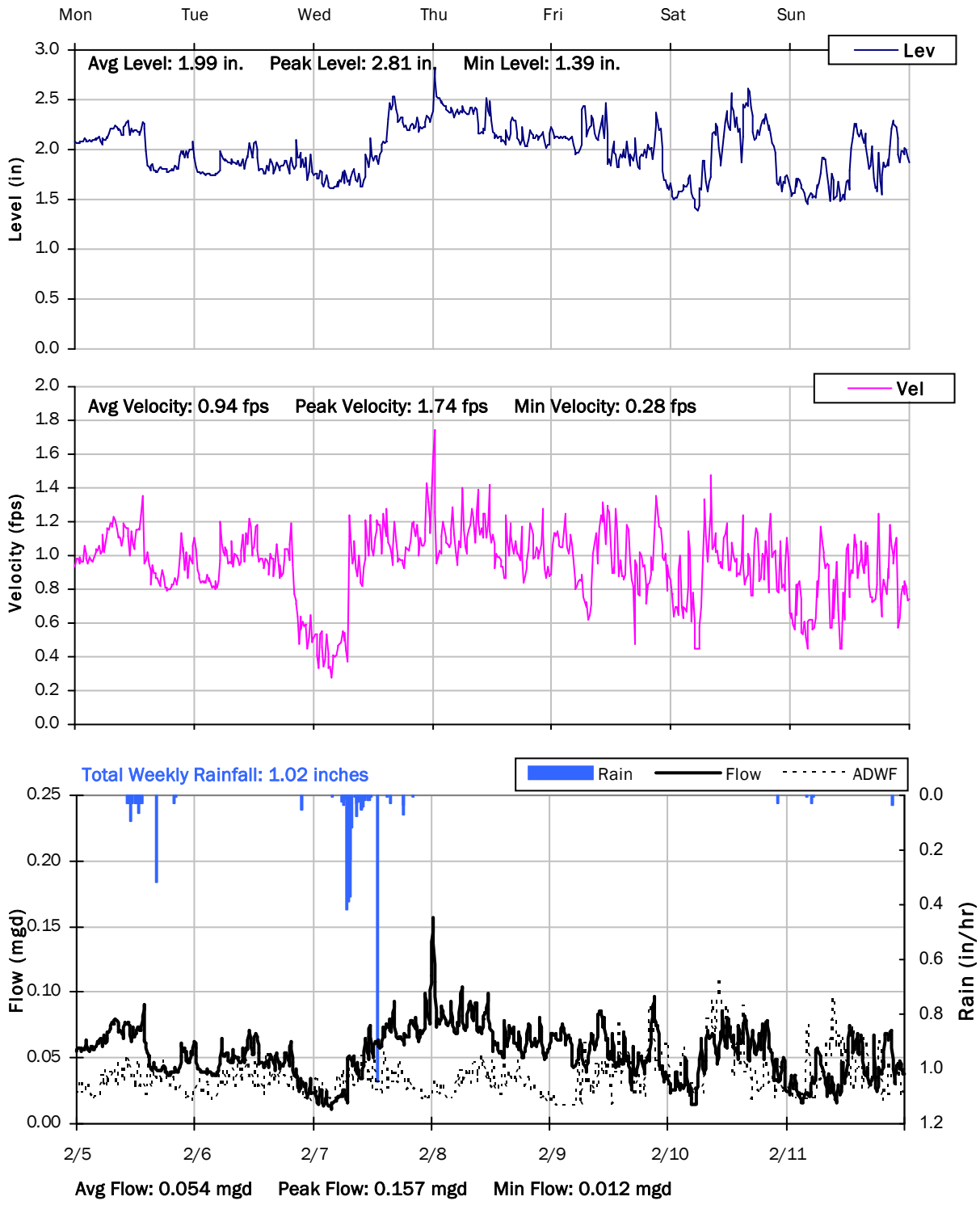
1/29/2024 to 2/5/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

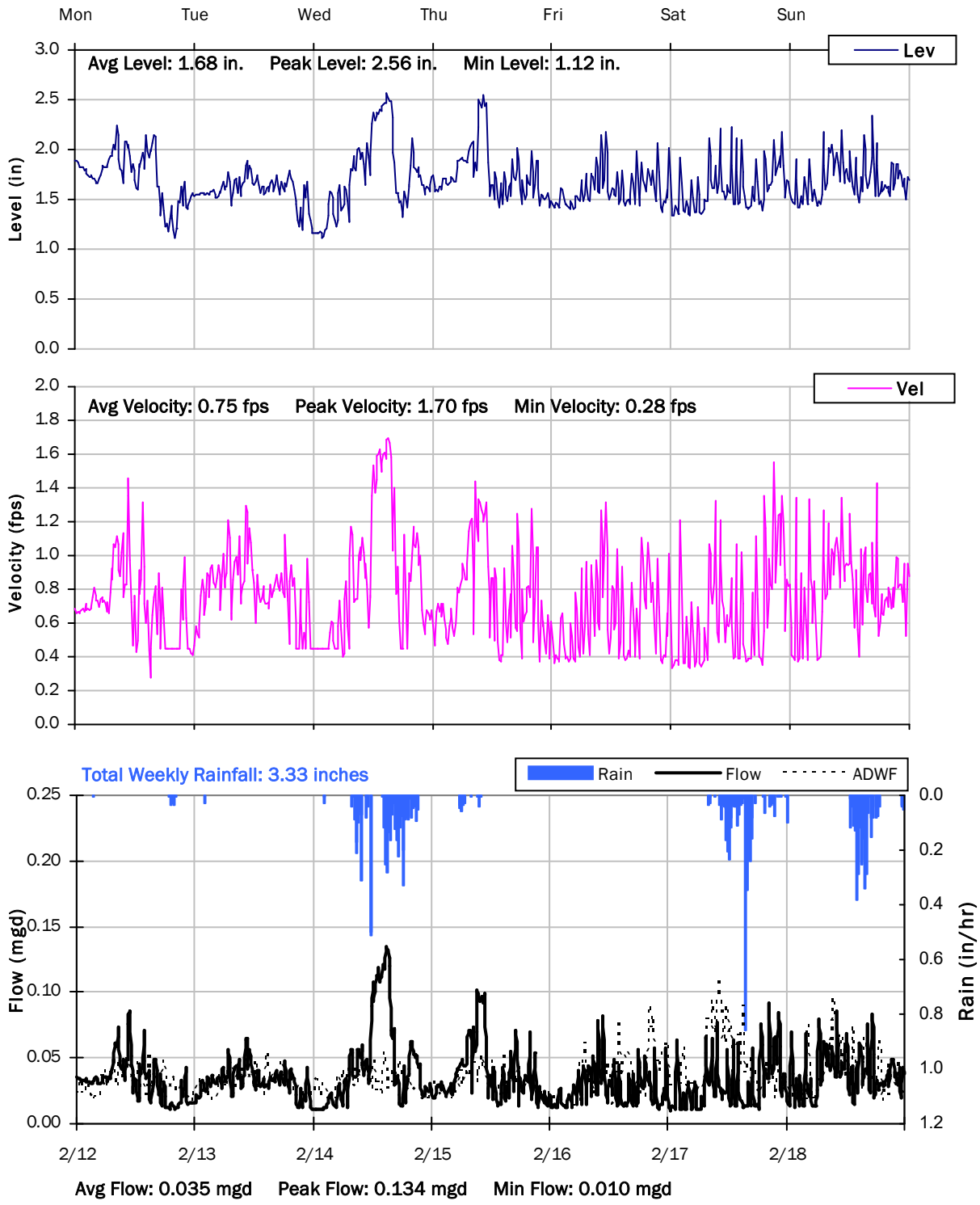
2/5/2024 to 2/12/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

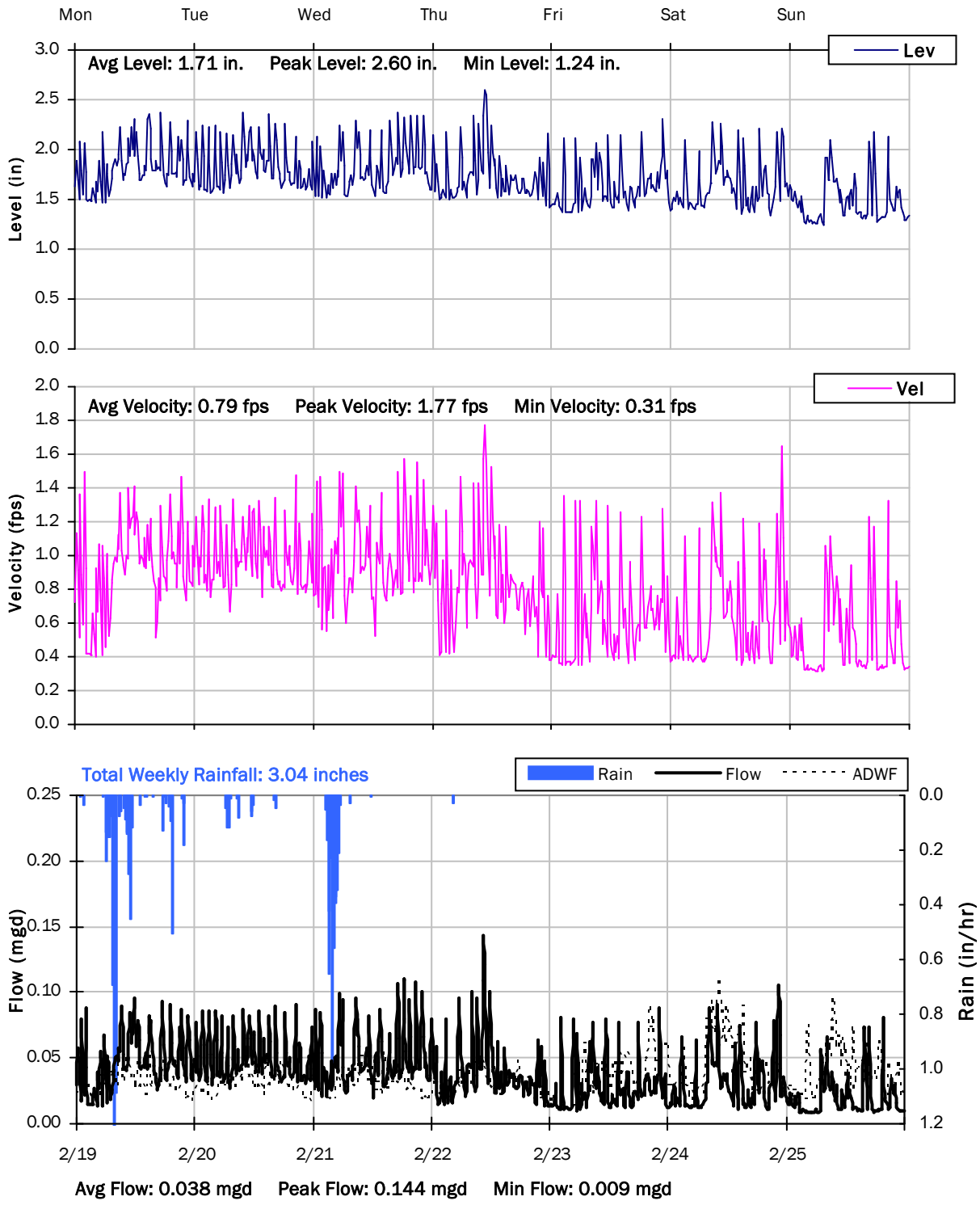
2/12/2024 to 2/19/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

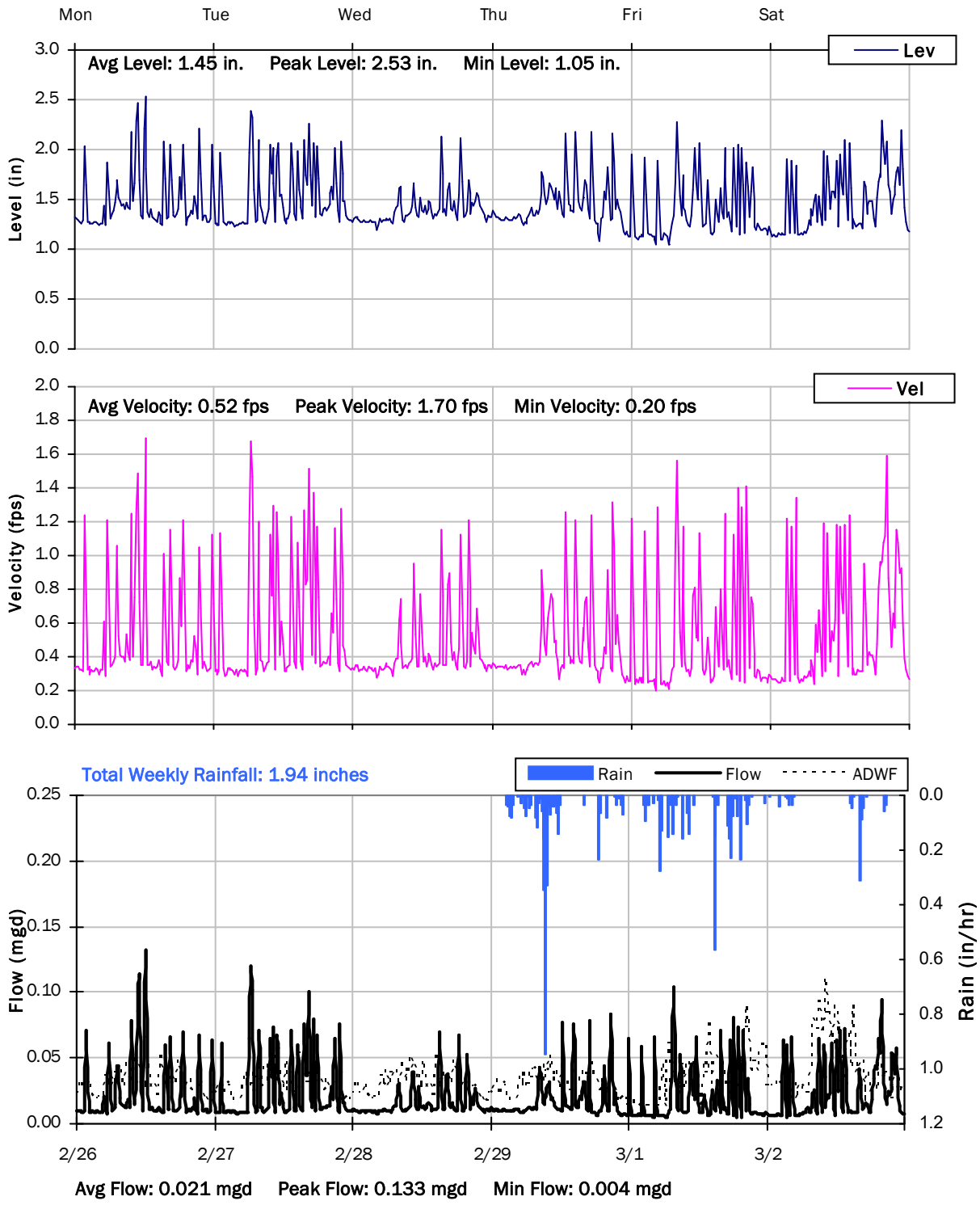
2/19/2024 to 2/26/2024



FM-01

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



Monitoring Site: FM-02

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: Within Pump Station off of 398 W Elm St

Data Summary Report

Vicinity Map: FM-02

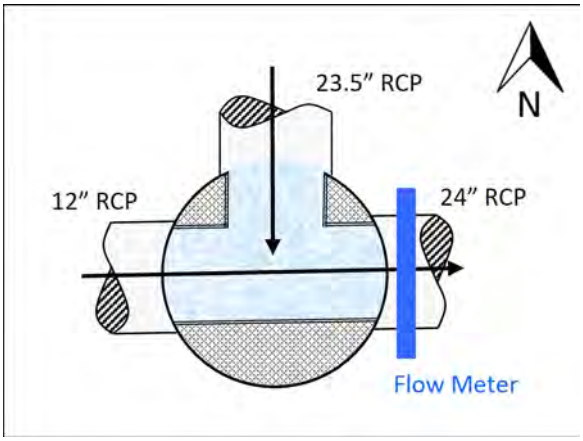
FM-02

Site Information MH ID: Mnhl-Chnnl-4058

Location:	Within Pump Station off of 398 W Elm St
Coordinates:	123.8092° W, 39.4520° N
Rim Elevation:	52 feet
Expected Pipe Diameter:	24 inches
Measured Pipe Diameter:	24 inches
ADWF:	0.189 mgd
Peak Measured Flow:	1.297 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

Plan View

FM-02

Additional Site Photos

Monitored East Outlet Pipe

North Inlet Pipe

FM-02

Additional Site Photos

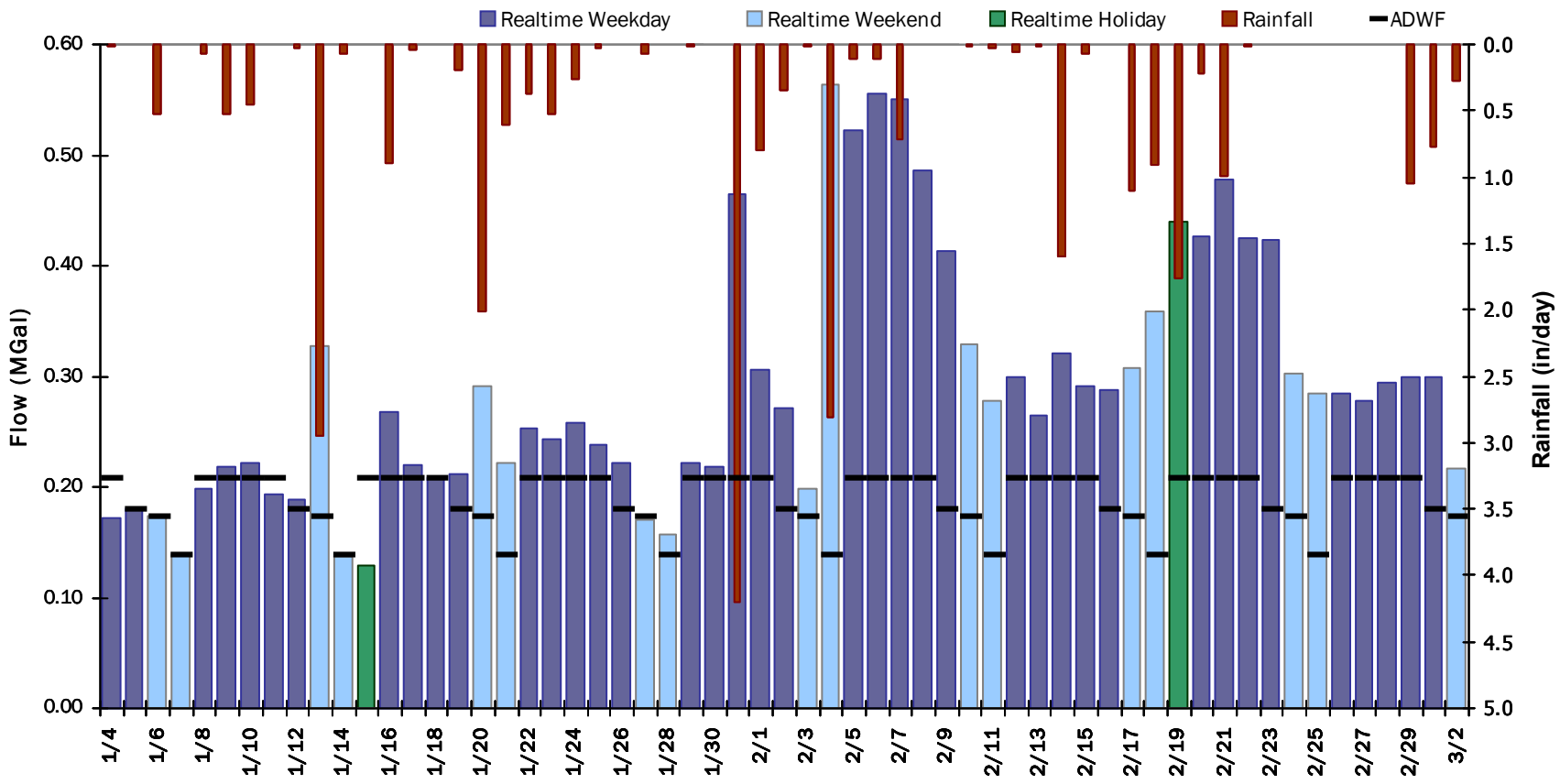
West Inlet Pipe

FM-02

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.290 MGal Peak Daily Flow: 0.564 MGal Min Daily Flow: 0.129 MGal

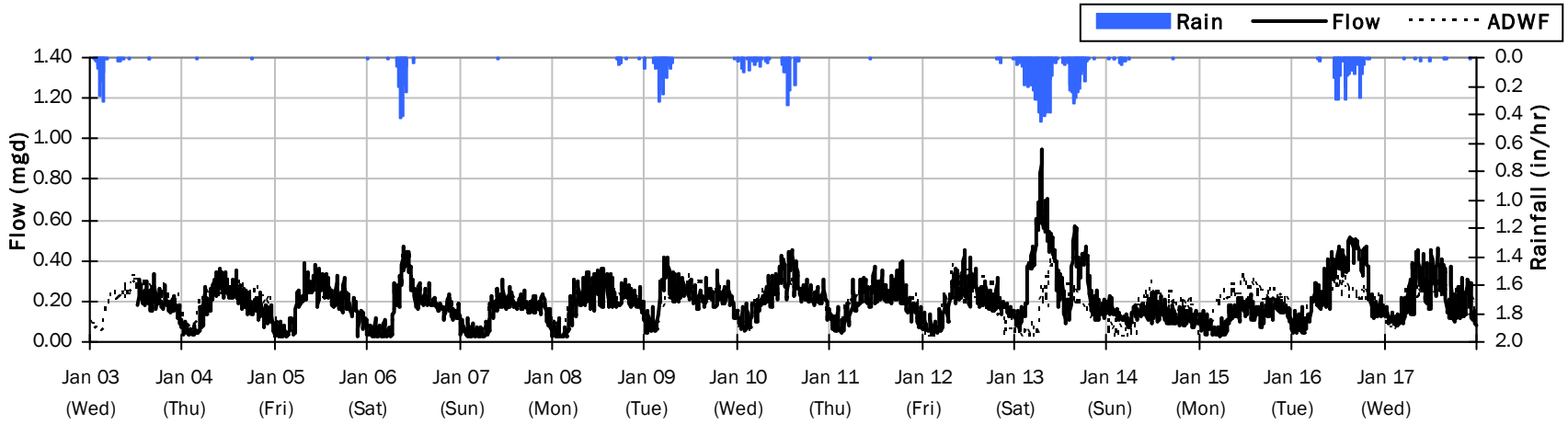
Total Rainfall: 27.58 inches

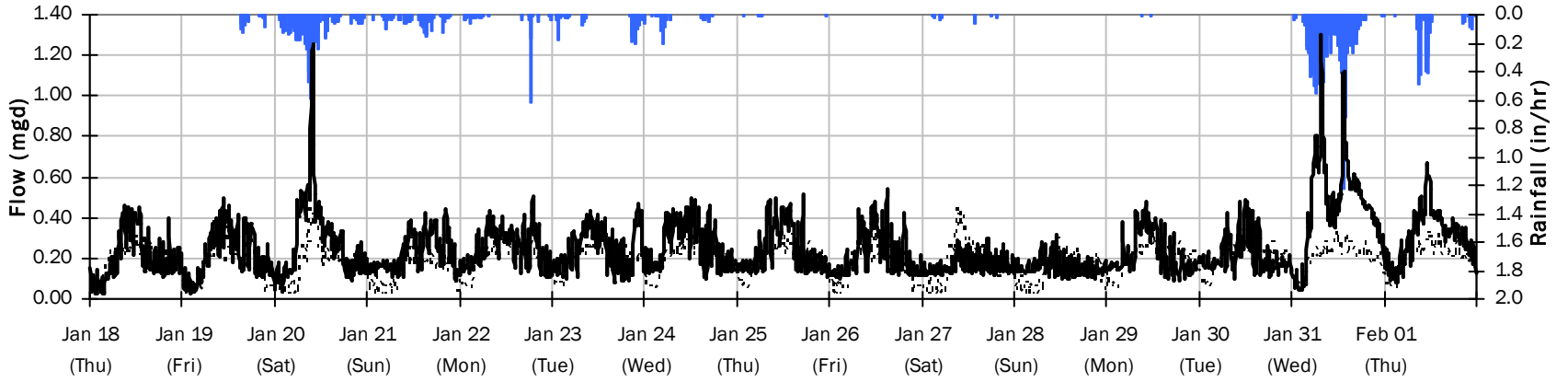


FM-02

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 14.95 inches Period Avg Flow: 0.222 mgd Period Peak Flow: 1.297 mgd Period Min Flow: 0.023 mgd

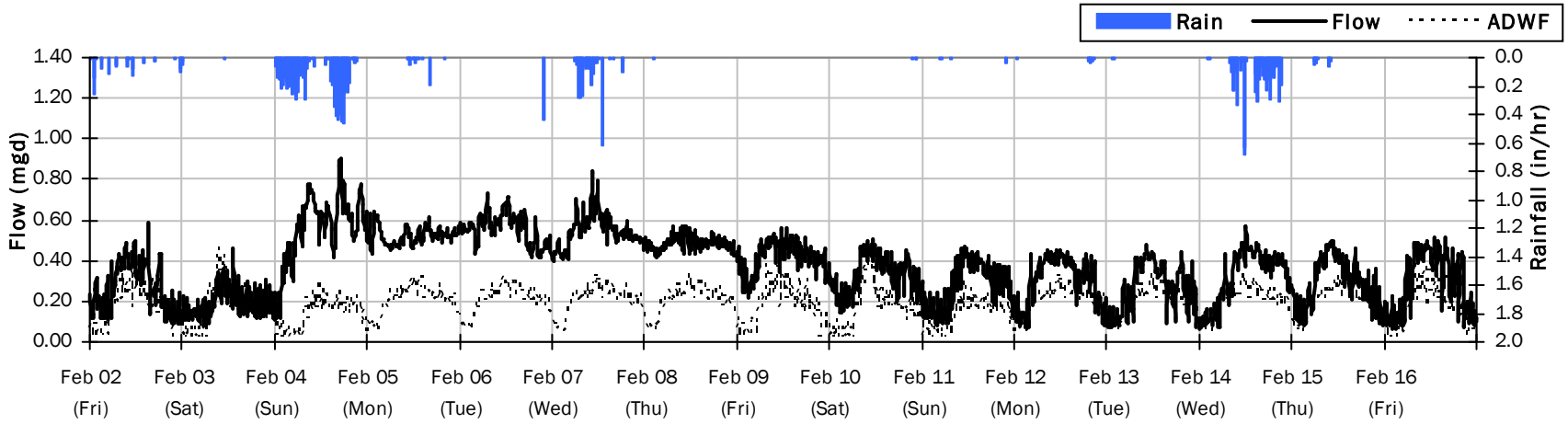


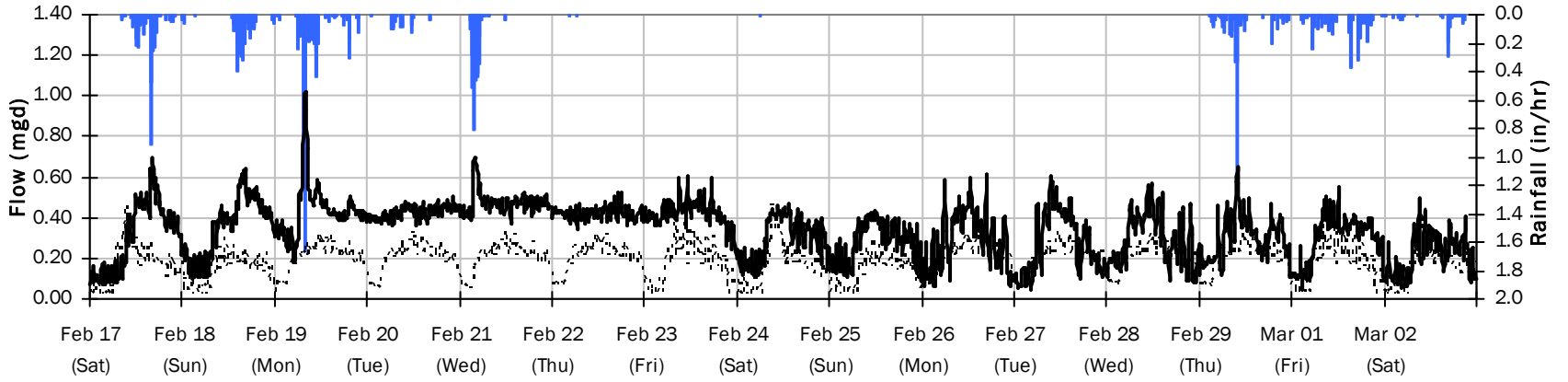


FM-02

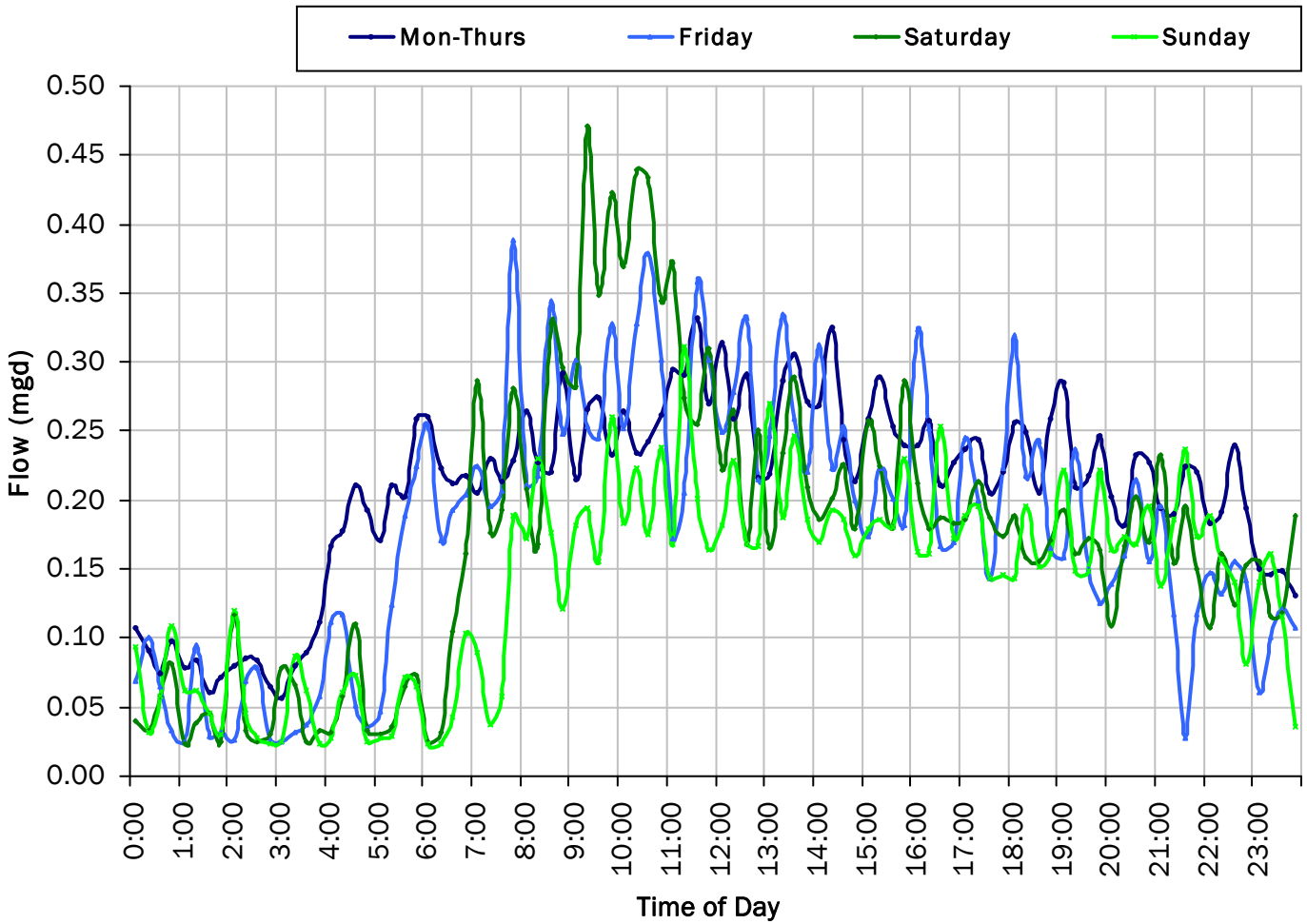
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 12.95 inches Period Avg Flow: 0.358 mgd Period Peak Flow: 1.021 mgd Period Min Flow: 0.048 mgd



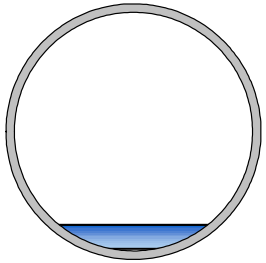


FM-02
Average Dry Weather Flow Hydrographs



ADWF:

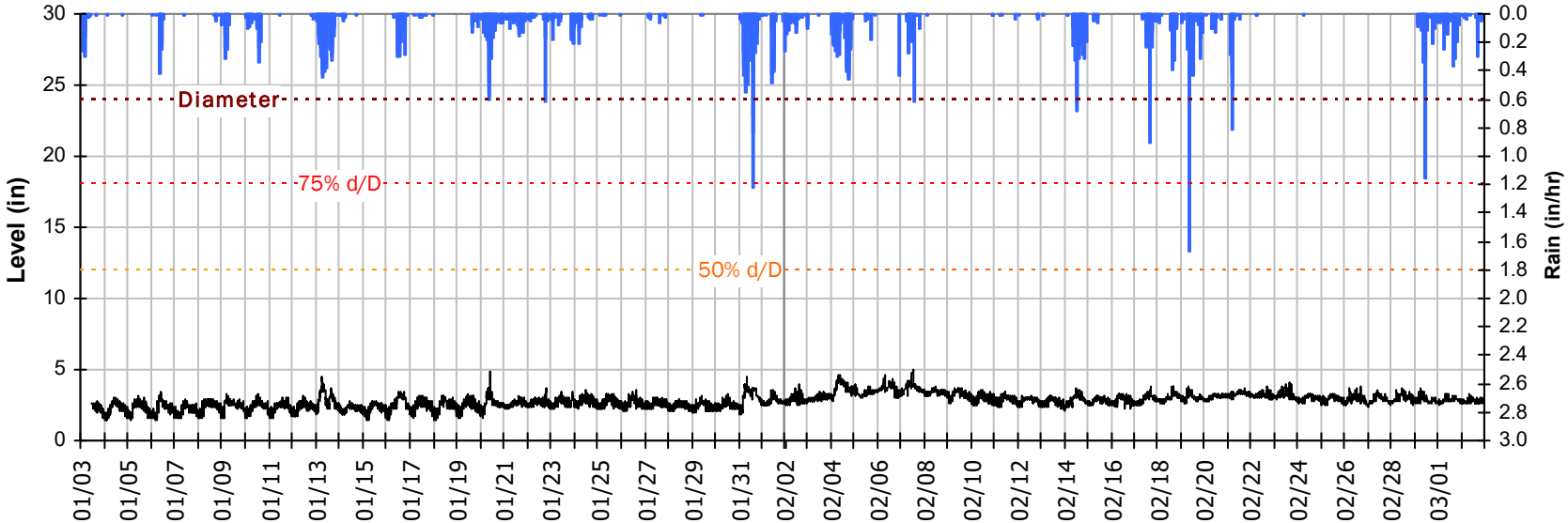
0.189 *mgd*

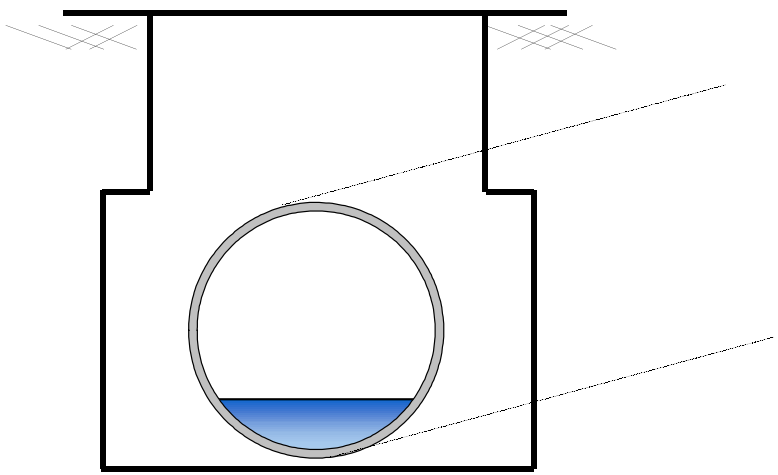


FM-02

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period

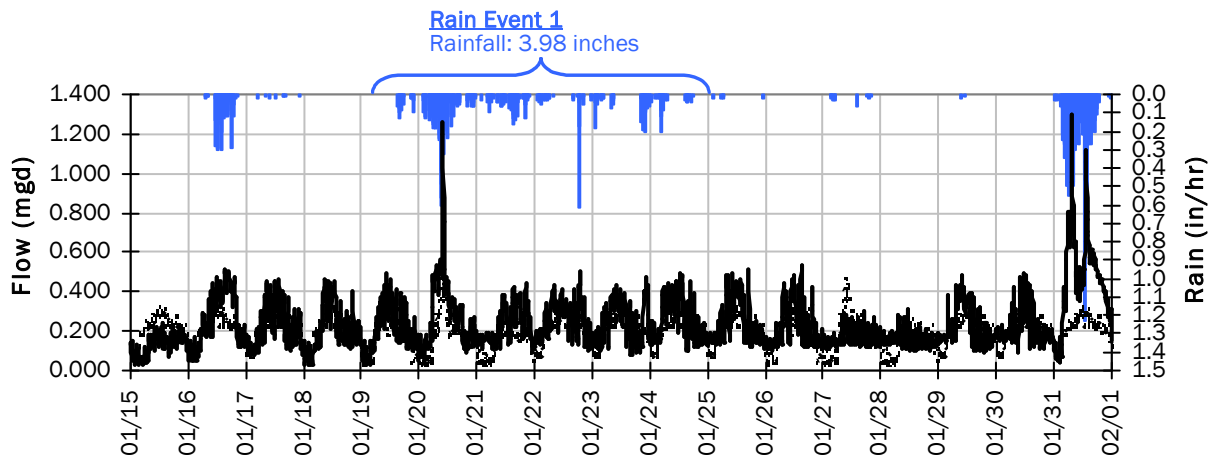




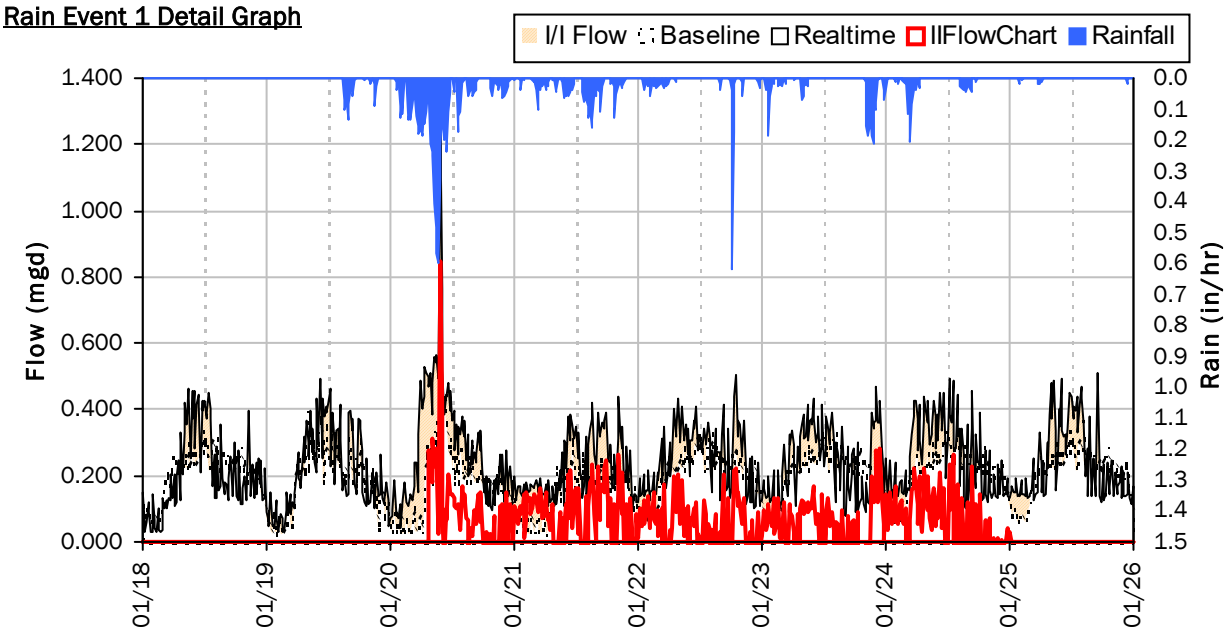
Pipe Diameter:	24	*inches*
Peak Measured Level:	5.05	*inches*
Peak d/D Ratio:	0.21	

FM-02
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

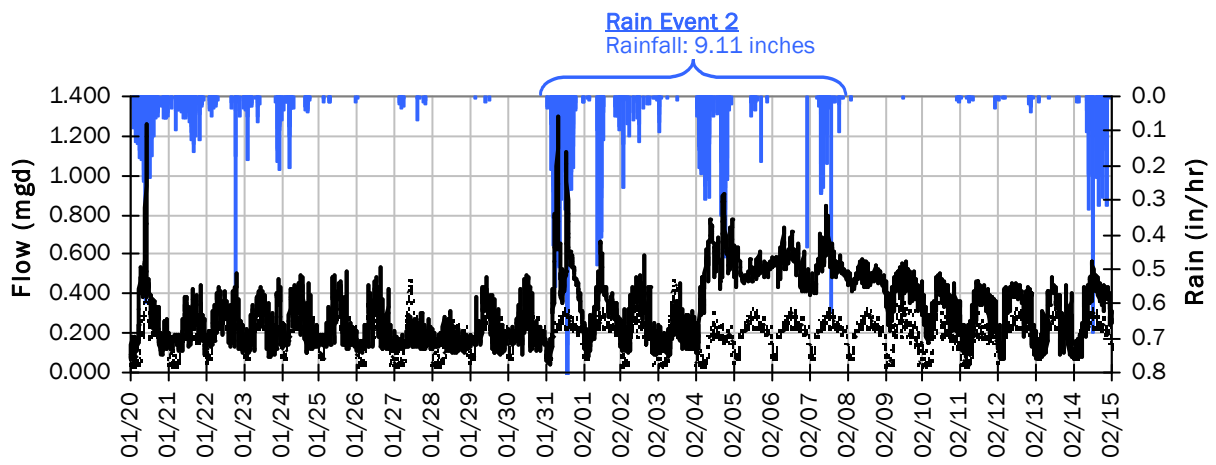


Storm Event I/I Analysis (Rain = 3.98 inches)

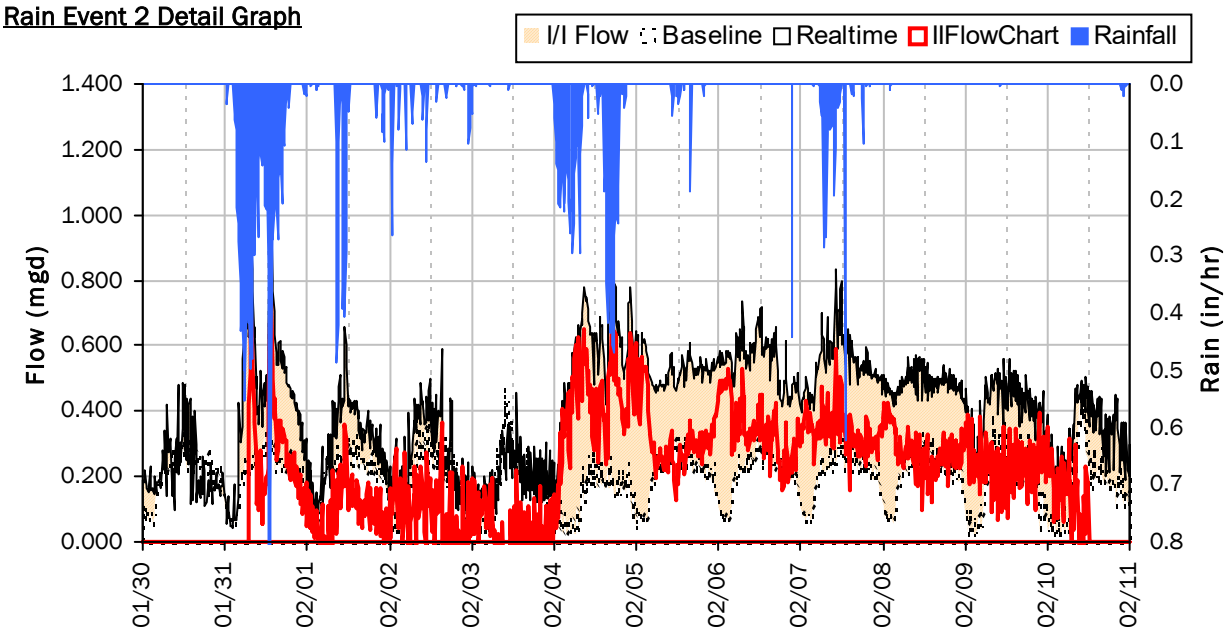
Capacity		Inflow / Infiltration	
Peak Flow:	1.258 *mgd*	**Peak I/I Rate:**	0.847 *mgd*
PF:	6.64	**Total I/I:**	284,000 *gallons*
Peak Level:	4.81 *in*		
d/D Ratio:	0.20		

FM-02
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

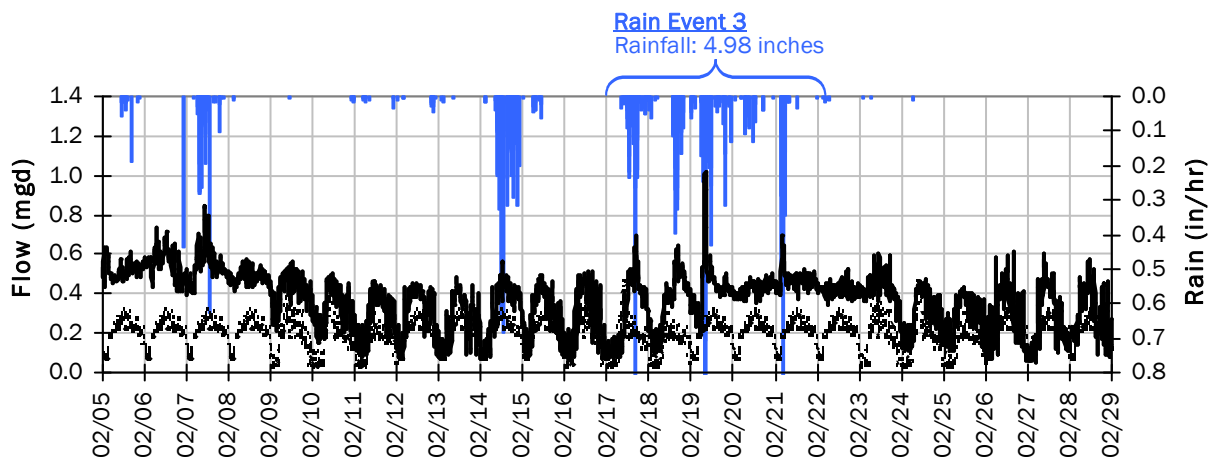


Storm Event I/I Analysis (Rain = 9.11 inches)

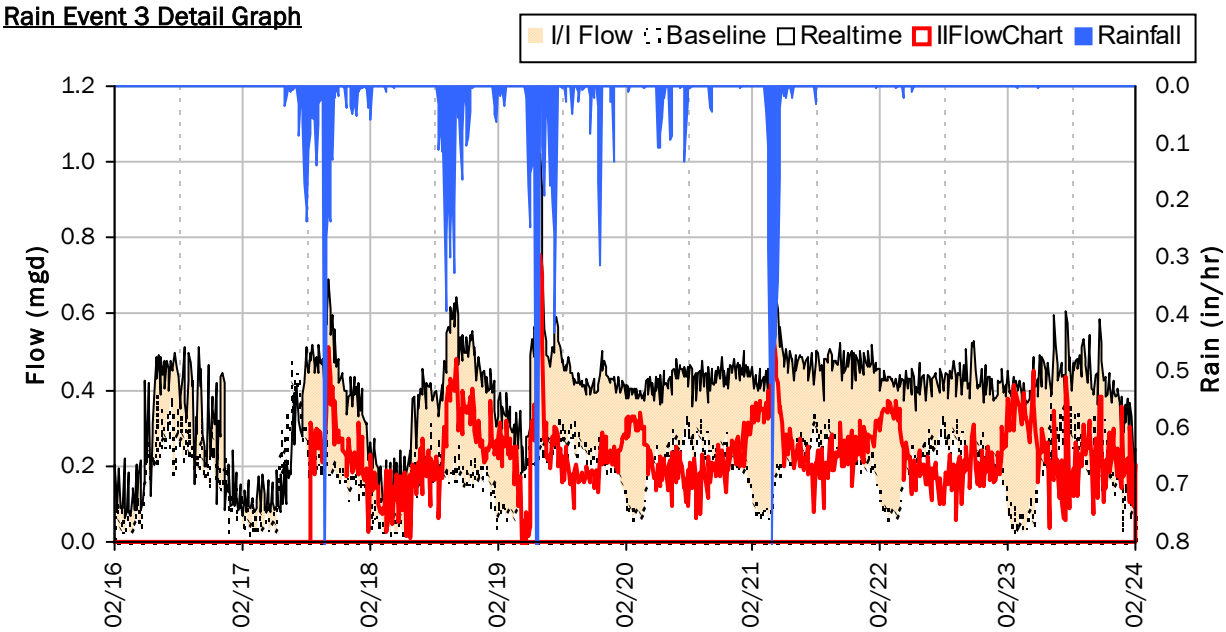
Capacity		Inflow / Infiltration	
Peak Flow:	1.297 *mgd*	**Peak I/I Rate:**	1.083 *mgd*
PF:	6.85	**Total I/I:**	2,444,000 *gallons*
Peak Level:	5.05 *in*		
d/D Ratio:	0.21		

FM-02
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

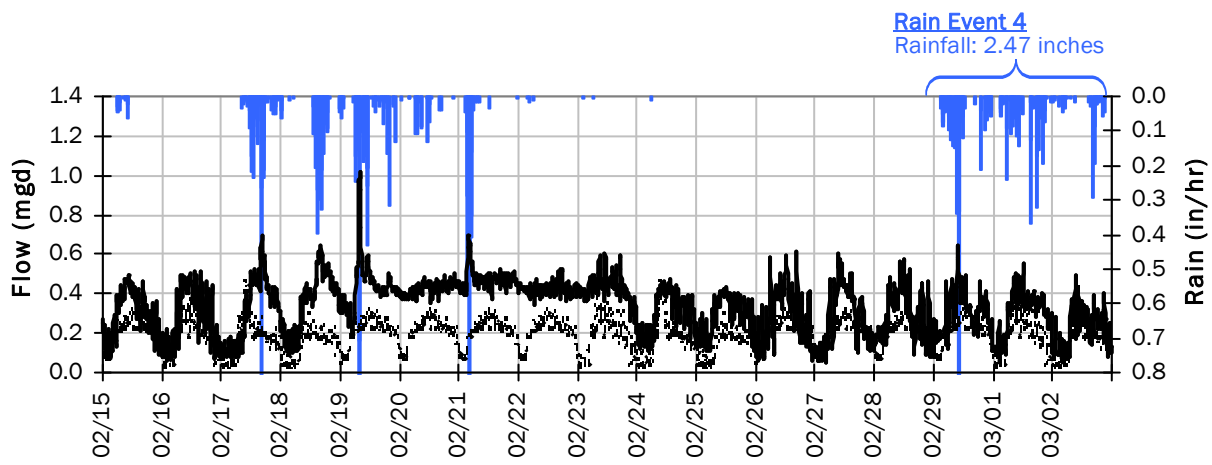


Storm Event I/I Analysis (Rain = 4.98 inches)

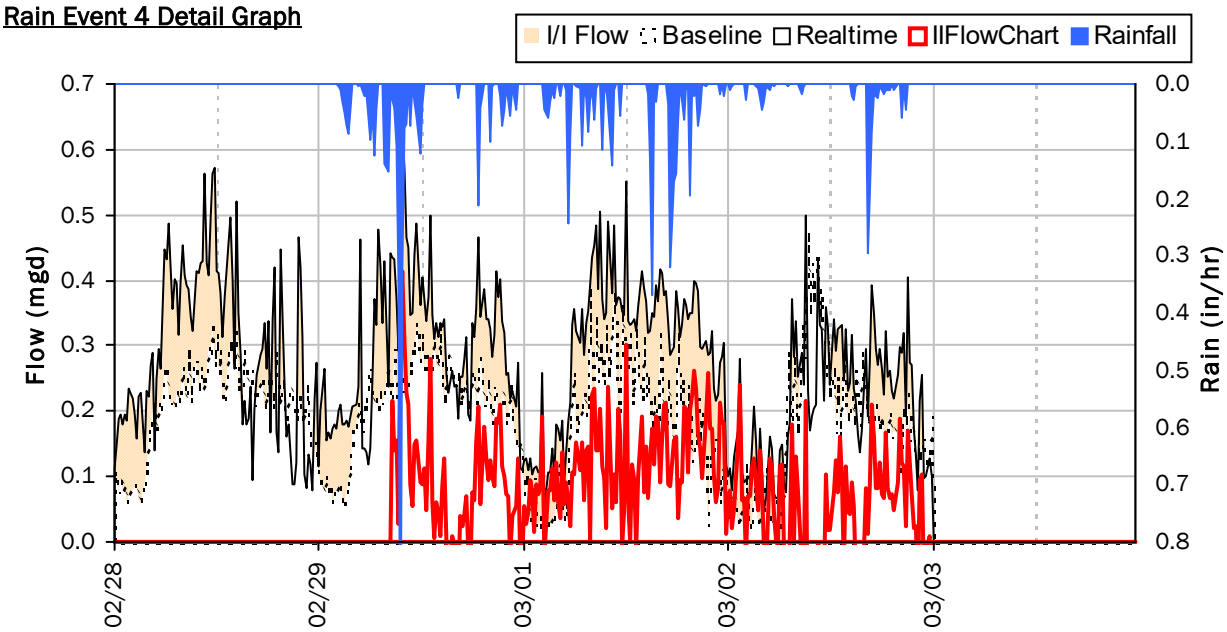
Capacity		Inflow / Infiltration	
Peak Flow:	1.02 *mgd*	**Peak I/I Rate:**	0.76 *mgd*
PF:	5.39	**Total I/I:**	1,520,000 *gallons*
Peak Level:	4.02 *in*		
d/D Ratio:	0.17		

FM-02
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



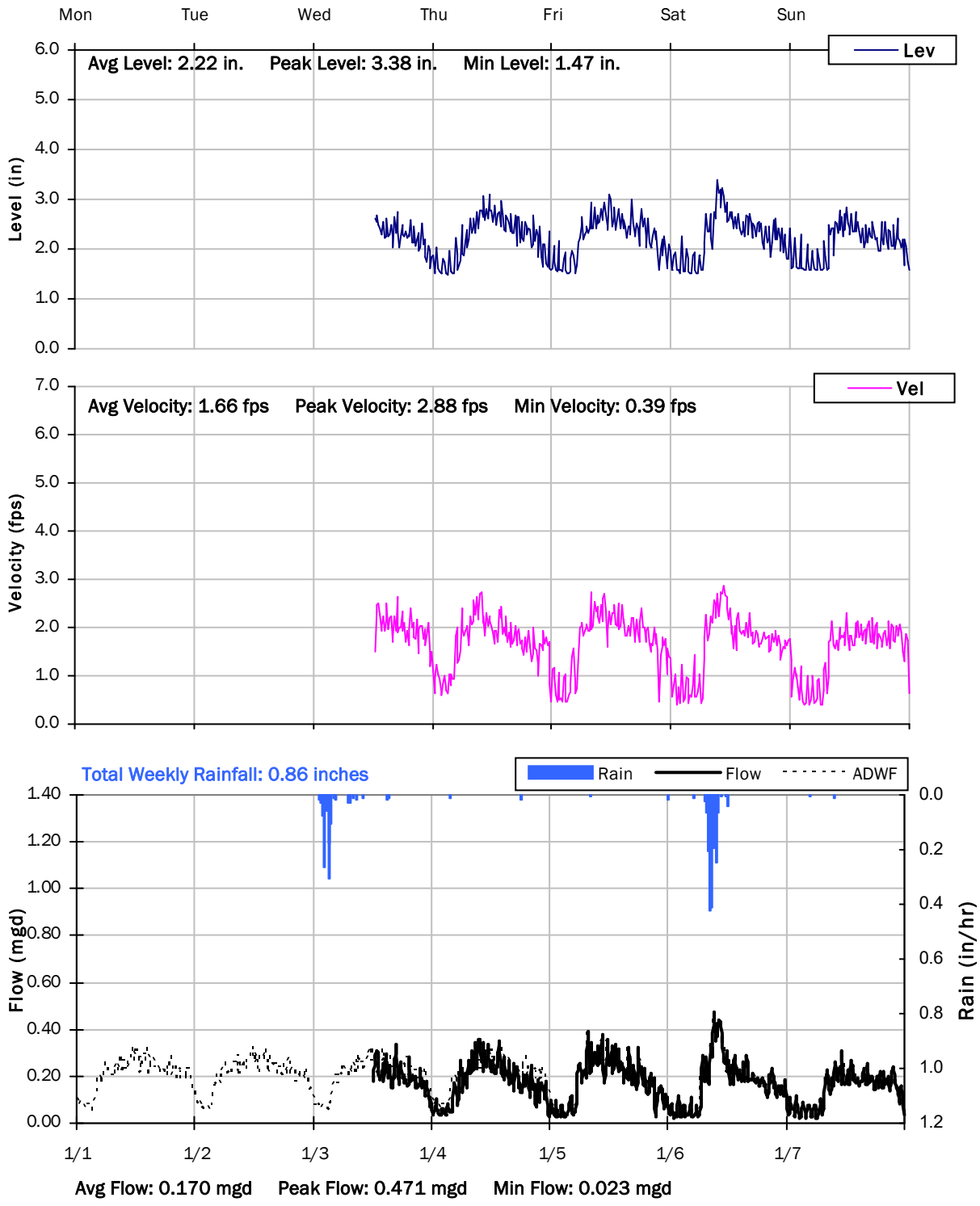
Storm Event I/I Analysis (Rain = 2.47 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.65 *mgd*	**Peak I/I Rate:**	0.41 *mgd*
PF:	3.41	**Total I/I:**	224,000 *gallons*
Peak Level:	3.37 *in*		
d/D Ratio:	0.14		

FM-02

Weekly Level, Velocity and Flow Hydrographs

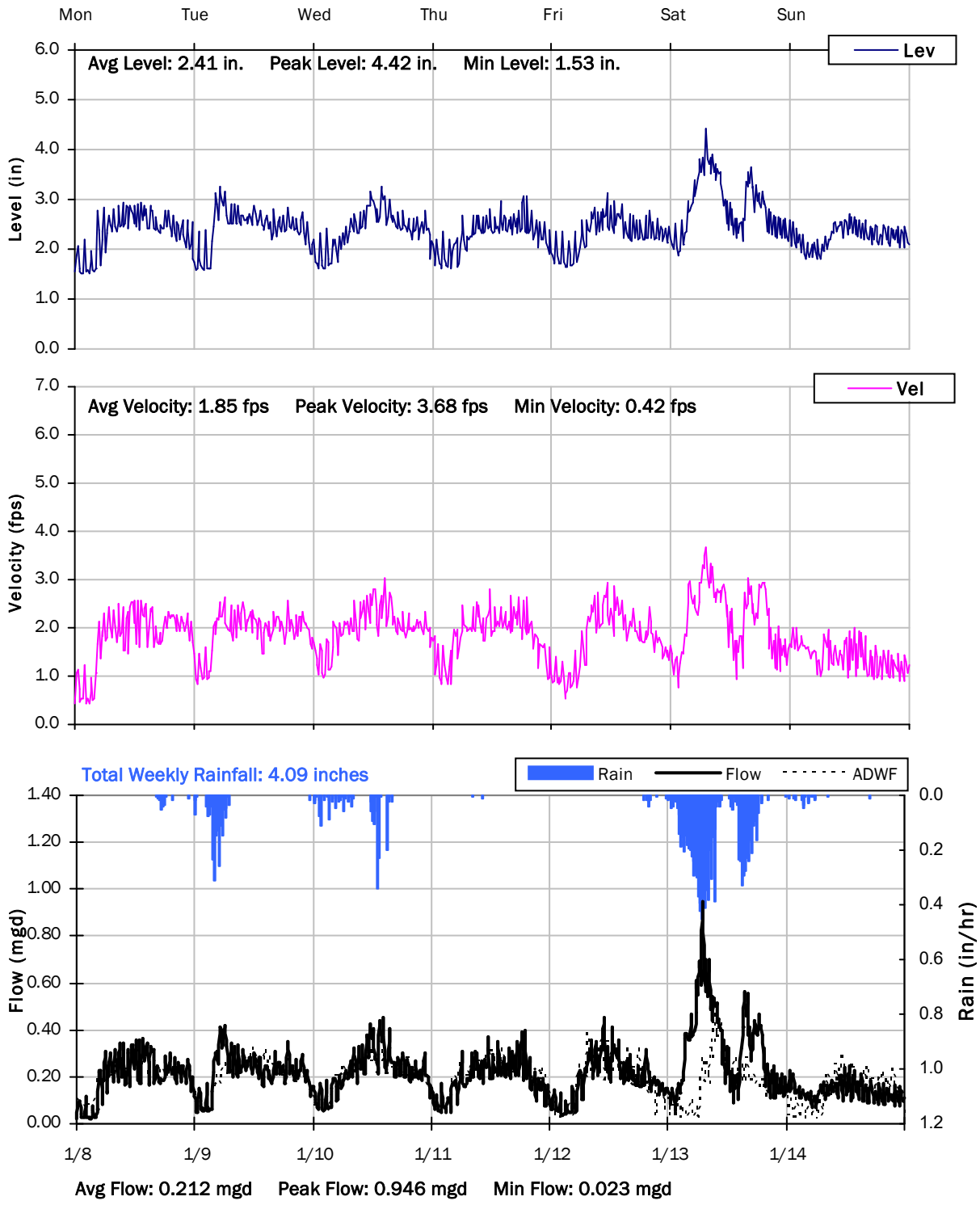
1/1/2024 to 1/8/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

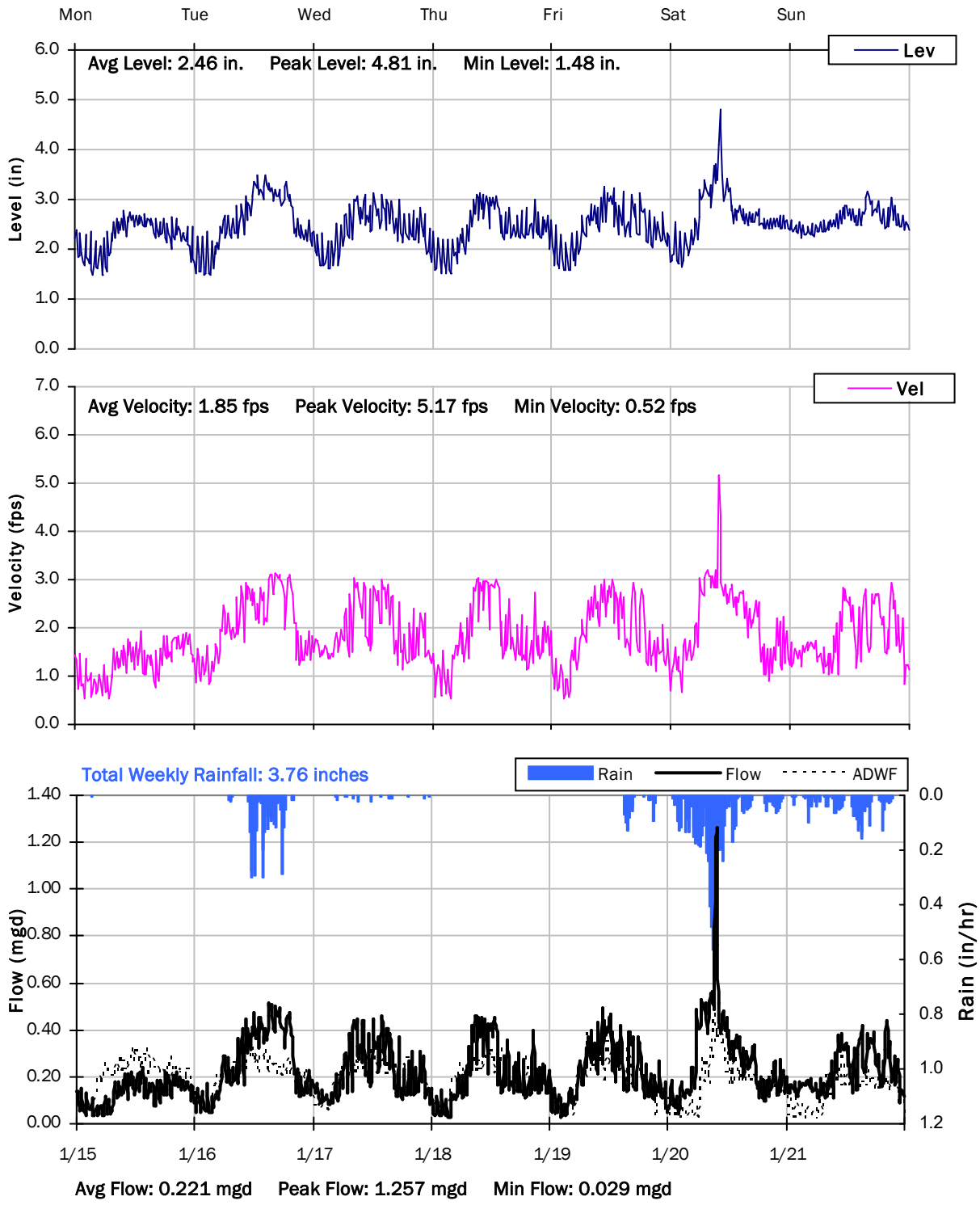
1/8/2024 to 1/15/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

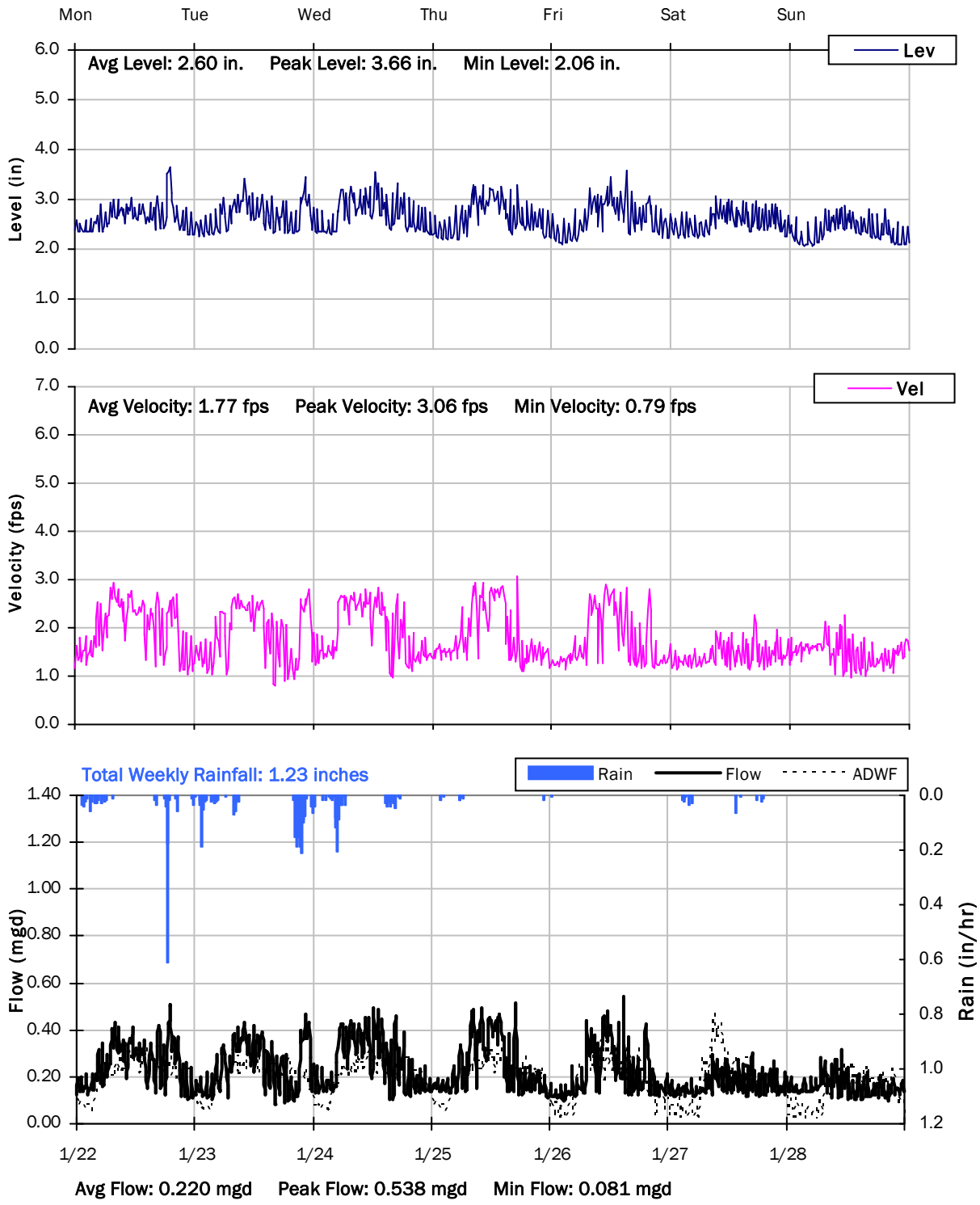
1/15/2024 to 1/22/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

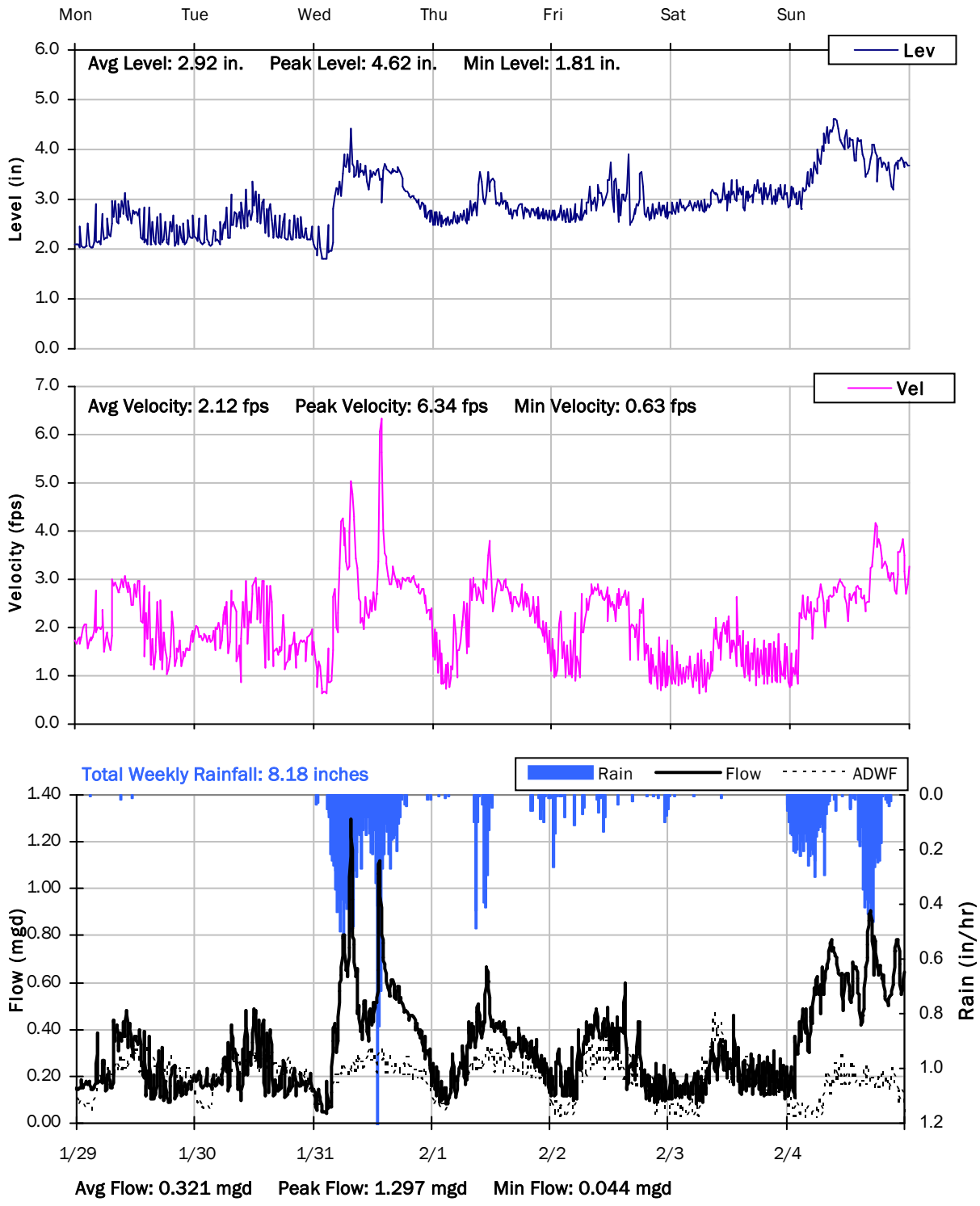
1/22/2024 to 1/29/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

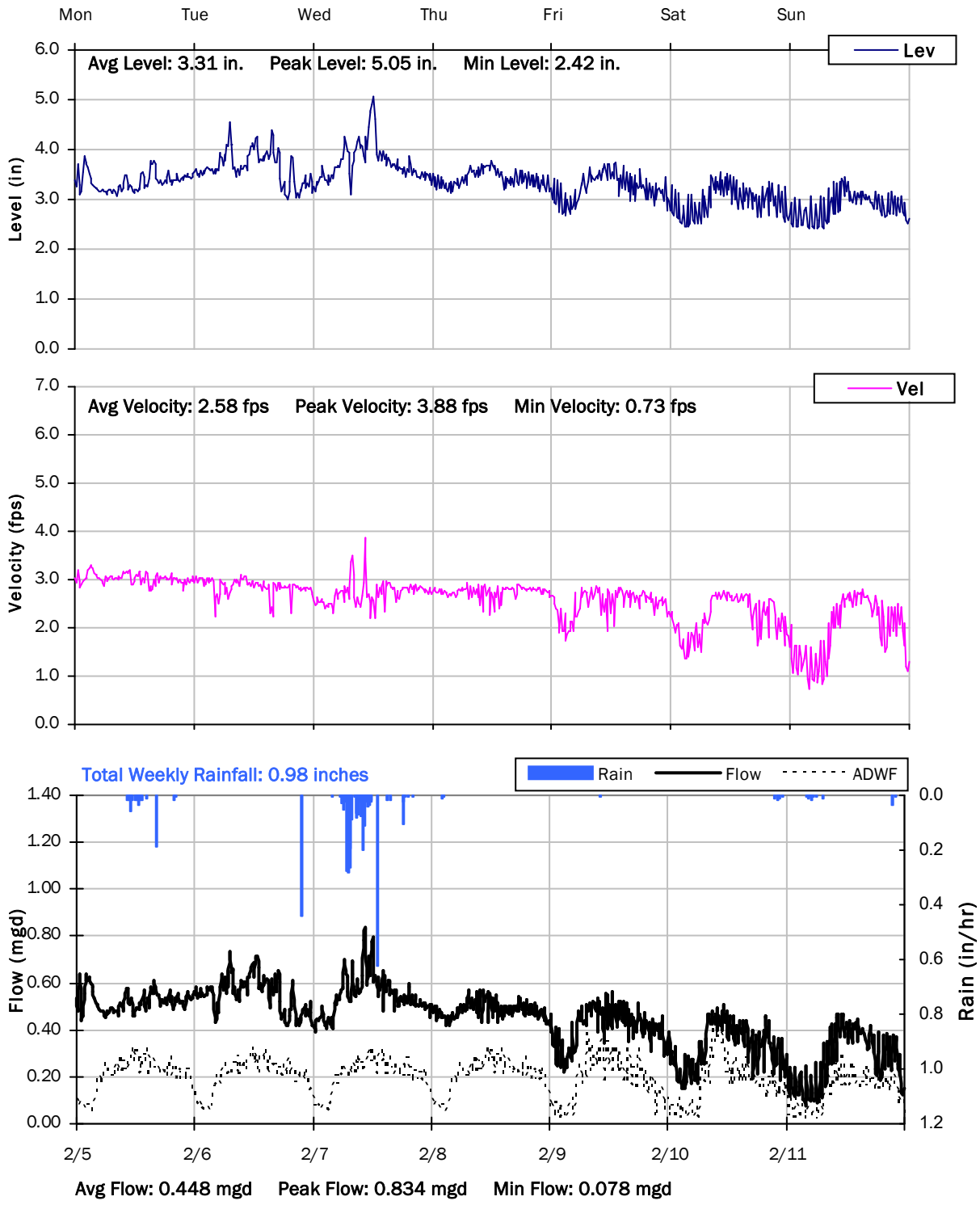
1/29/2024 to 2/5/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

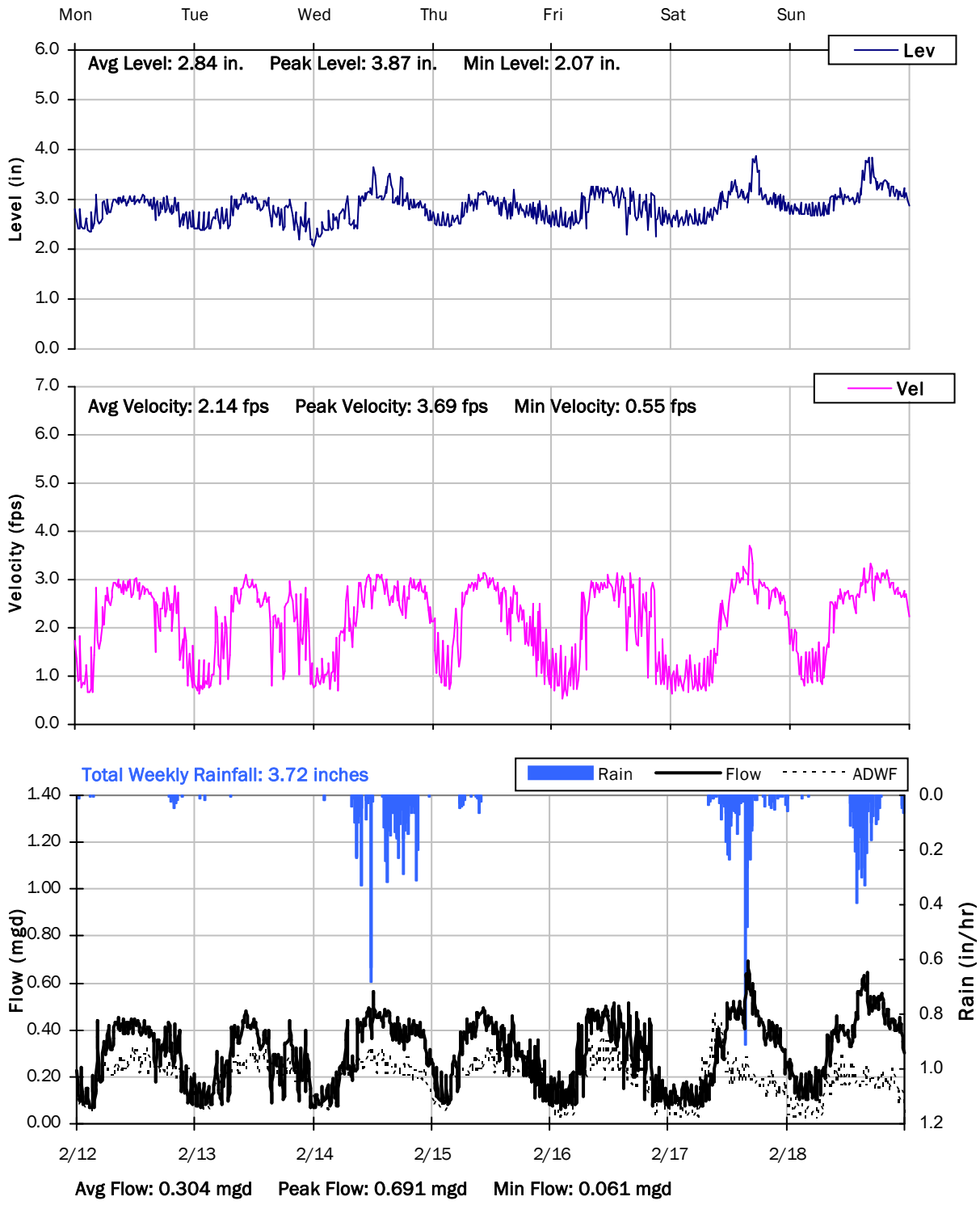
2/5/2024 to 2/12/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

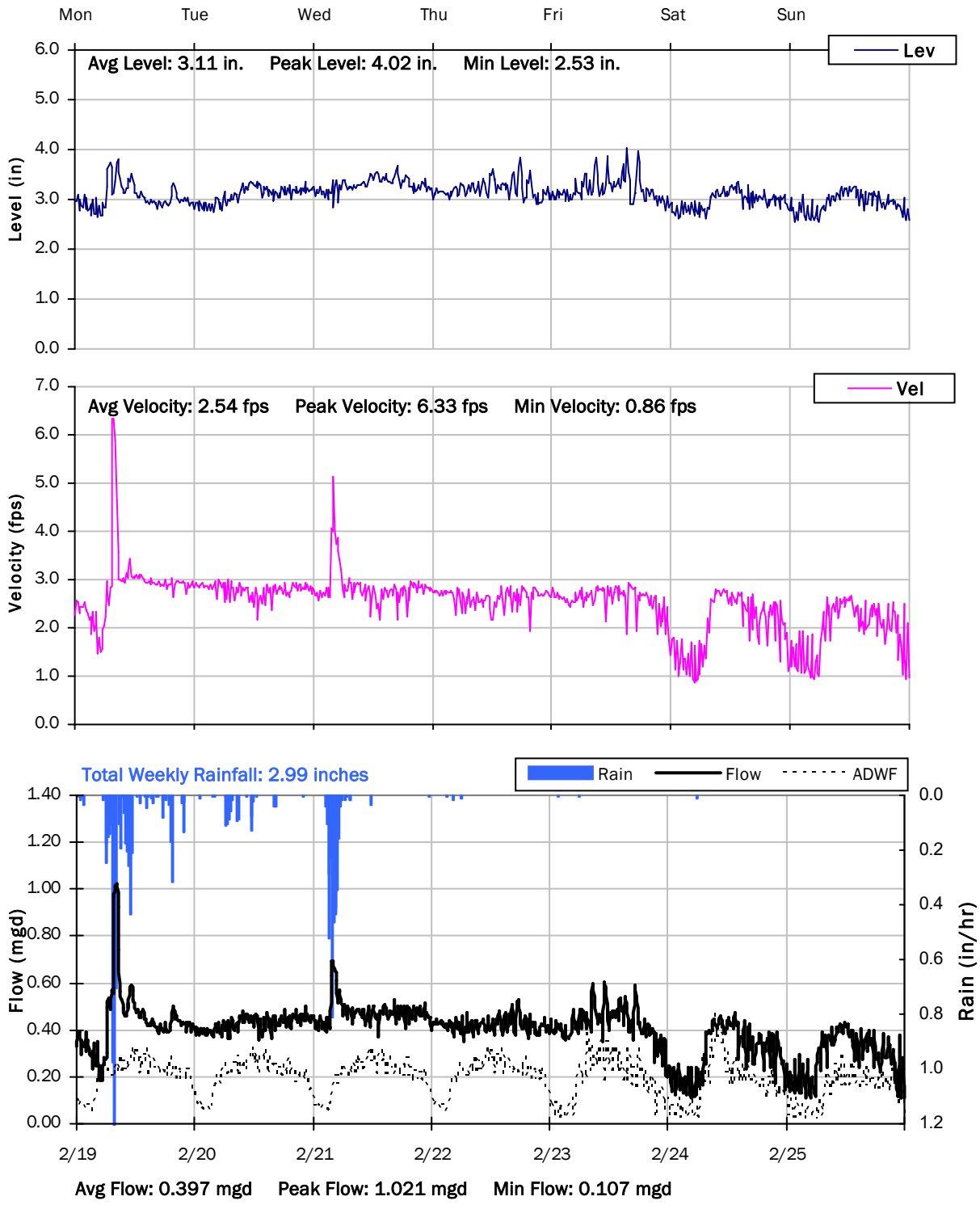
2/12/2024 to 2/19/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

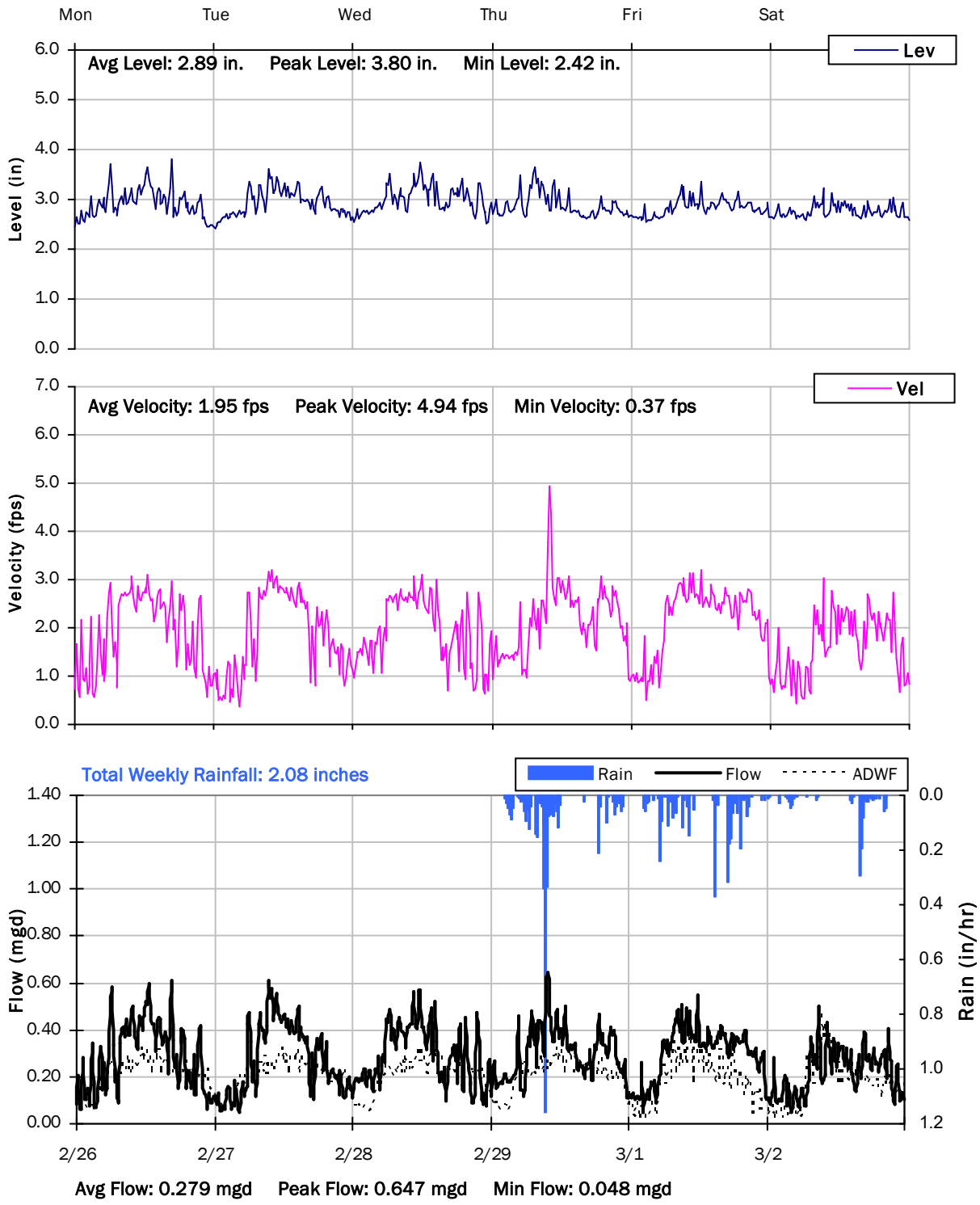
2/19/2024 to 2/26/2024



FM-02

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



Monitoring Site: FM-03

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: Chief Celeri Dr x E Alder St

Data Summary Report

Vicinity Map: FM-03

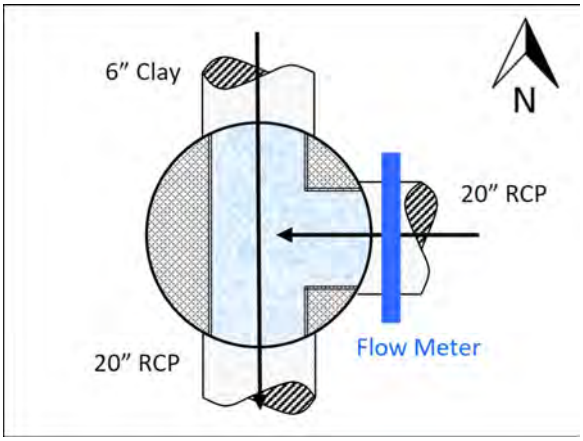
FM-03

Site Information MH ID: Mnhl-Chnnl-4112

Location:	Chief Celeri Dr x E Alder St
Coordinates:	123.8067° W, 39.4430° N
Rim Elevation:	65 feet
Expected Pipe Diameter:	18 inches
Measured Pipe Diameter:	20 inches
ADWF:	0.732 mgd
Peak Measured Flow:	4.394 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

Plan View

FM-03

Additional Site Photos

South Outlet Pipe

Monitored East Inlet Pipe

FM-03

Additional Site Photos

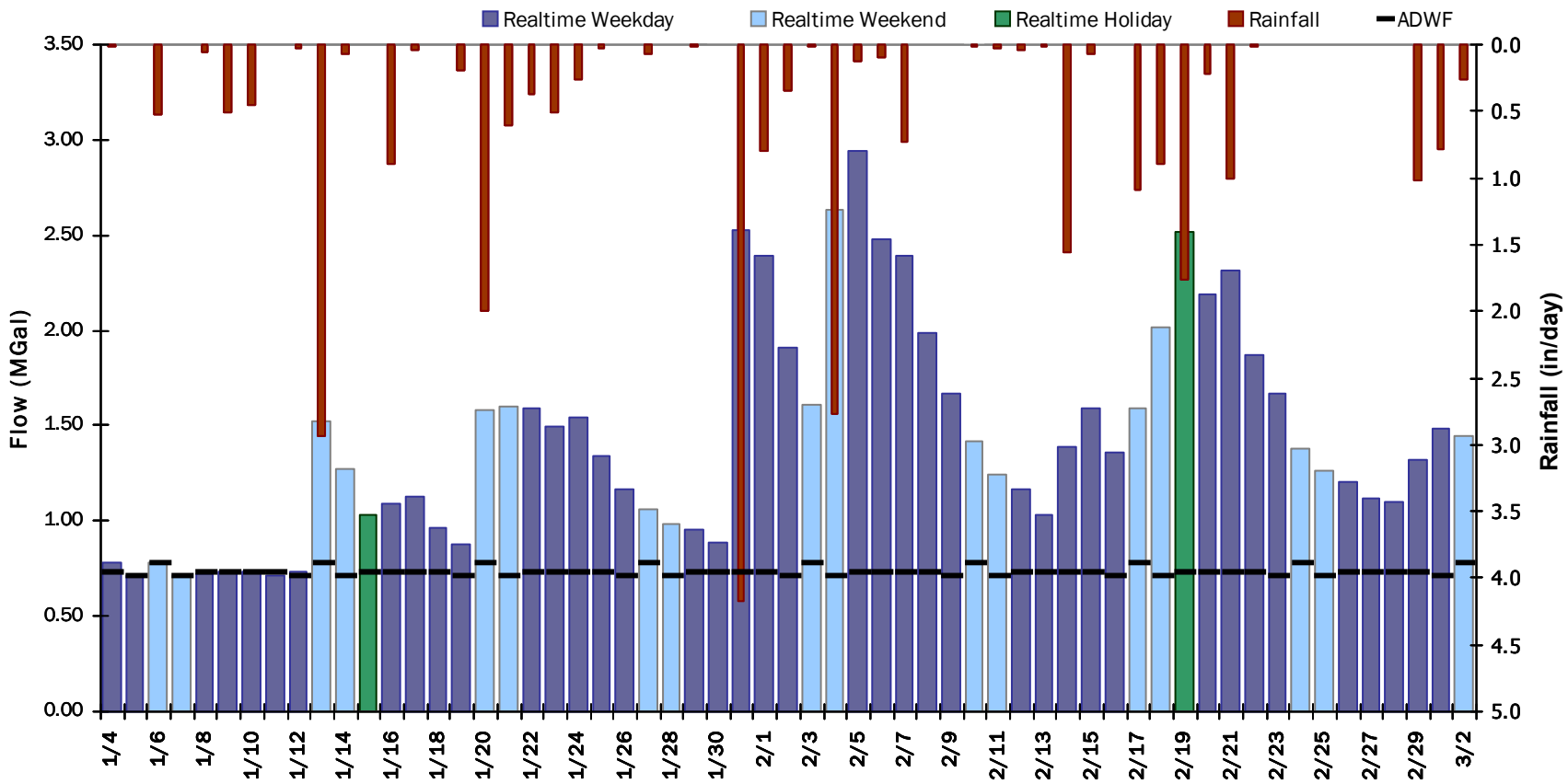
North Inlet Pipe

FM-03

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 1.432 MGal Peak Daily Flow: 2.937 MGal Min Daily Flow: 0.713 MGal

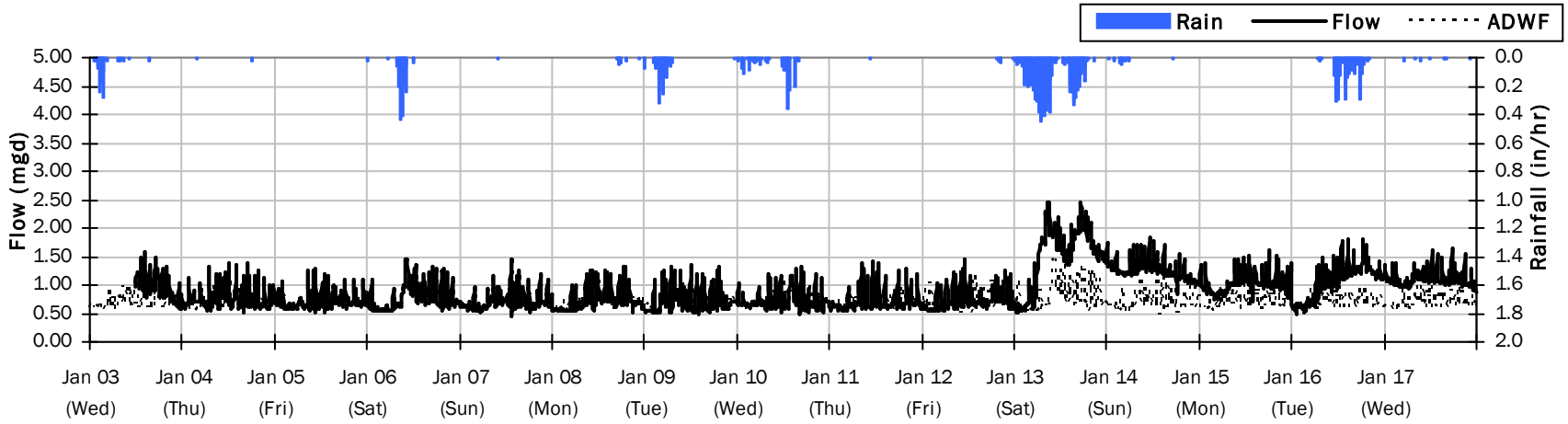
Total Rainfall: 27.38 inches

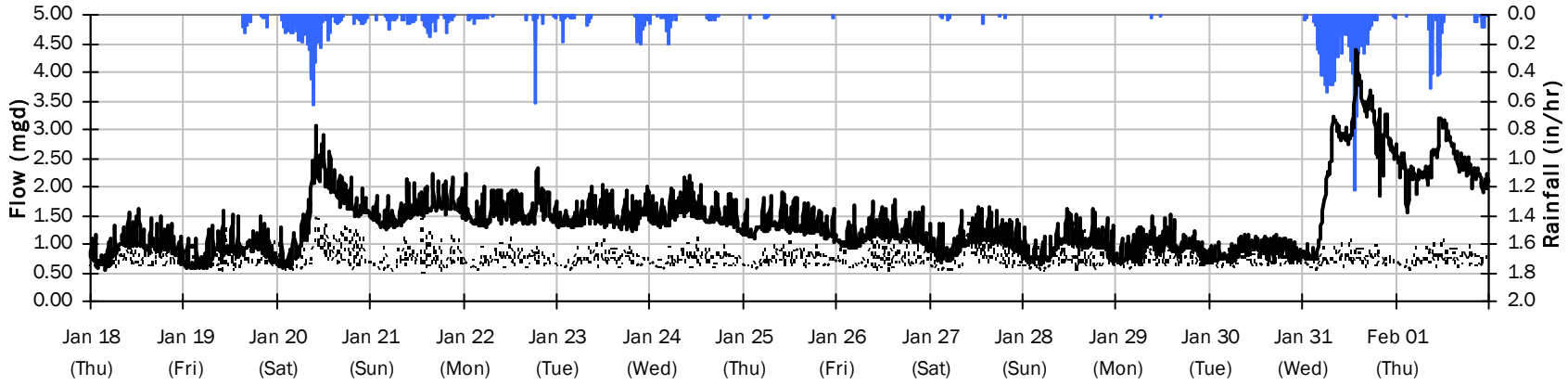


FM-03

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 14.87 inches Period Avg Flow: 1.157 mgd Period Peak Flow: 4.394 mgd Period Min Flow: 0.491 mgd

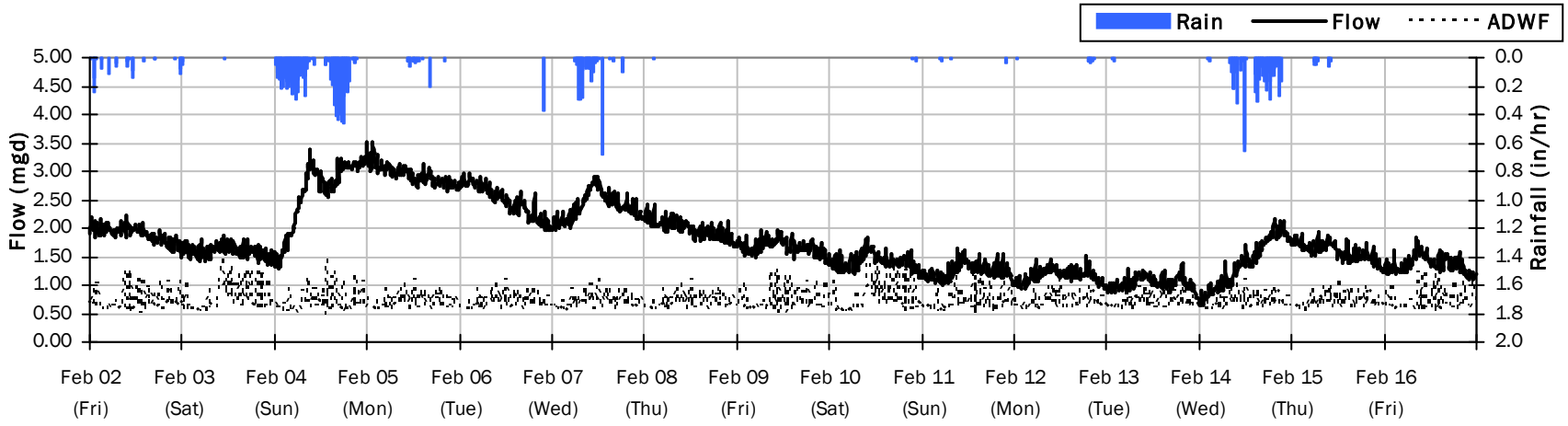


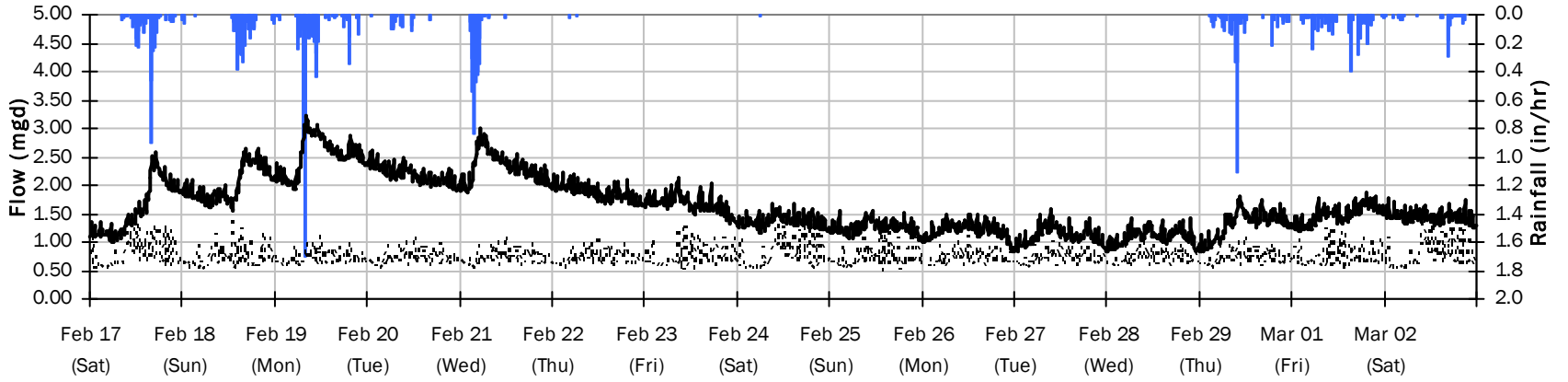


FM-03

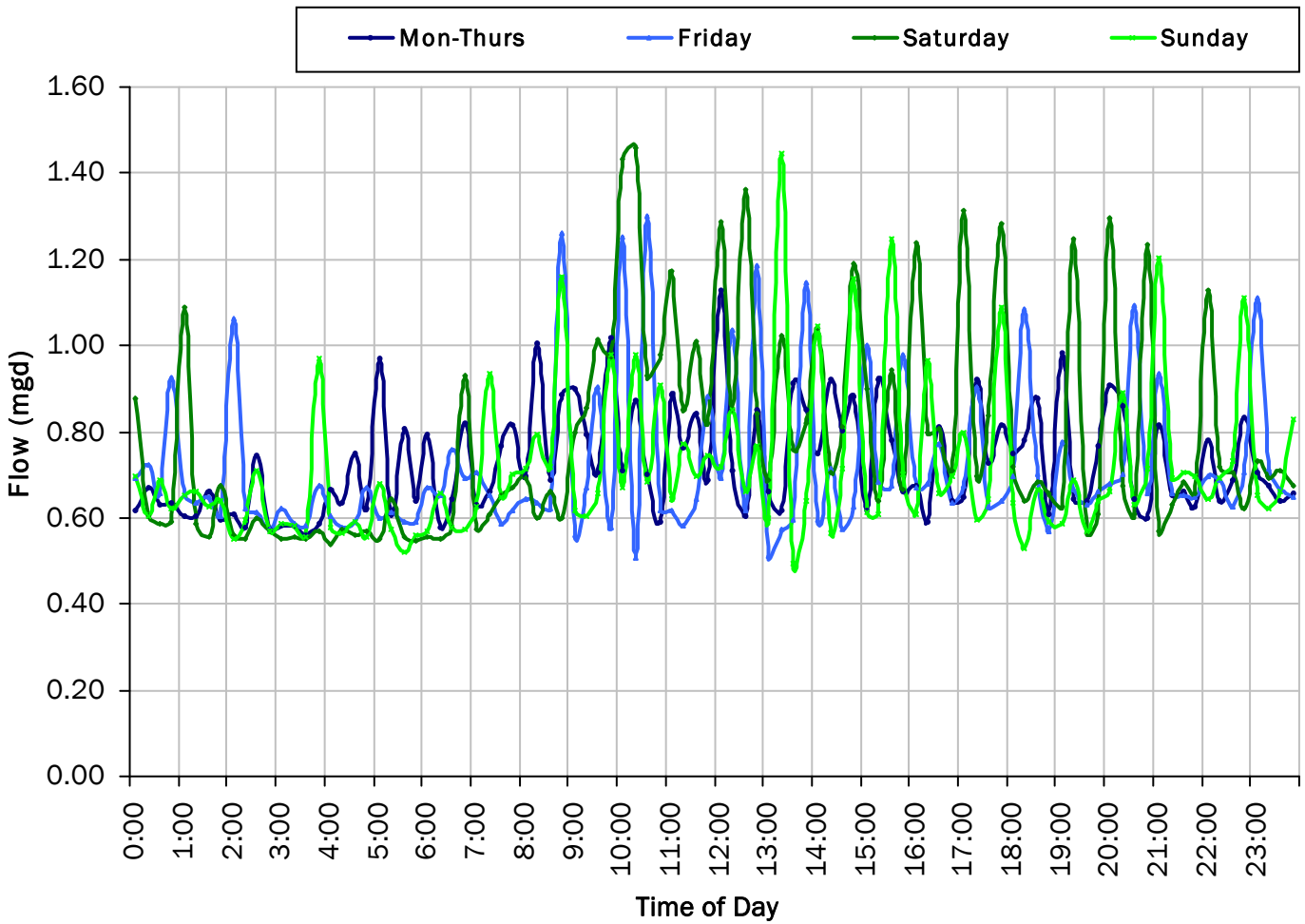
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 12.83 inches Period Avg Flow: 1.710 mgd Period Peak Flow: 3.516 mgd Period Min Flow: 0.646 mgd



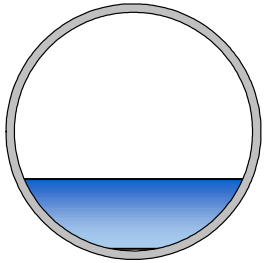


FM-03
Average Dry Weather Flow Hydrographs



ADWF:

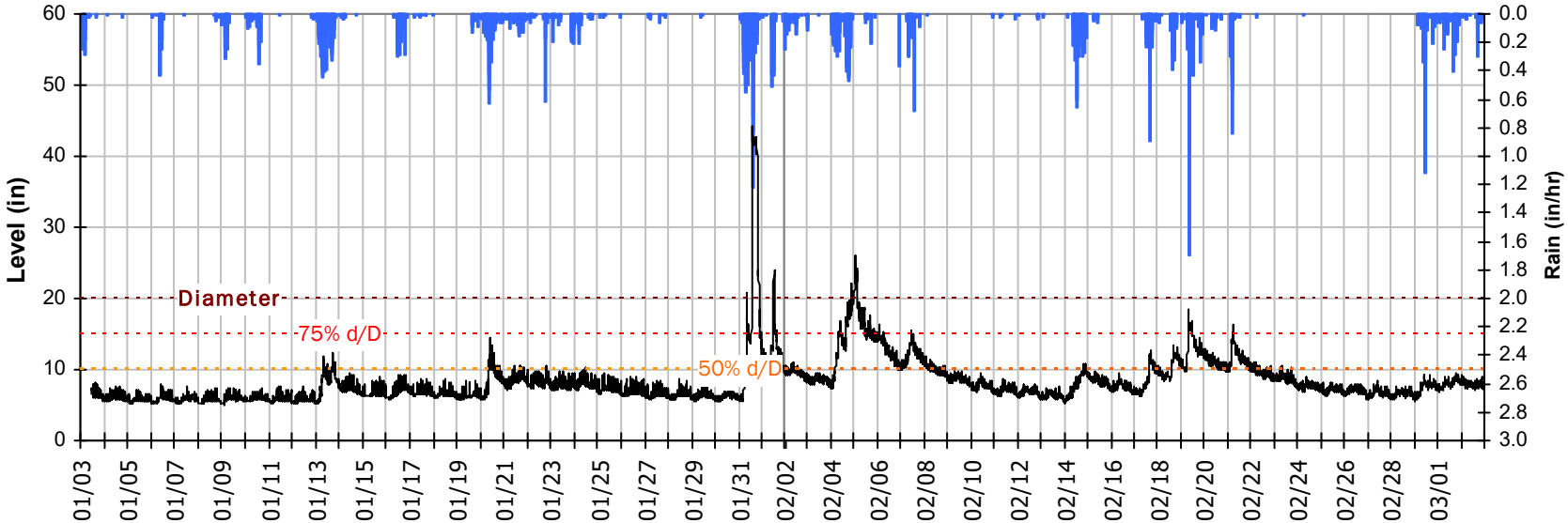
0.732 *mgd*

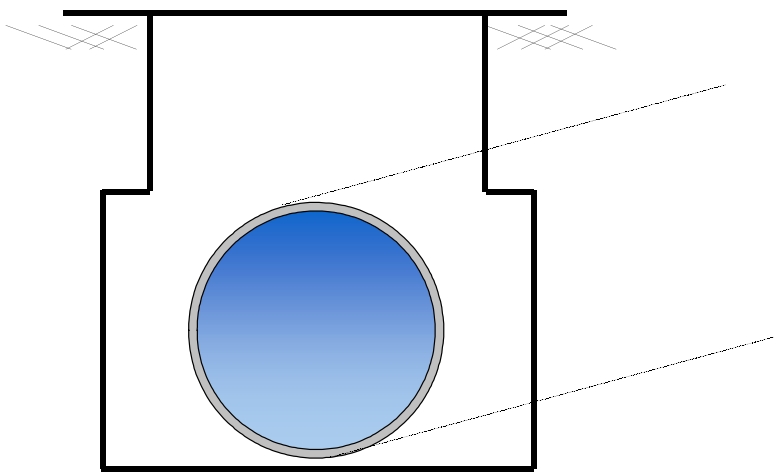


FM-03

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period



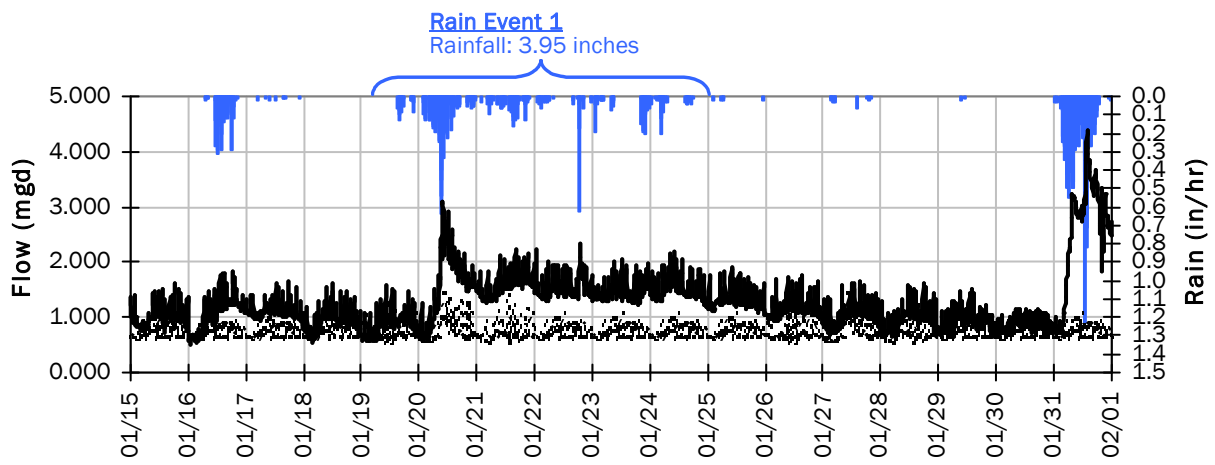


Pipe Diameter:	20	*inches*
Peak Measured Level:	44.1	*inches*
Peak d/D Ratio:	2.20	

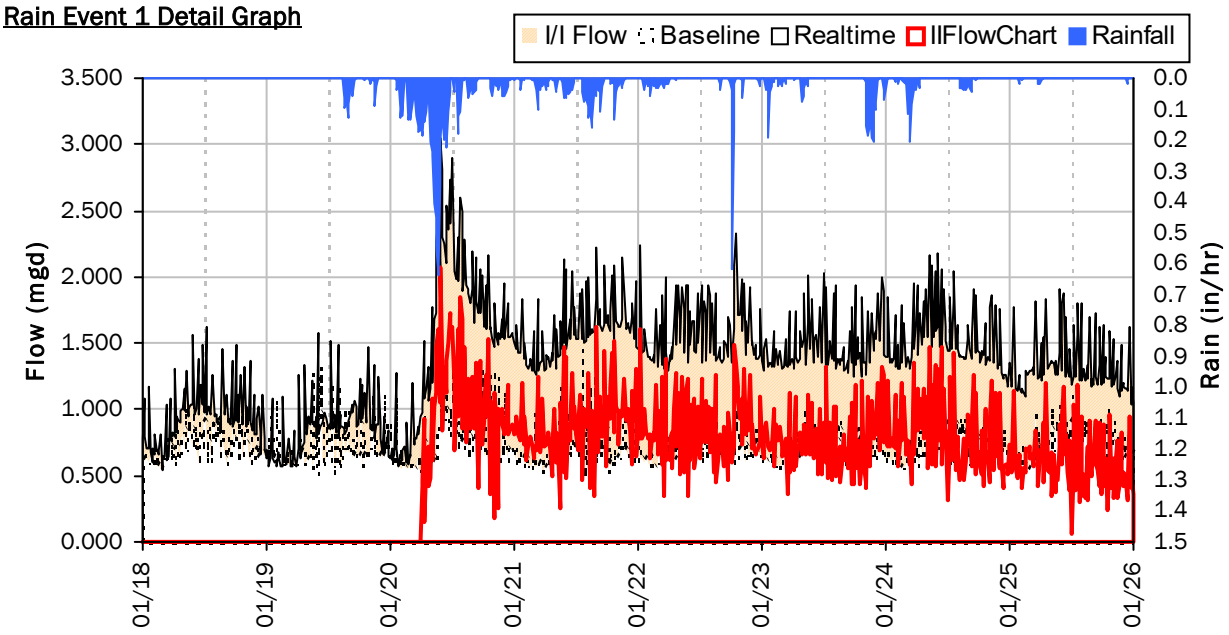
Surcharged 24.1 inches over crown

FM-03
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

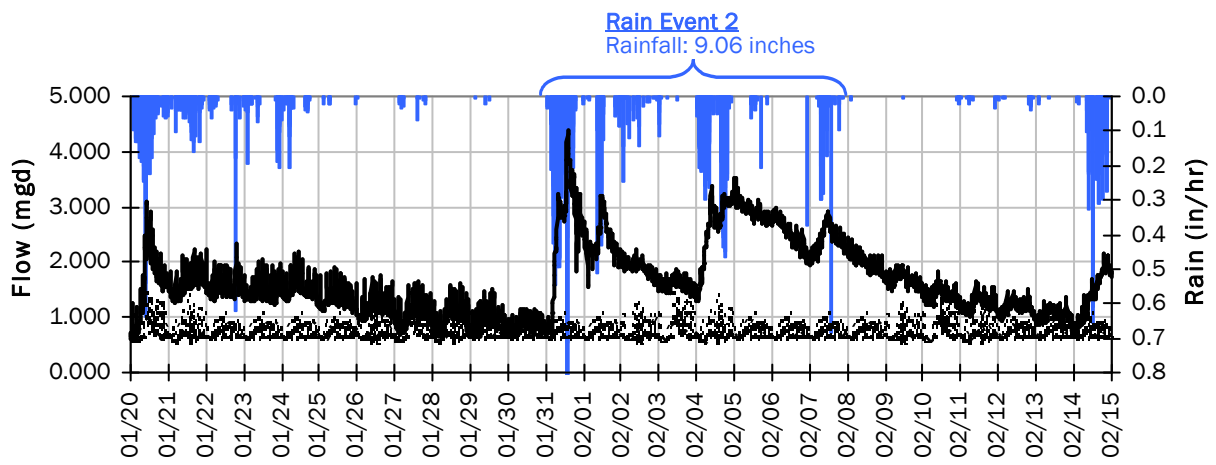


Storm Event I/I Analysis (Rain = 3.95 inches)

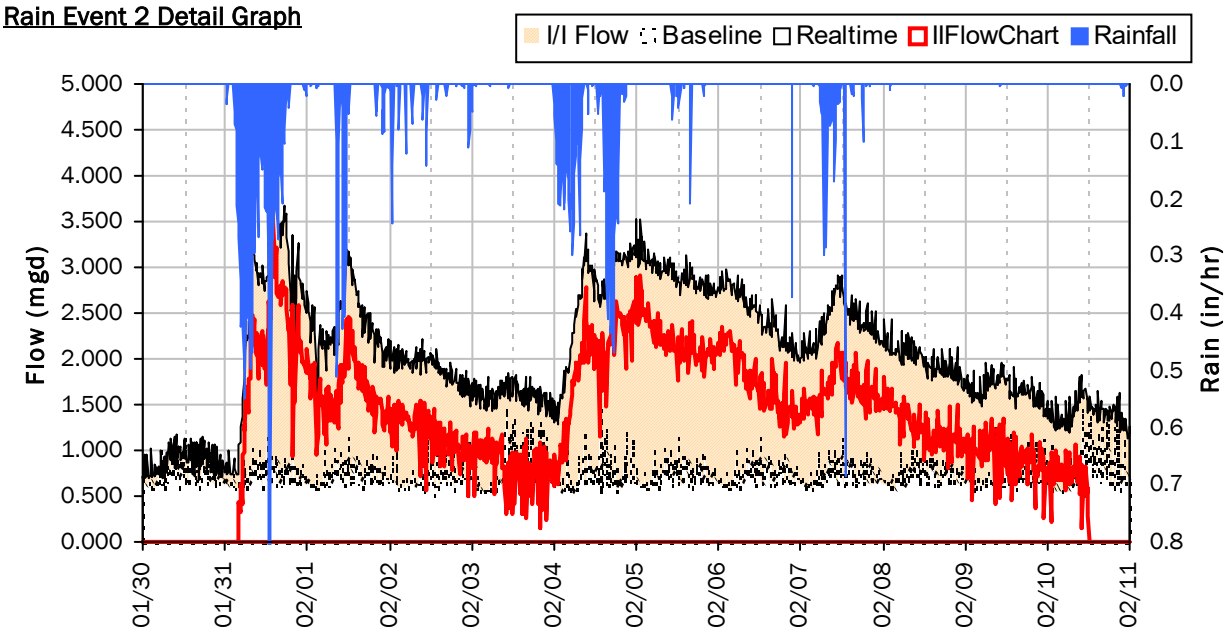
Capacity		Inflow / Infiltration	
Peak Flow:	3.043 *mgd*	**Peak I/I Rate:**	2.067 *mgd*
PF:	4.16	**Total I/I:**	4,712,000 *gallons*
Peak Level:	14.60 *in*		
d/D Ratio:	0.73		

FM-03
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

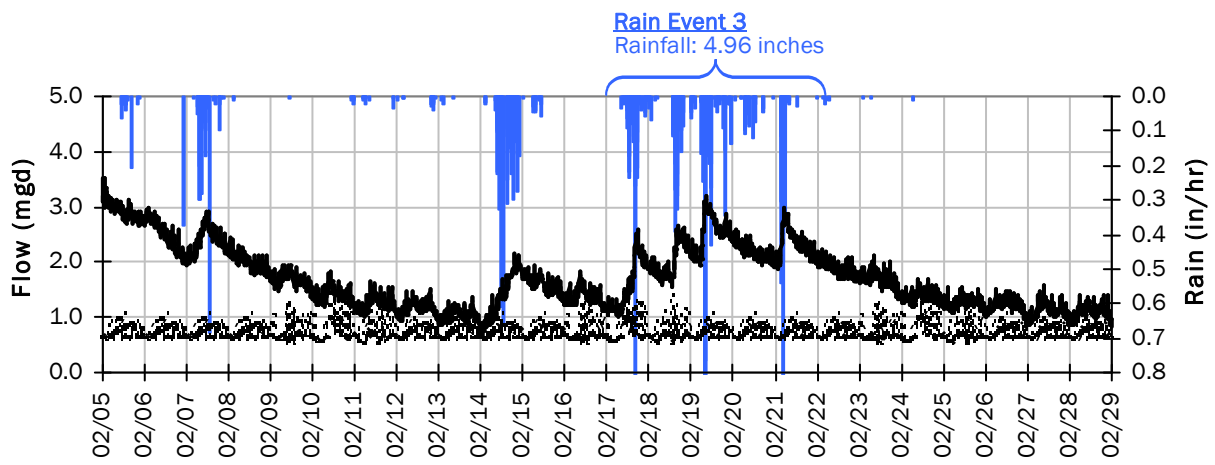


Storm Event I/I Analysis (Rain = 9.06 inches)

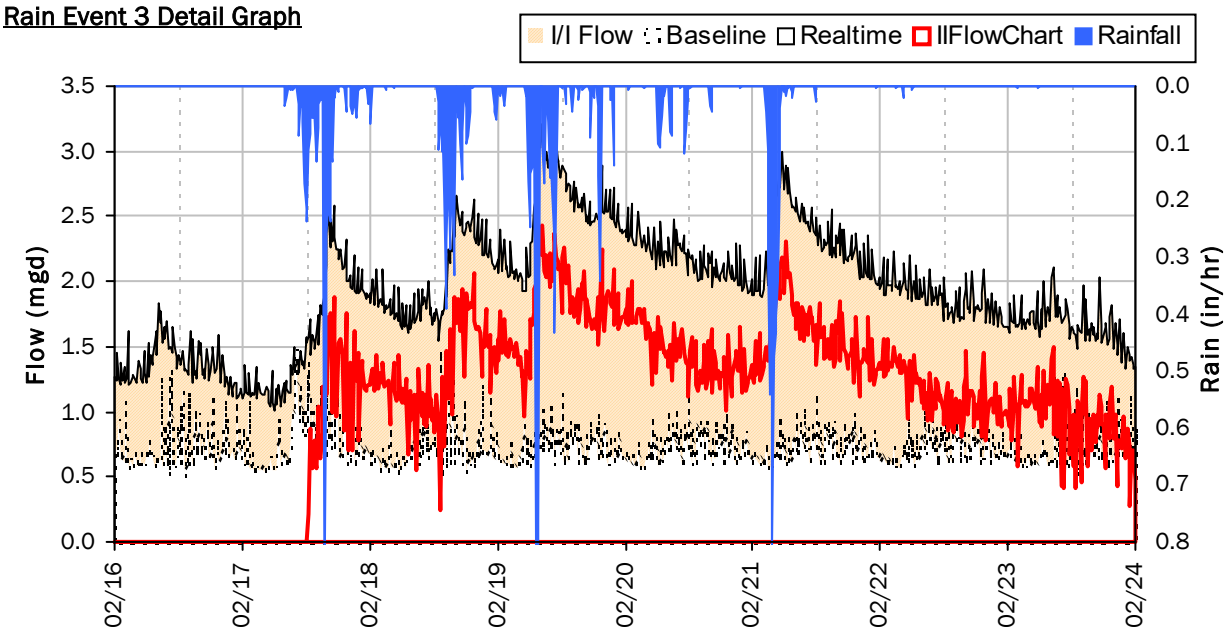
Capacity		Inflow / Infiltration	
Peak Flow:	4.394 *mgd*	**Peak I/I Rate:**	3.559 *mgd*
PF:	6.01	**Total I/I:**	15,572,000 *gallons*
Peak Level:	44.08 *in*		
d/D Ratio:	2.20		

FM-03
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

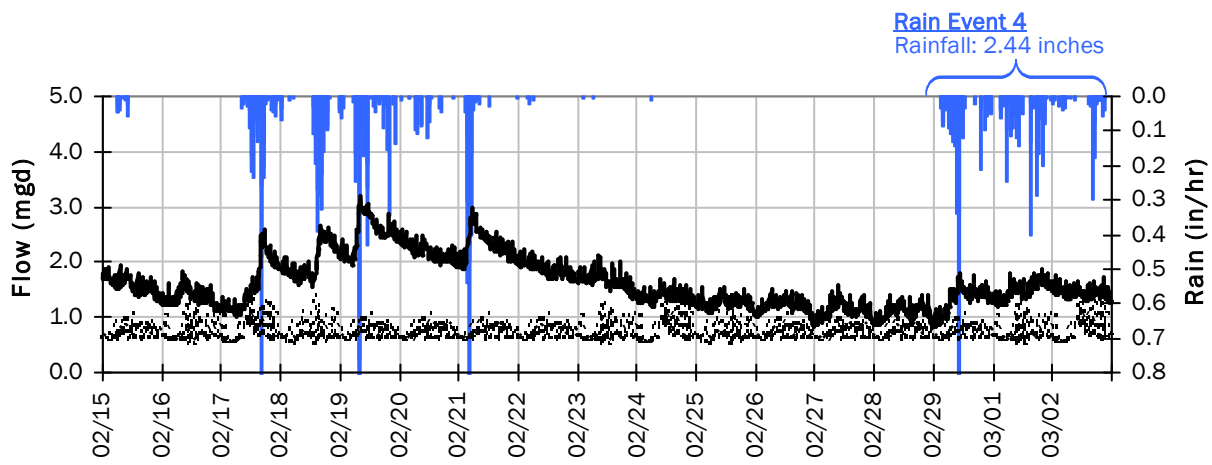


Storm Event I/I Analysis (Rain = 4.96 inches)

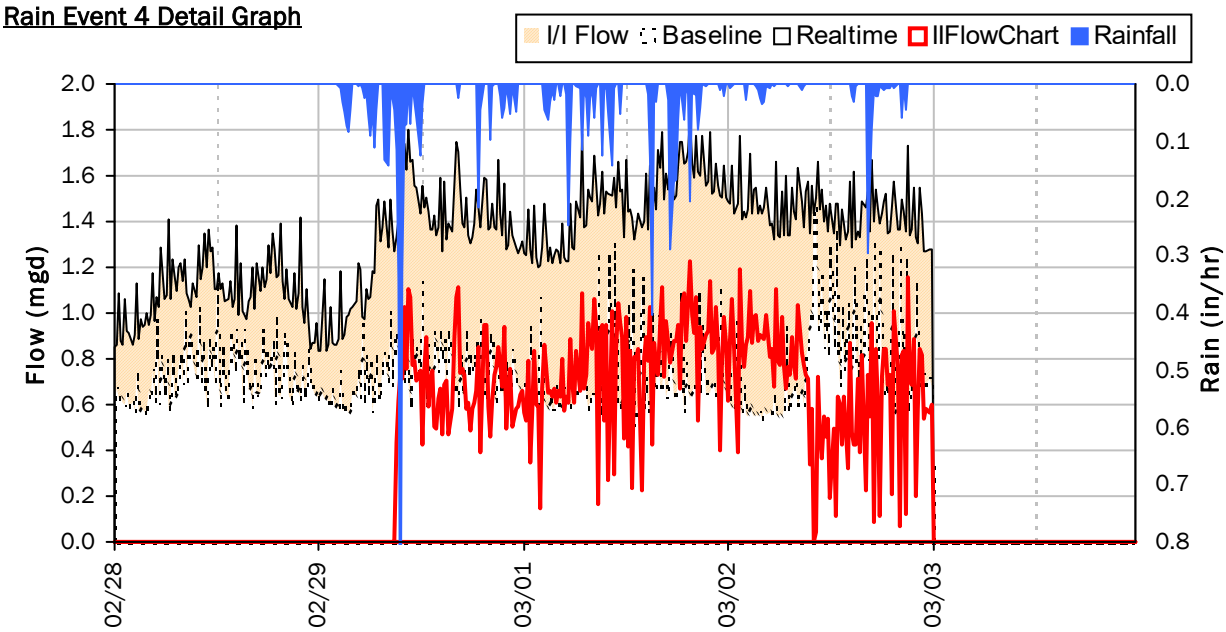
Capacity		Inflow / Infiltration	
Peak Flow:	3.21 *mgd*	Peak I/I Rate:	2.43 *mgd*
PF:	4.39	Total I/I:	8,790,000 *gallons*
Peak Level:	18.53 *in*		
d/D Ratio:	0.93		

FM-03
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



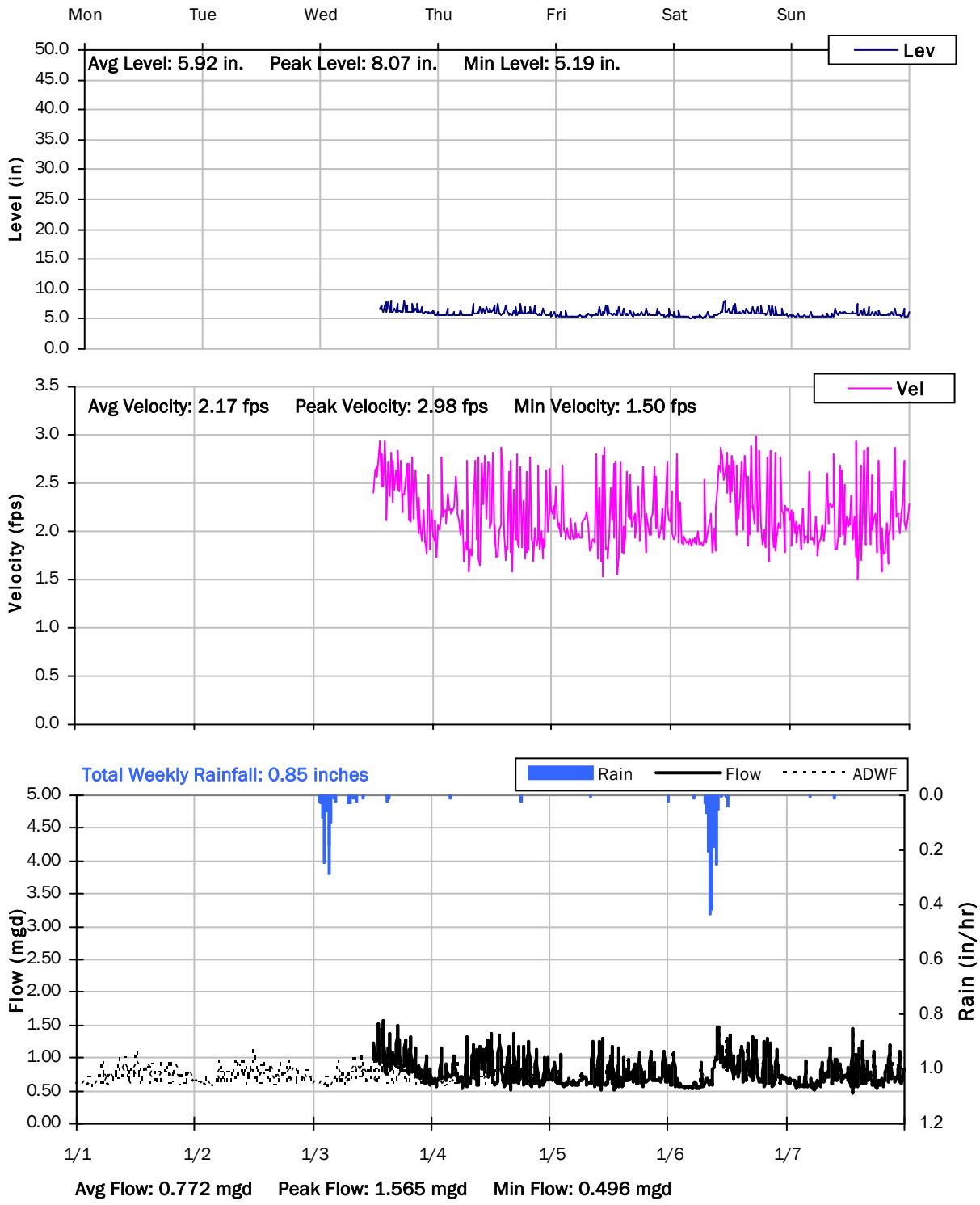
Storm Event I/I Analysis (Rain = 2.44 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	1.86 *mgd*	**Peak I/I Rate:**	1.23 *mgd*
PF:	2.54	**Total I/I:**	1,880,000 *gallons*
Peak Level:	9.39 *in*		
d/D Ratio:	0.47		

FM-03

Weekly Level, Velocity and Flow Hydrographs

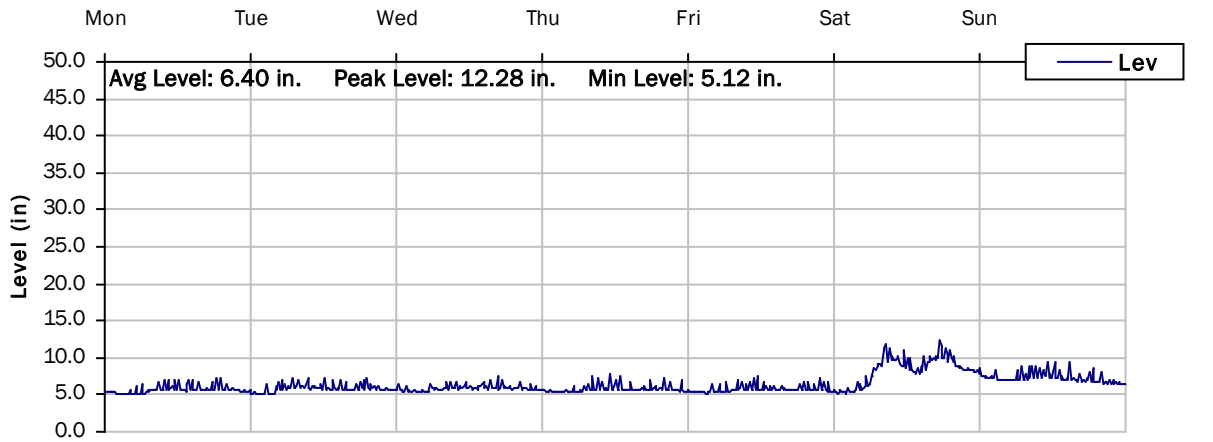
1/1/2024 to 1/8/2024

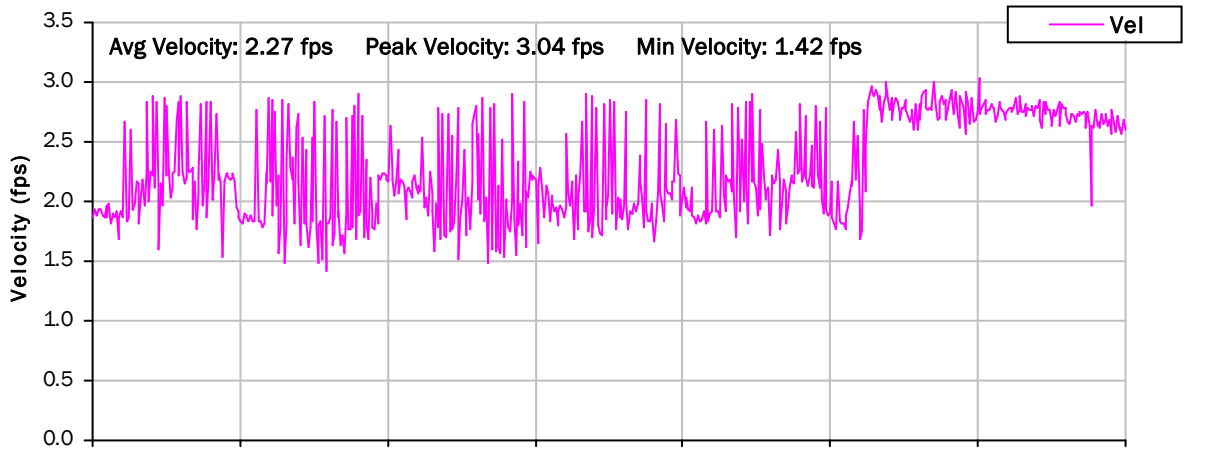


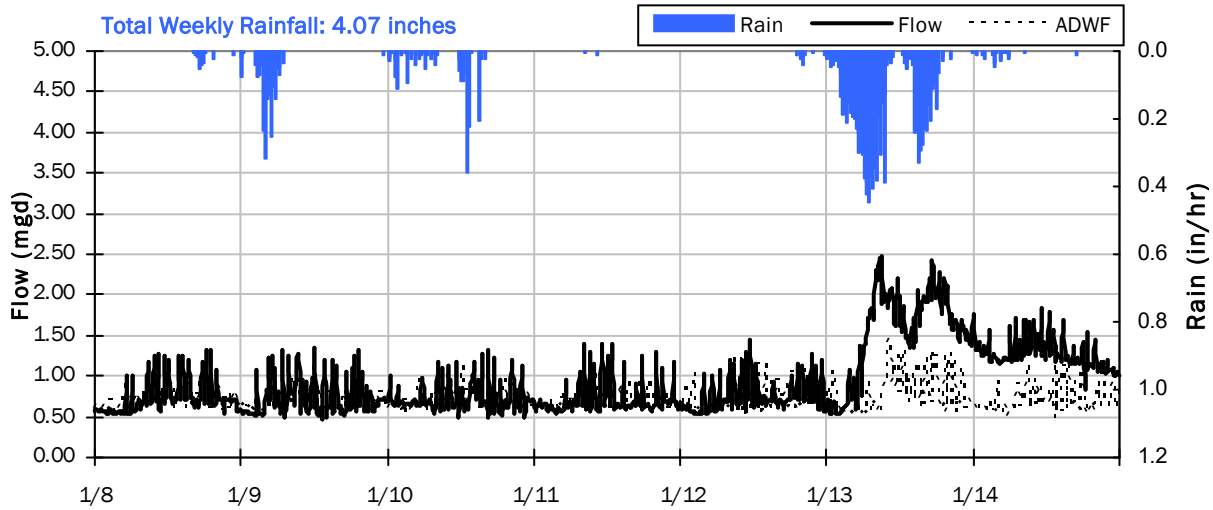
FM-03

Weekly Level, Velocity and Flow Hydrographs

1/8/2024 to 1/15/2024





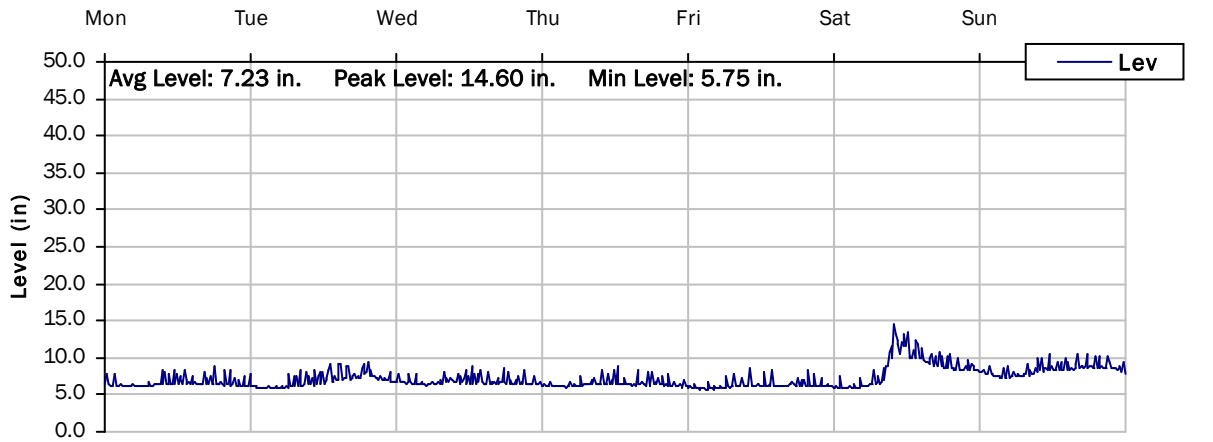


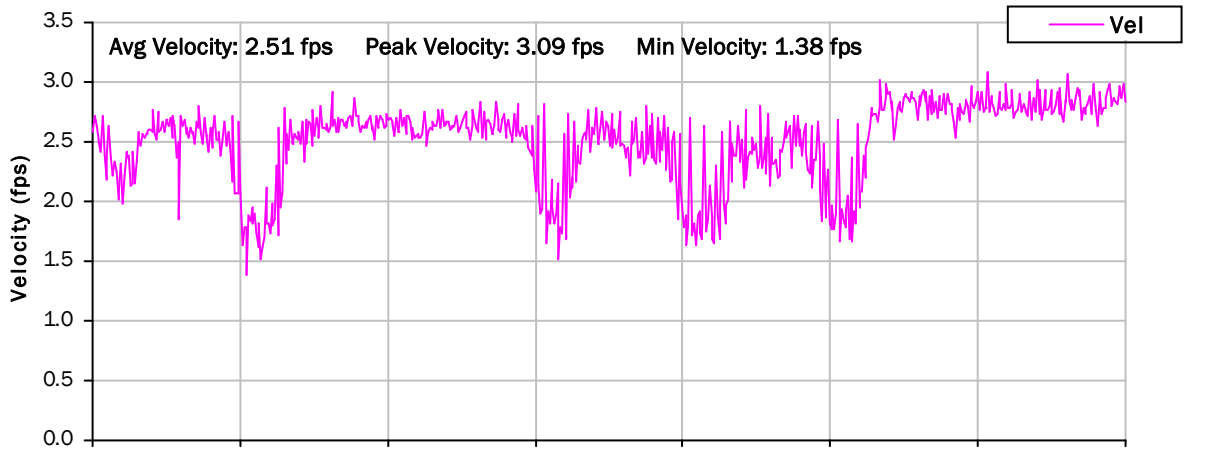
Avg Flow: 0.921 mgd Peak Flow: 2.466 mgd Min Flow: 0.491 mgd

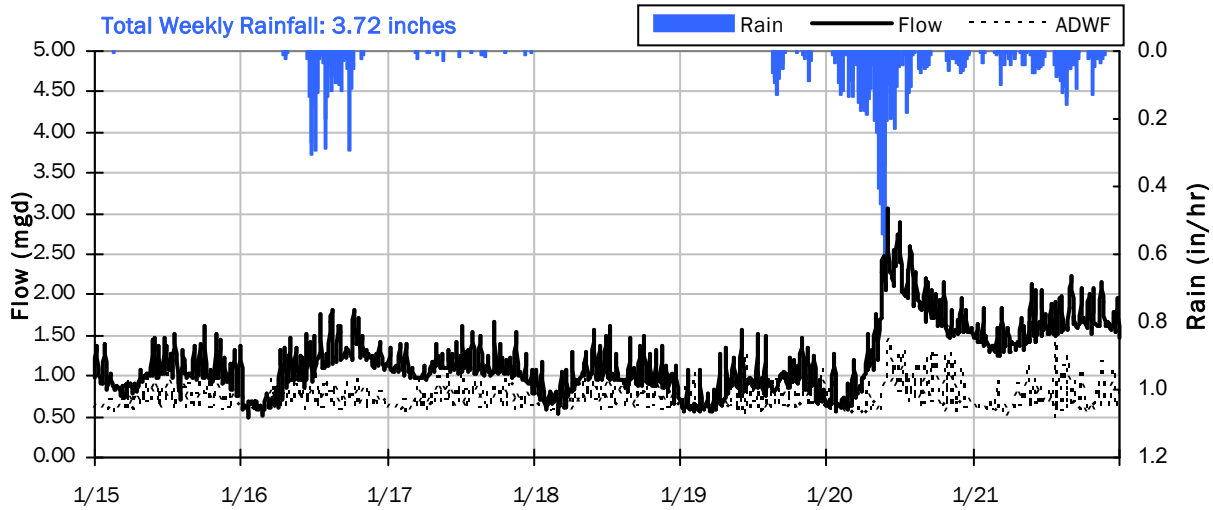
FM-03

Weekly Level, Velocity and Flow Hydrographs

1/15/2024 to 1/22/2024





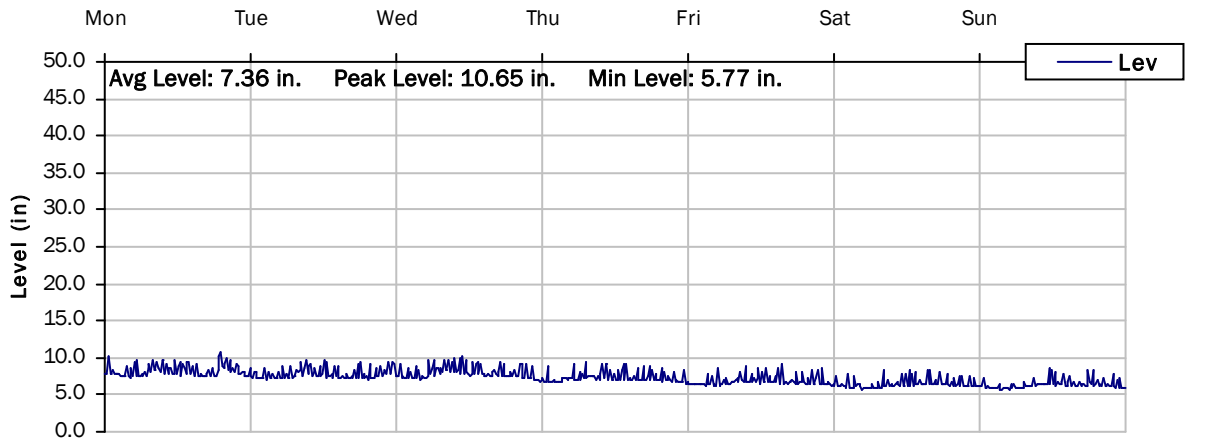


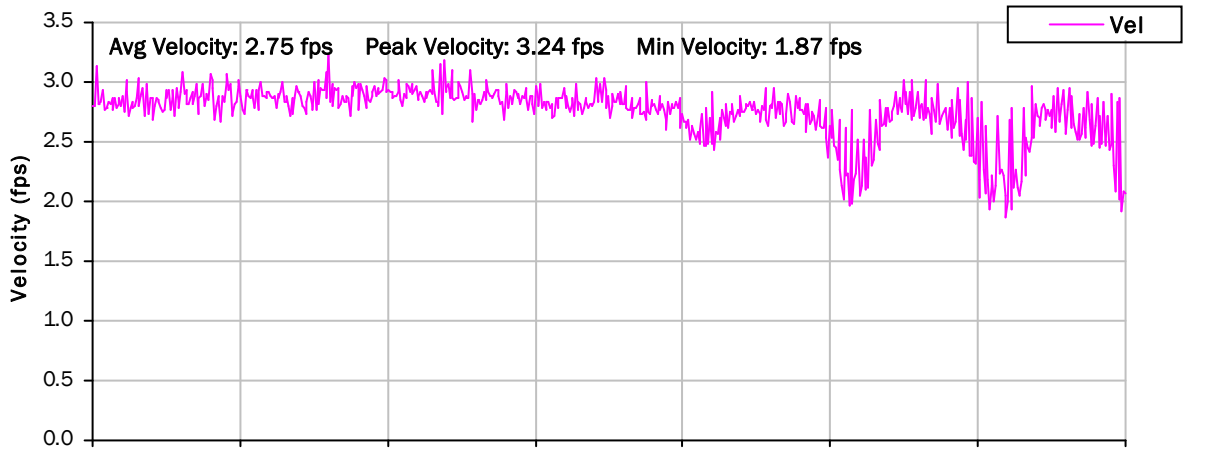
Avg Flow: 1.182 mgd Peak Flow: 3.043 mgd Min Flow: 0.491 mgd

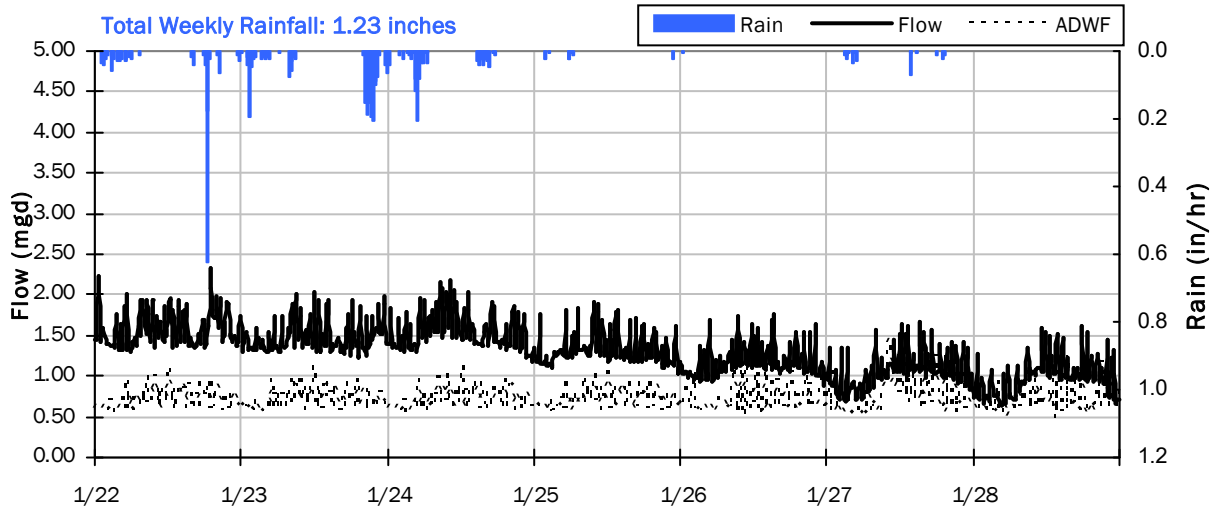
FM-03

Weekly Level, Velocity and Flow Hydrographs

1/22/2024 to 1/29/2024





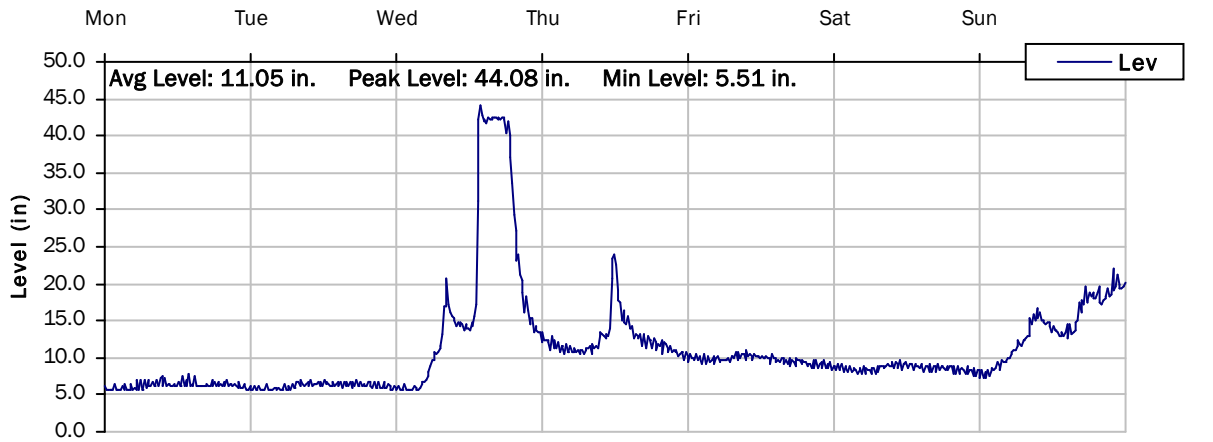


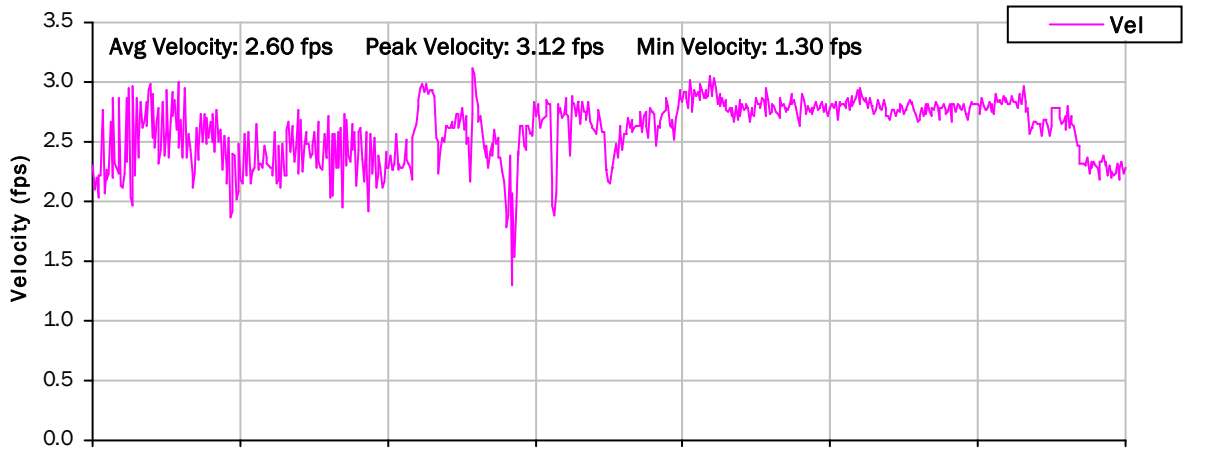
Avg Flow: 1.311 mgd Peak Flow: 2.335 mgd Min Flow: 0.647 mgd

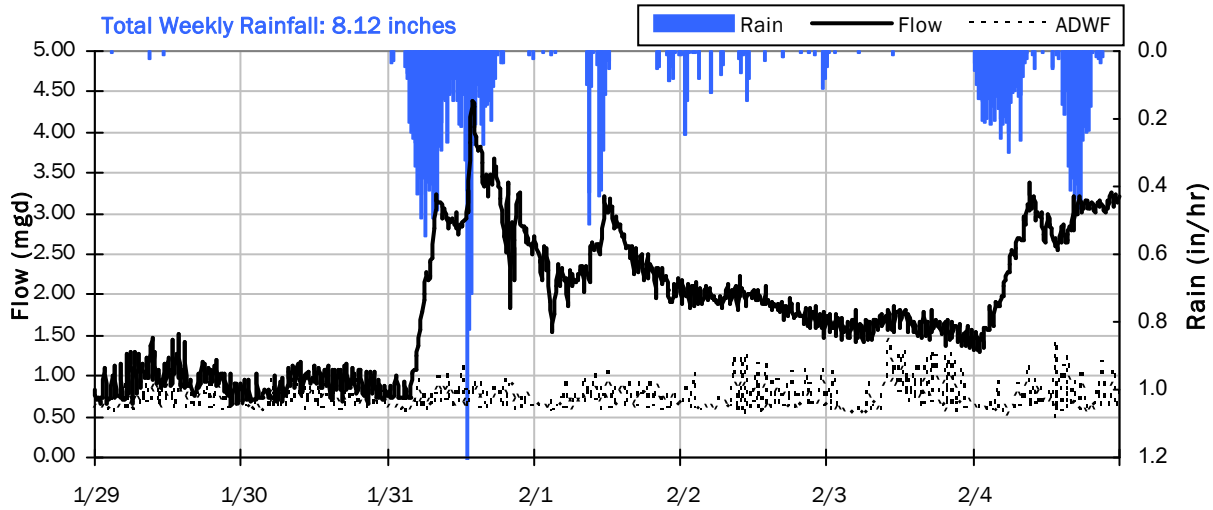
FM-03

Weekly Level, Velocity and Flow Hydrographs

1/29/2024 to 2/5/2024





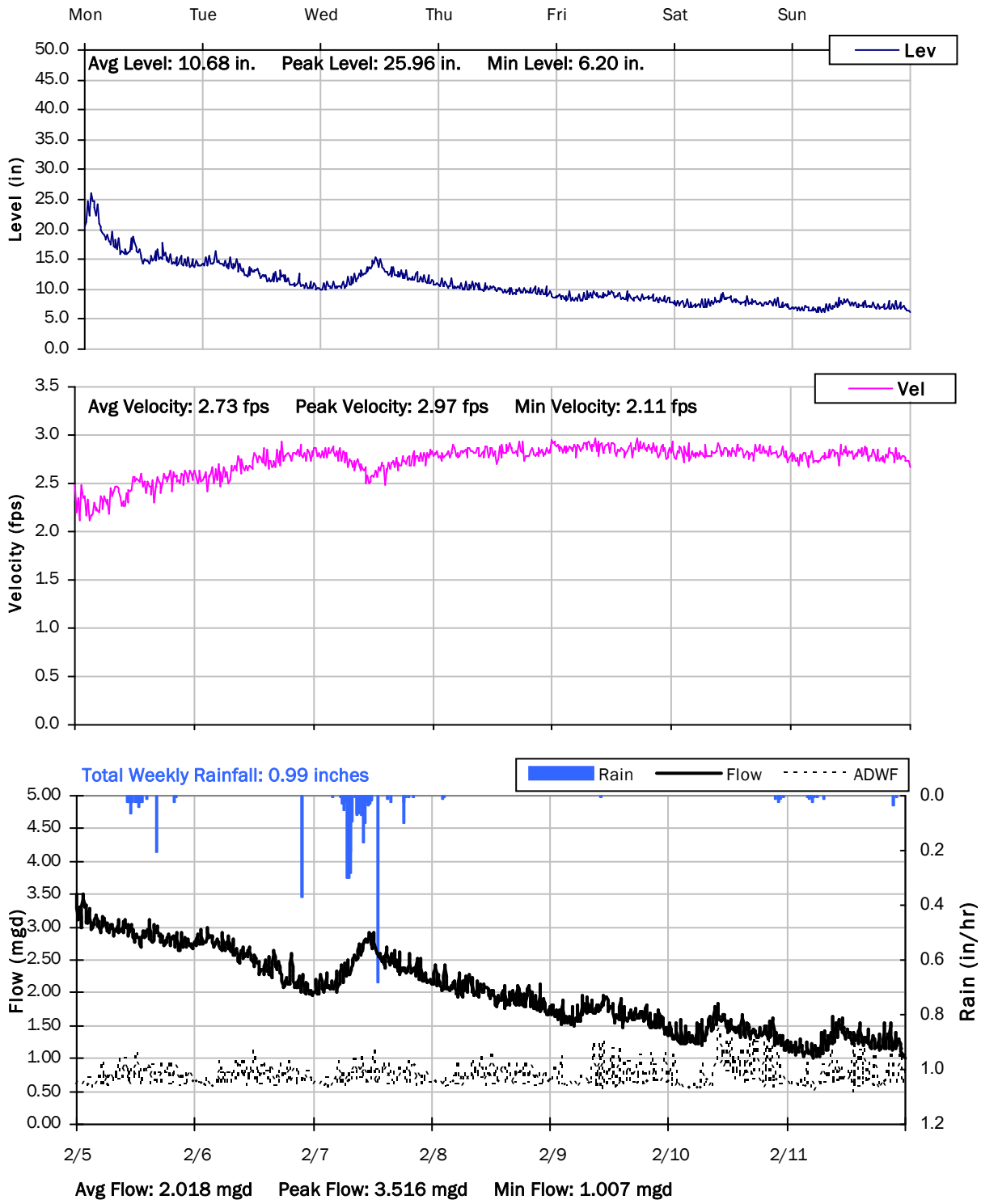


Avg Flow: 1.845 mgd Peak Flow: 4.394 mgd Min Flow: 0.641 mgd

FM-03

Weekly Level, Velocity and Flow Hydrographs

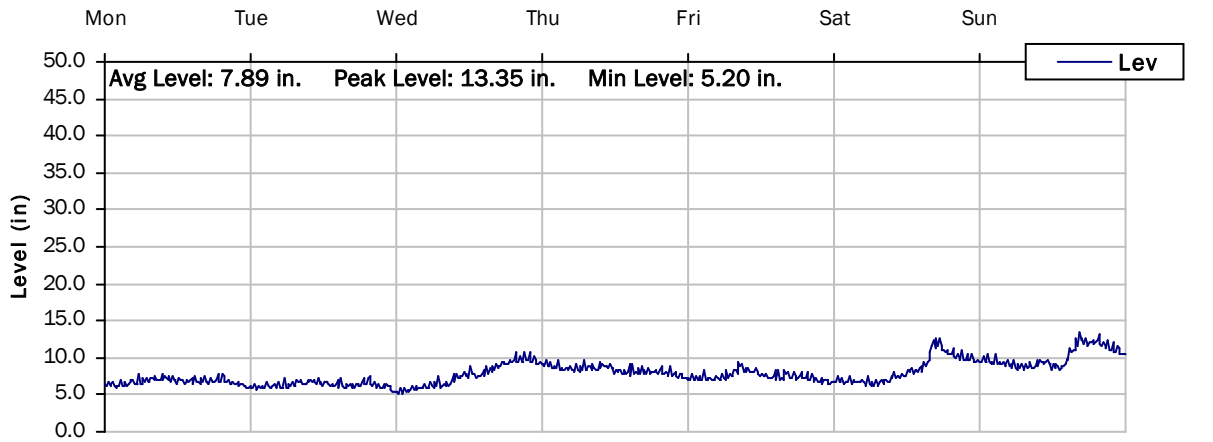
2/5/2024 to 2/12/2024

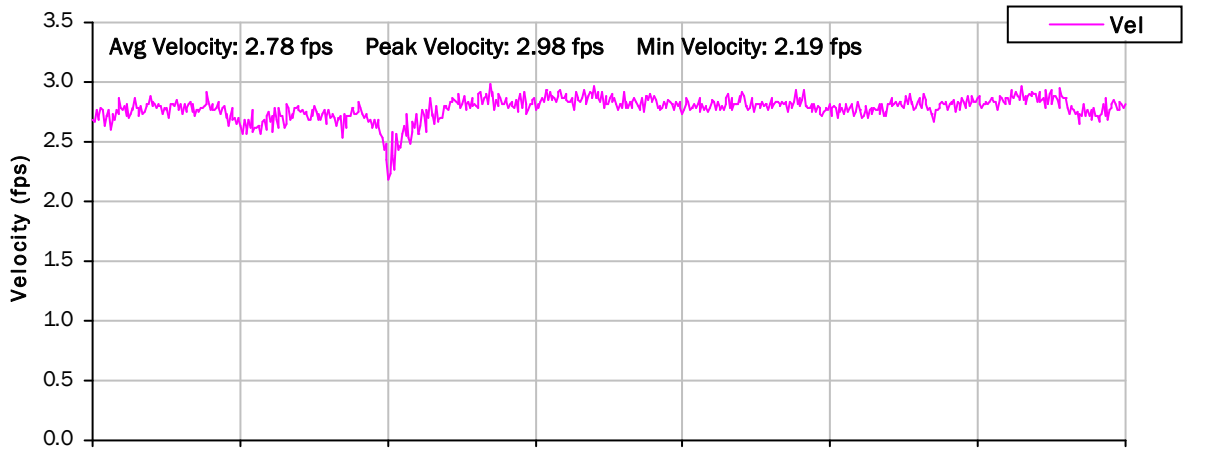


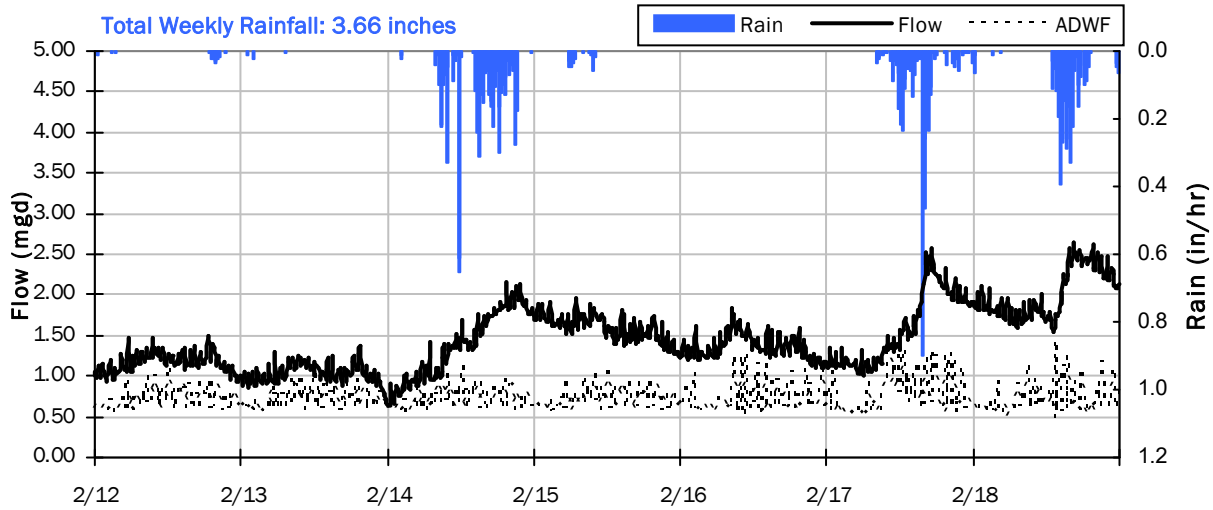
FM-03

Weekly Level, Velocity and Flow Hydrographs

2/12/2024 to 2/19/2024





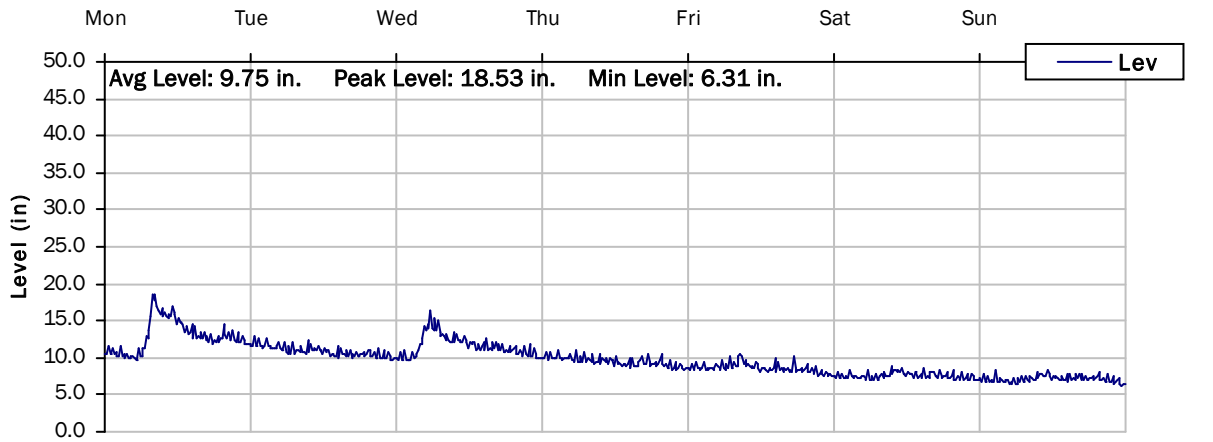


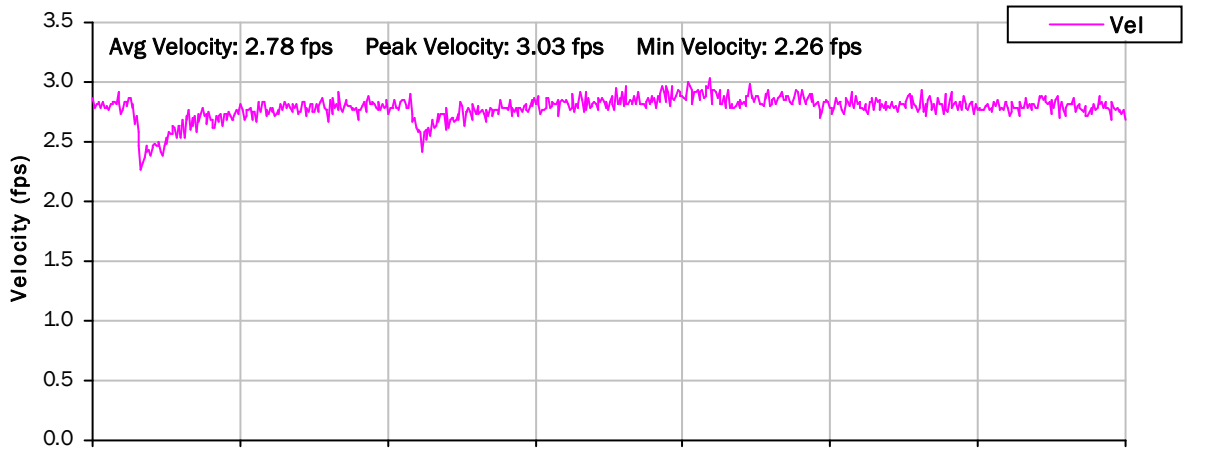
Avg Flow: 1.448 mgd Peak Flow: 2.652 mgd Min Flow: 0.646 mgd

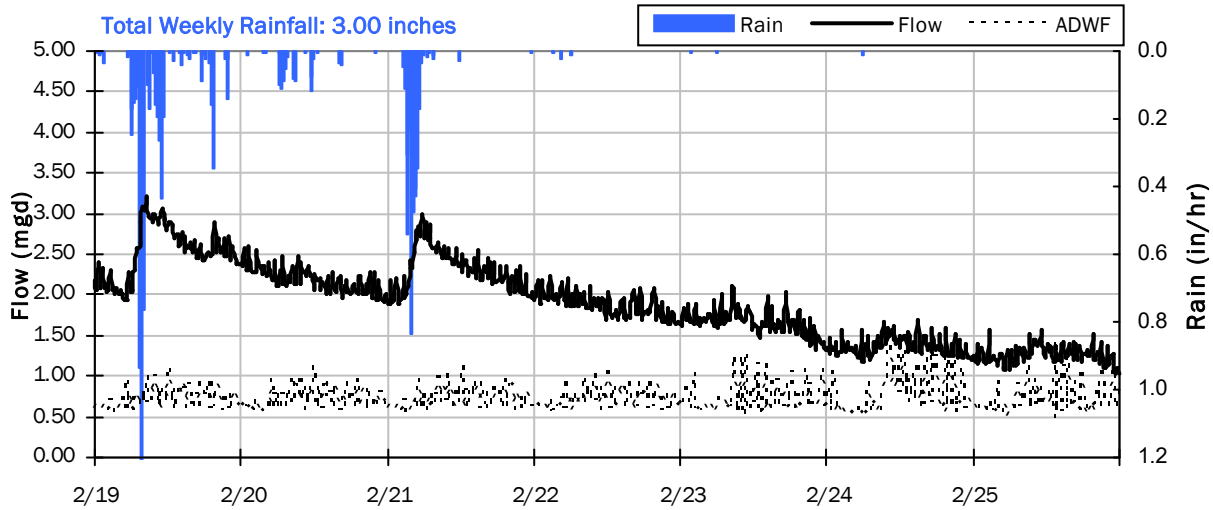
FM-03

Weekly Level, Velocity and Flow Hydrographs

2/19/2024 to 2/26/2024





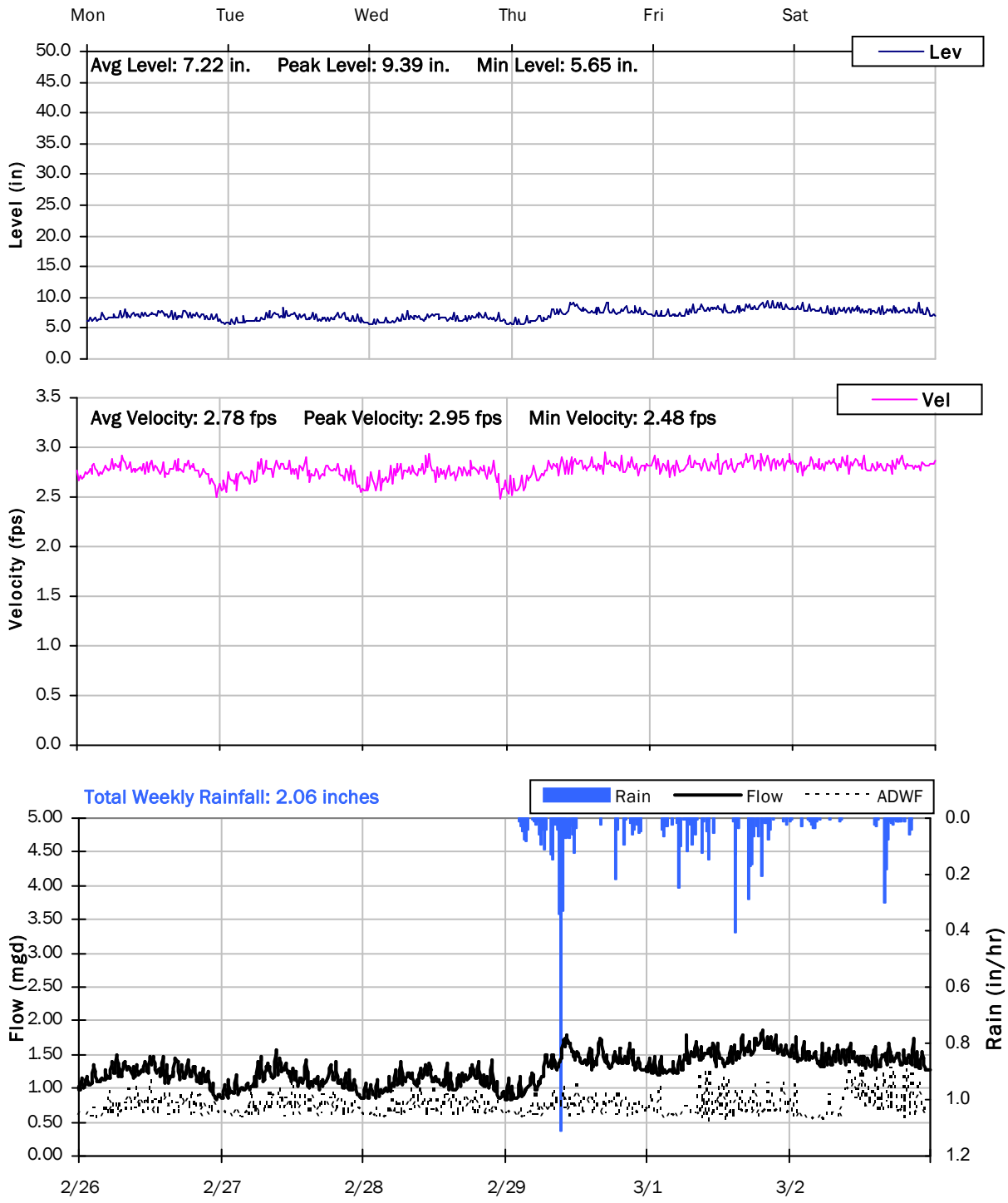


Avg Flow: 1.885 mgd Peak Flow: 3.210 mgd Min Flow: 1.029 mgd

FM-03

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



Monitoring Site: FM-04

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: E Oak St x W Whipple St

Data Summary Report

Vicinity Map: FM-04

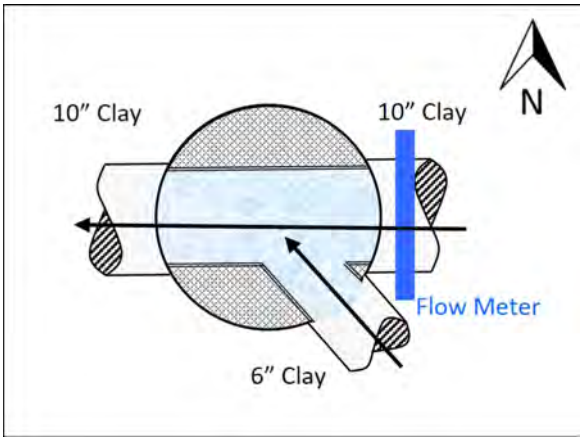
FM-04

Site Information MH ID: Mnhl-Chnnl-4125

Location:	E Oak St x W Whipple St
Coordinates:	123.8014° W, 39.4417° N
Rim Elevation:	107 feet
Expected Pipe Diameter:	6 inches
Measured Pipe Diameter:	10 inches
ADWF:	0.315 mgd
Peak Measured Flow:	3.343 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

Plan View

FM-04

Additional Site Photos

West Outlet Pipe

Monitored East Inlet Pipe

FM-04

Additional Site Photos

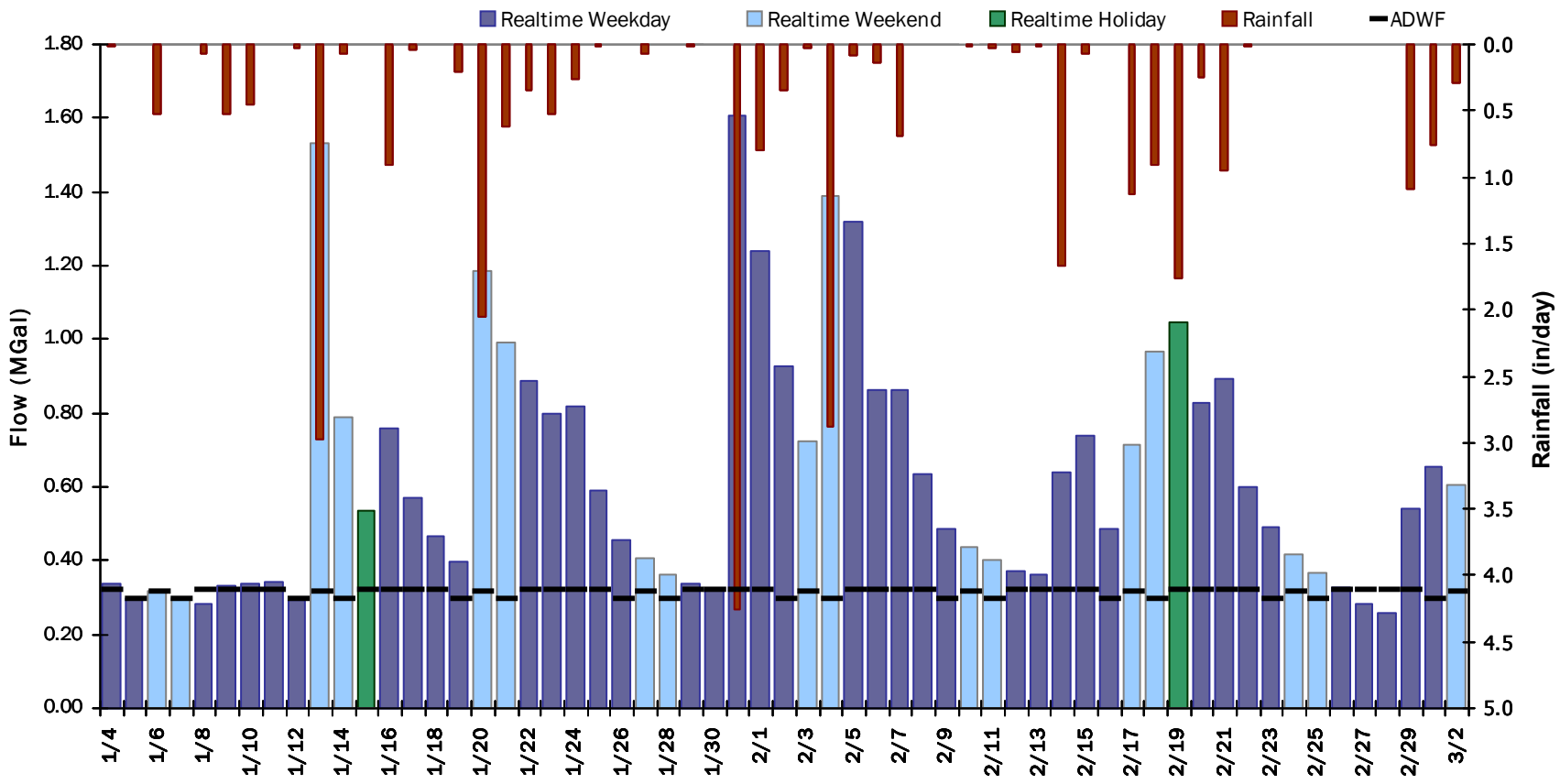
Southeast Inlet Pipe

FM-04

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.632 MGal Peak Daily Flow: 1.604 MGal Min Daily Flow: 0.258 MGal

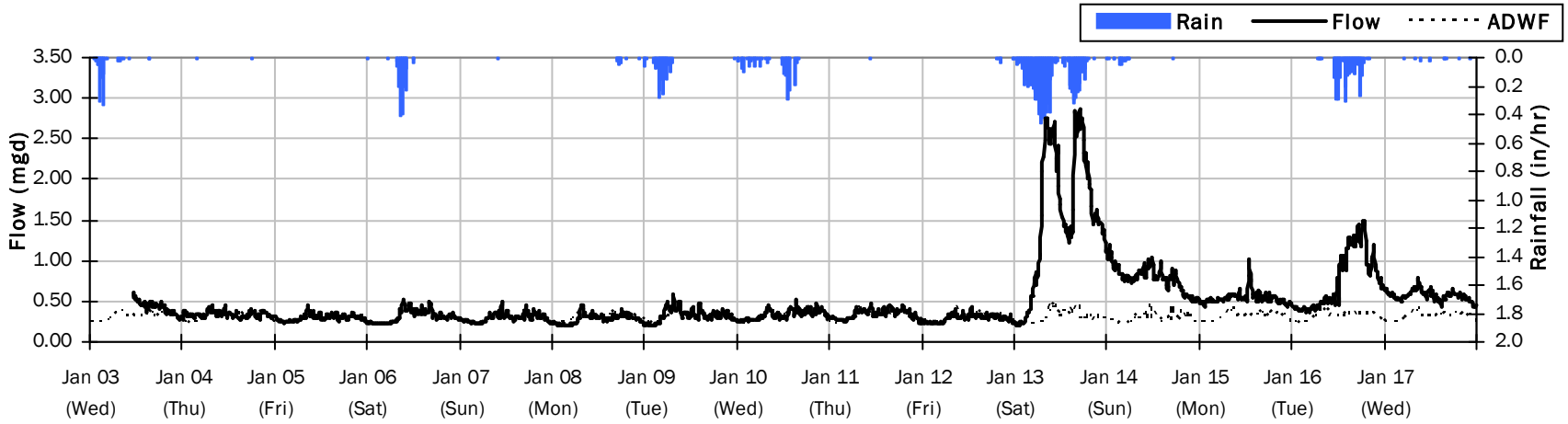
Total Rainfall: 27.96 inches

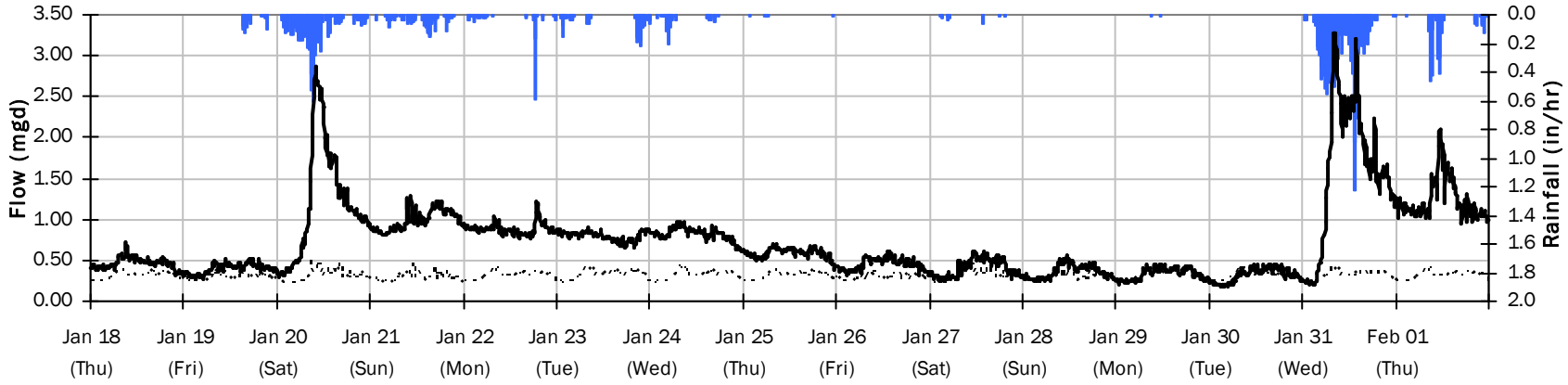


FM-04

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 15.12 inches Period Avg Flow: 0.613 mgd Period Peak Flow: 3.278 mgd Period Min Flow: 0.177 mgd

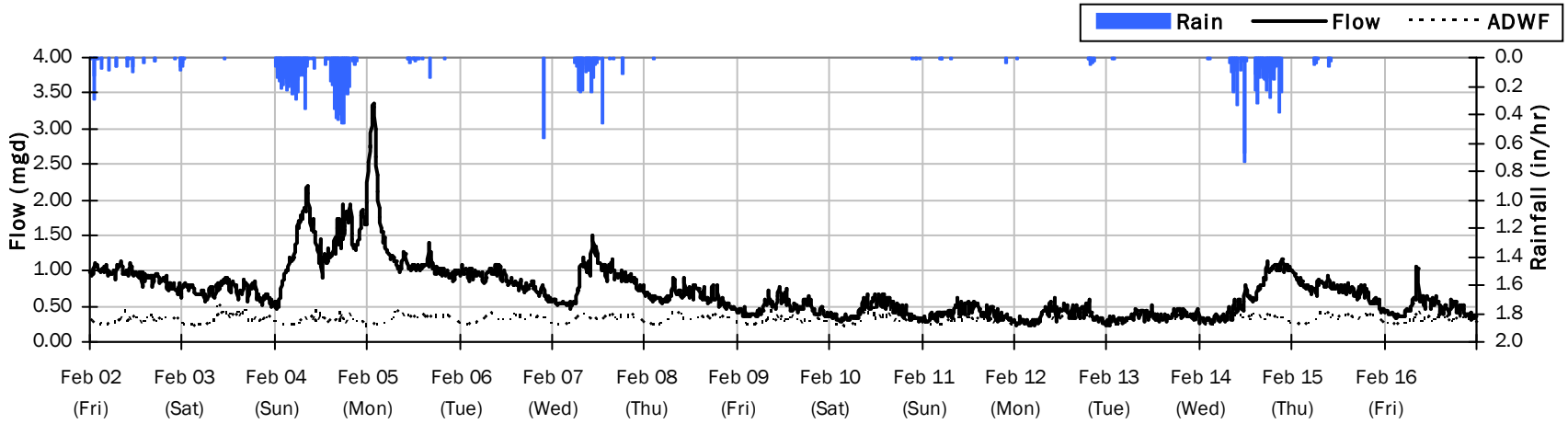


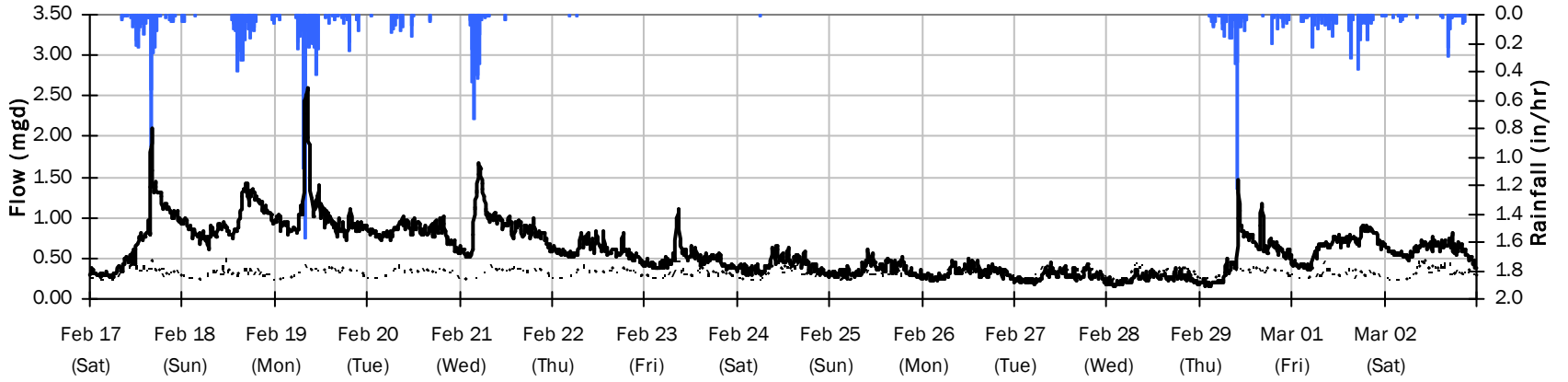


FM-04

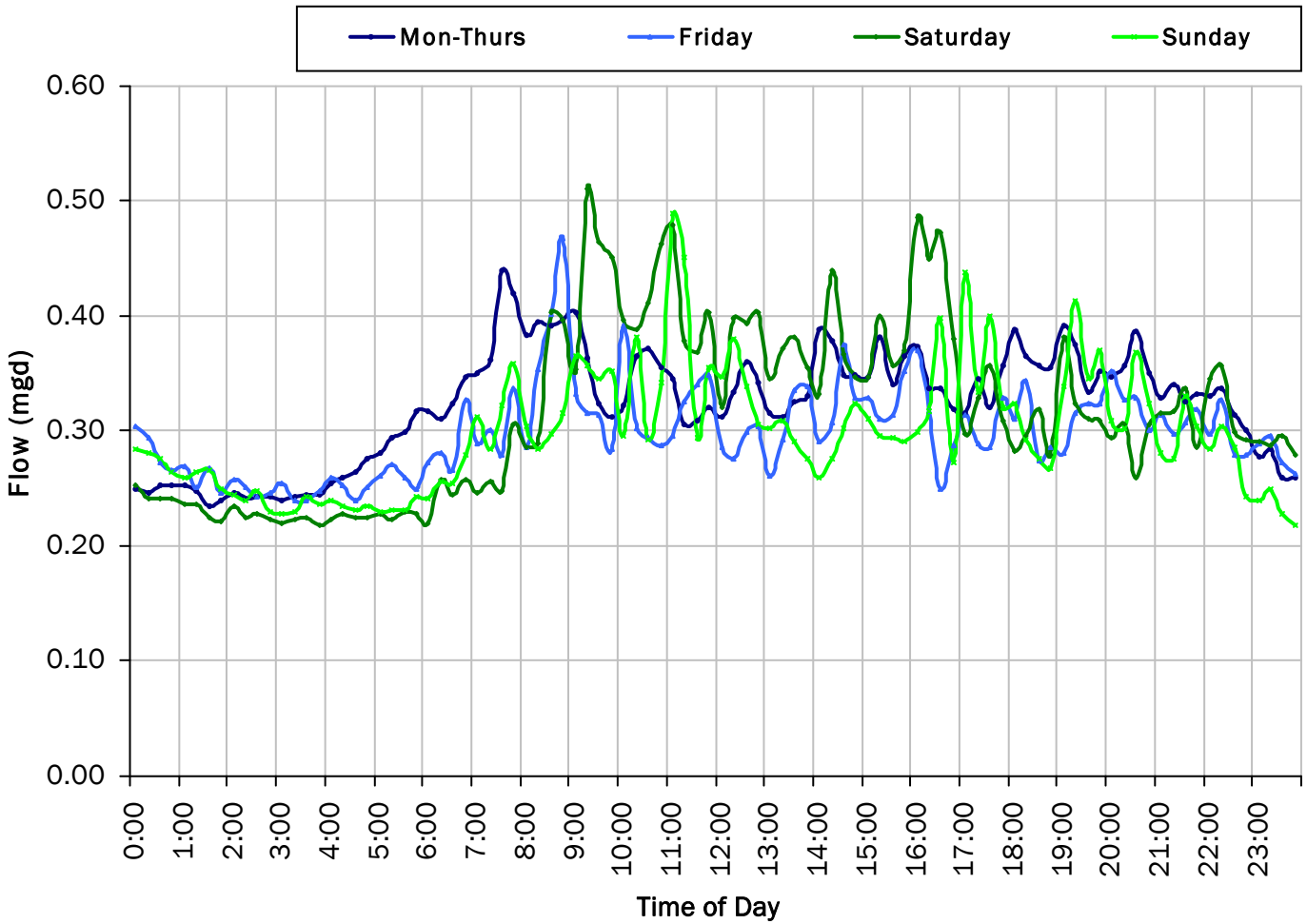
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 13.16 inches Period Avg Flow: 0.655 mgd Period Peak Flow: 3.343 mgd Period Min Flow: 0.156 mgd



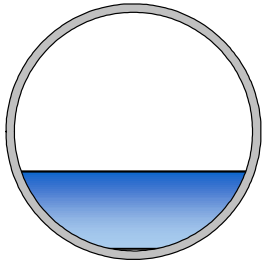


FM-04
Average Dry Weather Flow Hydrographs



ADWF:

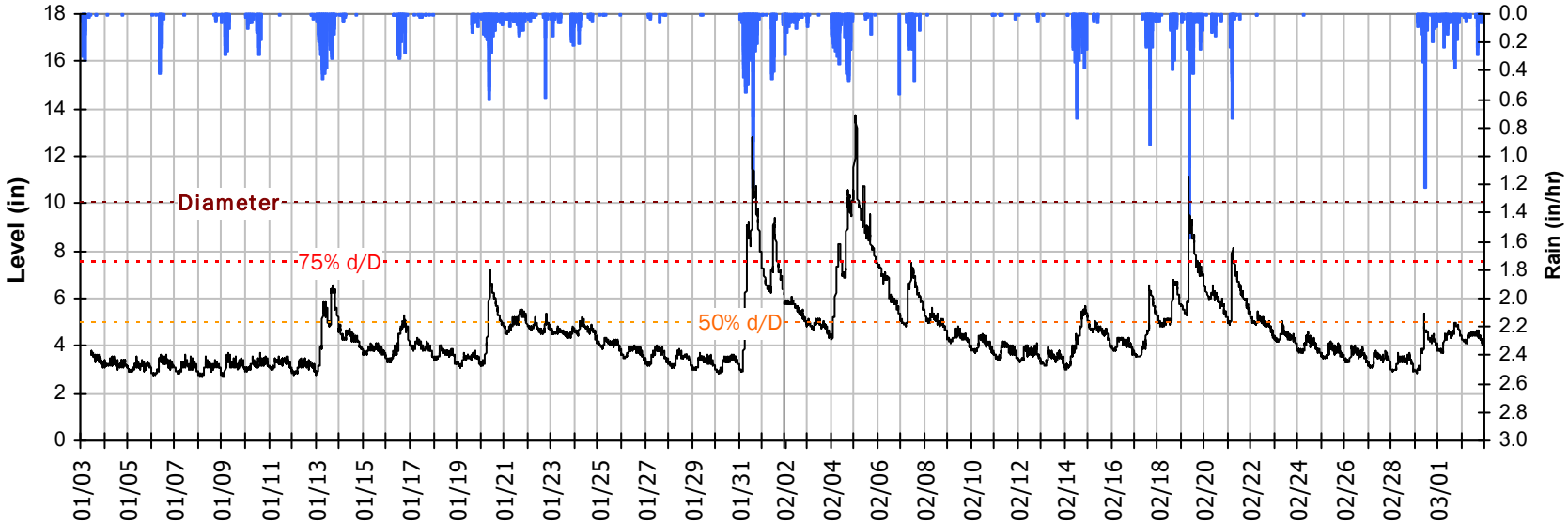
0.315 *mgd*

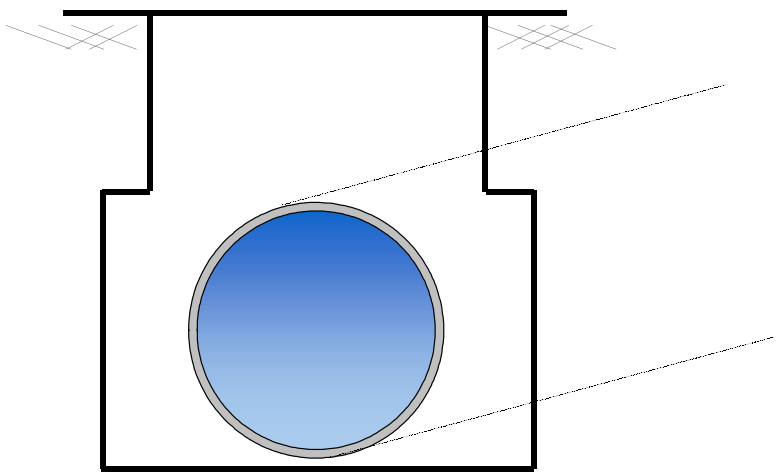


FM-04

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period



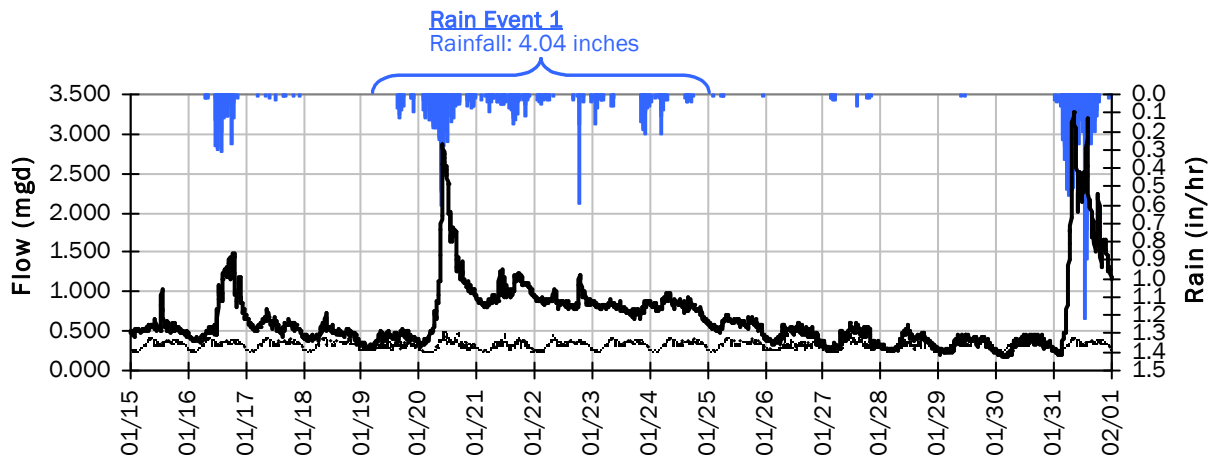


Pipe Diameter:	10	*inches*
Peak Measured Level:	13.7	*inches*
Peak d/D Ratio:	1.37	

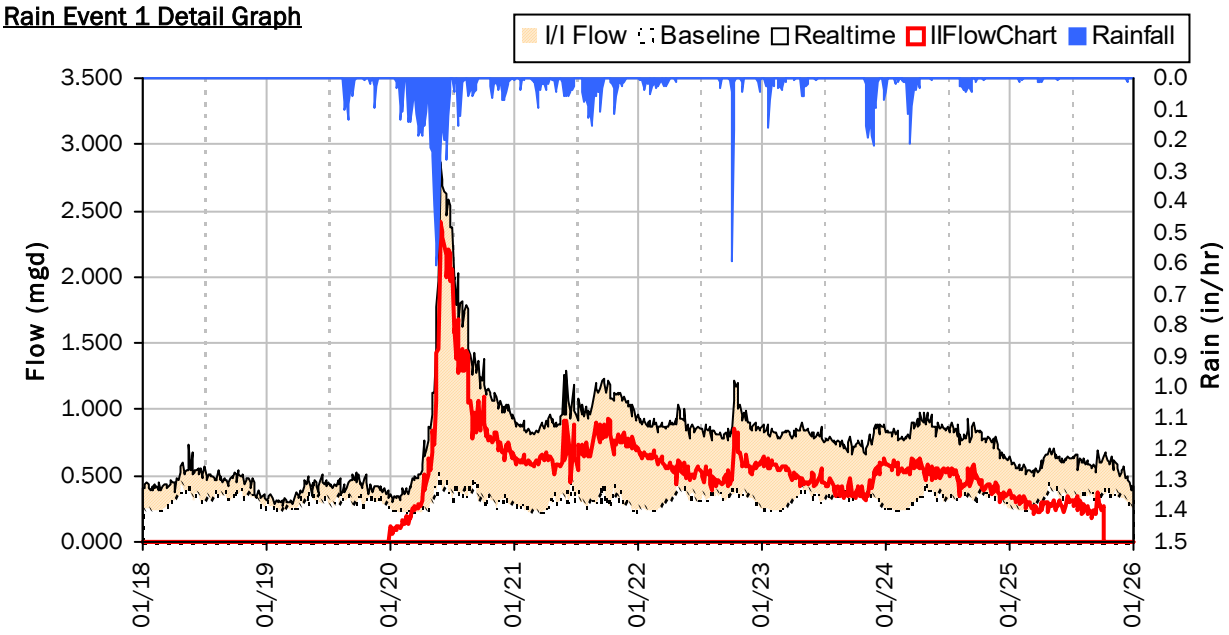
Surcharged 3.7 inches over crown

FM-04
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

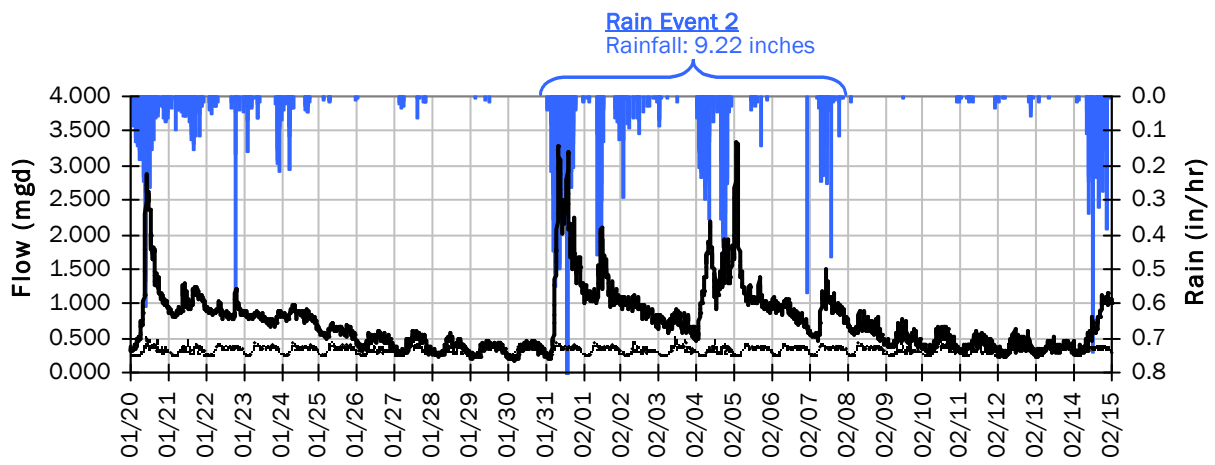


Storm Event I/I Analysis (Rain = 4.04 inches)

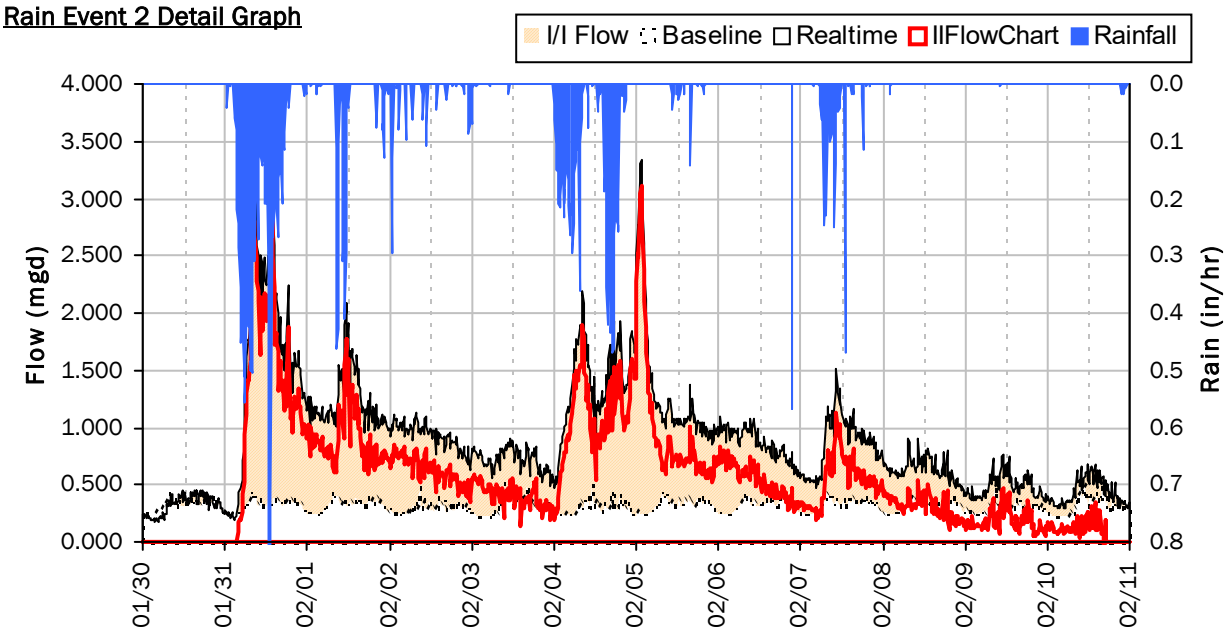
Capacity		Inflow / Infiltration	
Peak Flow:	2.867 *mgd*	**Peak I/I Rate:**	2.416 *mgd*
PF:	9.10	**Total I/I:**	3,316,000 *gallons*
Peak Level:	7.22 *in*		
d/D Ratio:	0.72		

FM-04
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

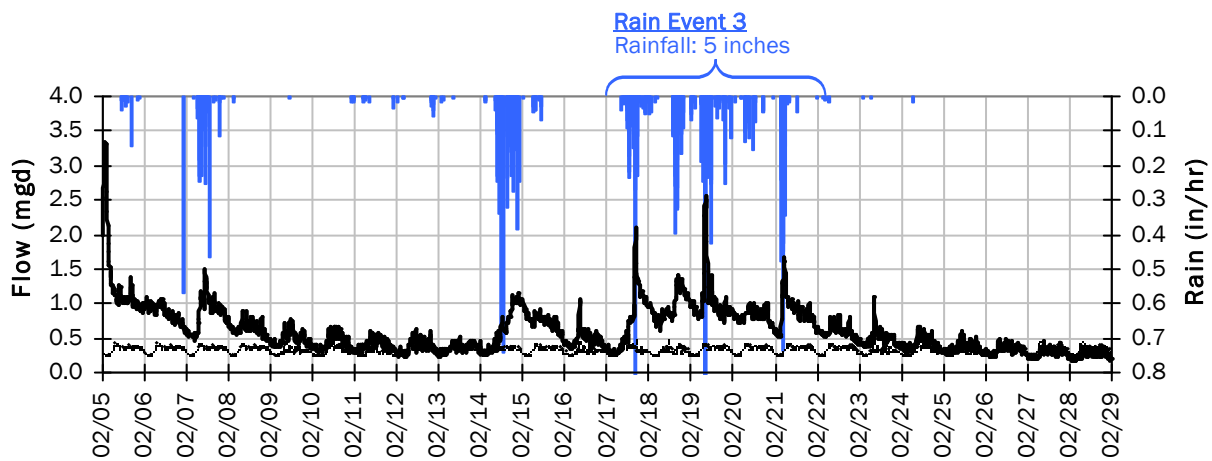


Storm Event I/I Analysis (Rain = 9.22 inches)

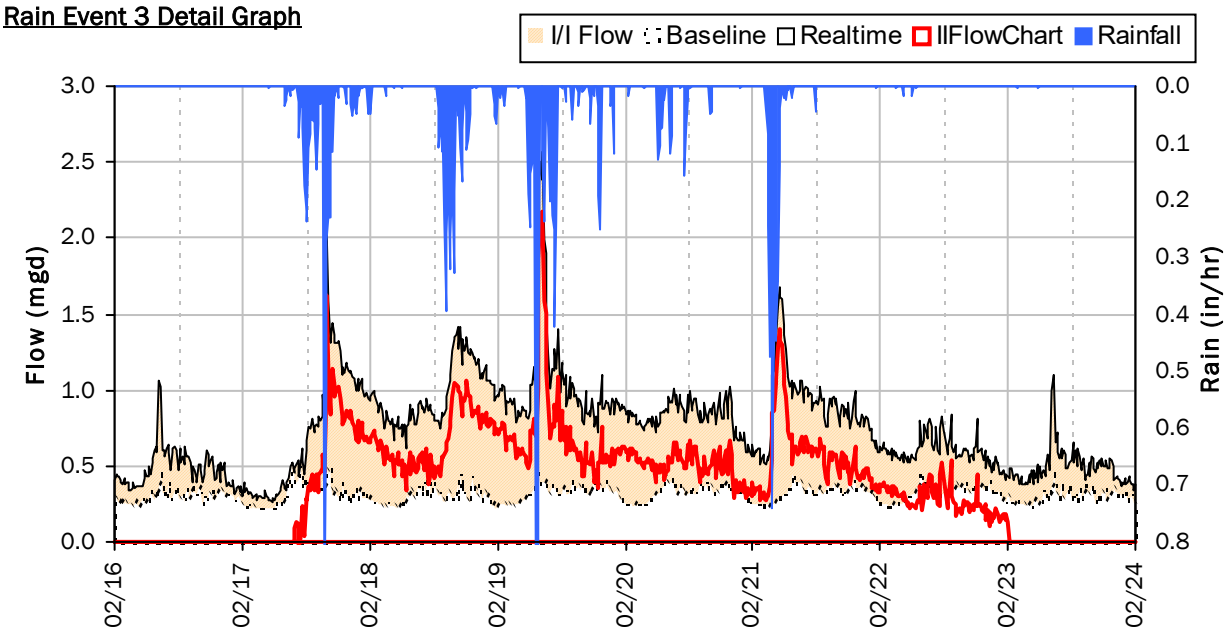
Capacity		Inflow / Infiltration	
Peak Flow:	3.343 *mgd*	**Peak I/I Rate:**	3.108 *mgd*
PF:	10.62	**Total I/I:**	6,999,000 *gallons*
Peak Level:	13.70 *in*		
d/D Ratio:	1.37		

FM-04
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

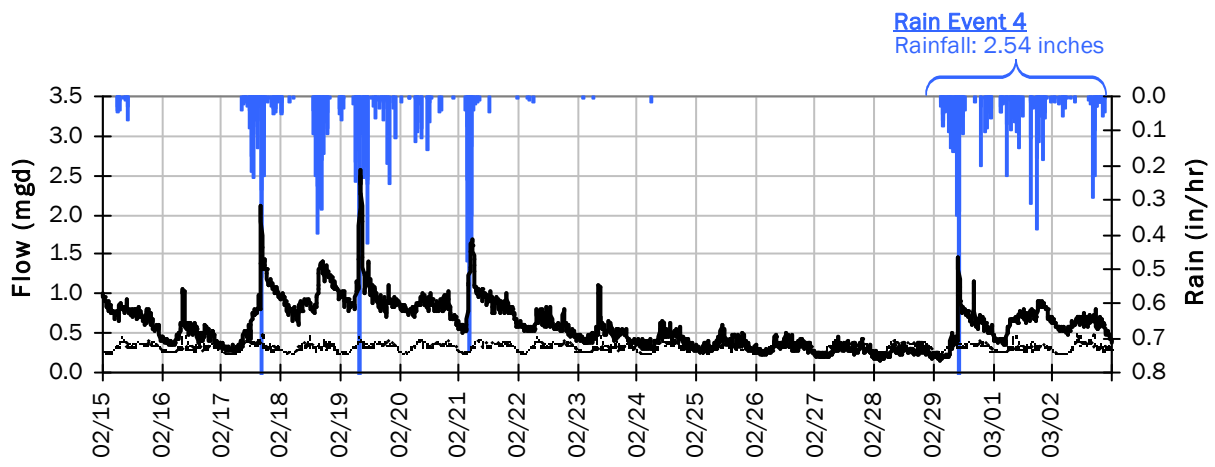


Storm Event I/I Analysis (Rain = 5.00 inches)

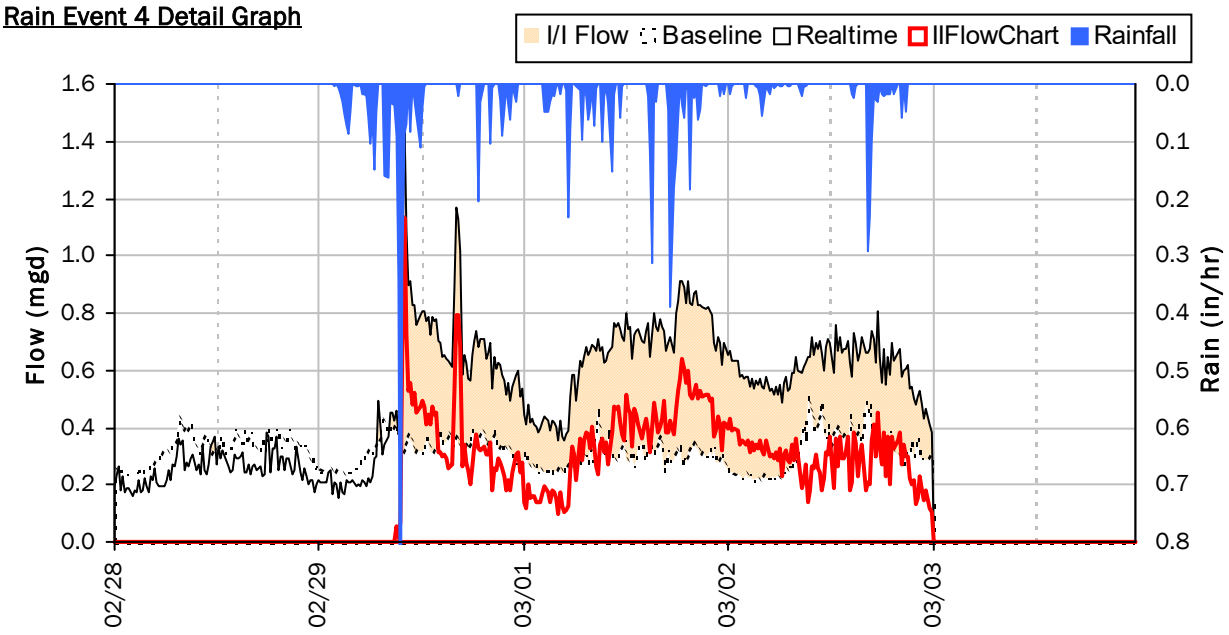
Capacity		Inflow / Infiltration	
Peak Flow:	2.57 *mgd*	**Peak I/I Rate:**	2.17 *mgd*
PF:	8.15	**Total I/I:**	3,114,000 *gallons*
Peak Level:	11.09 *in*		
d/D Ratio:	1.11		

FM-04
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



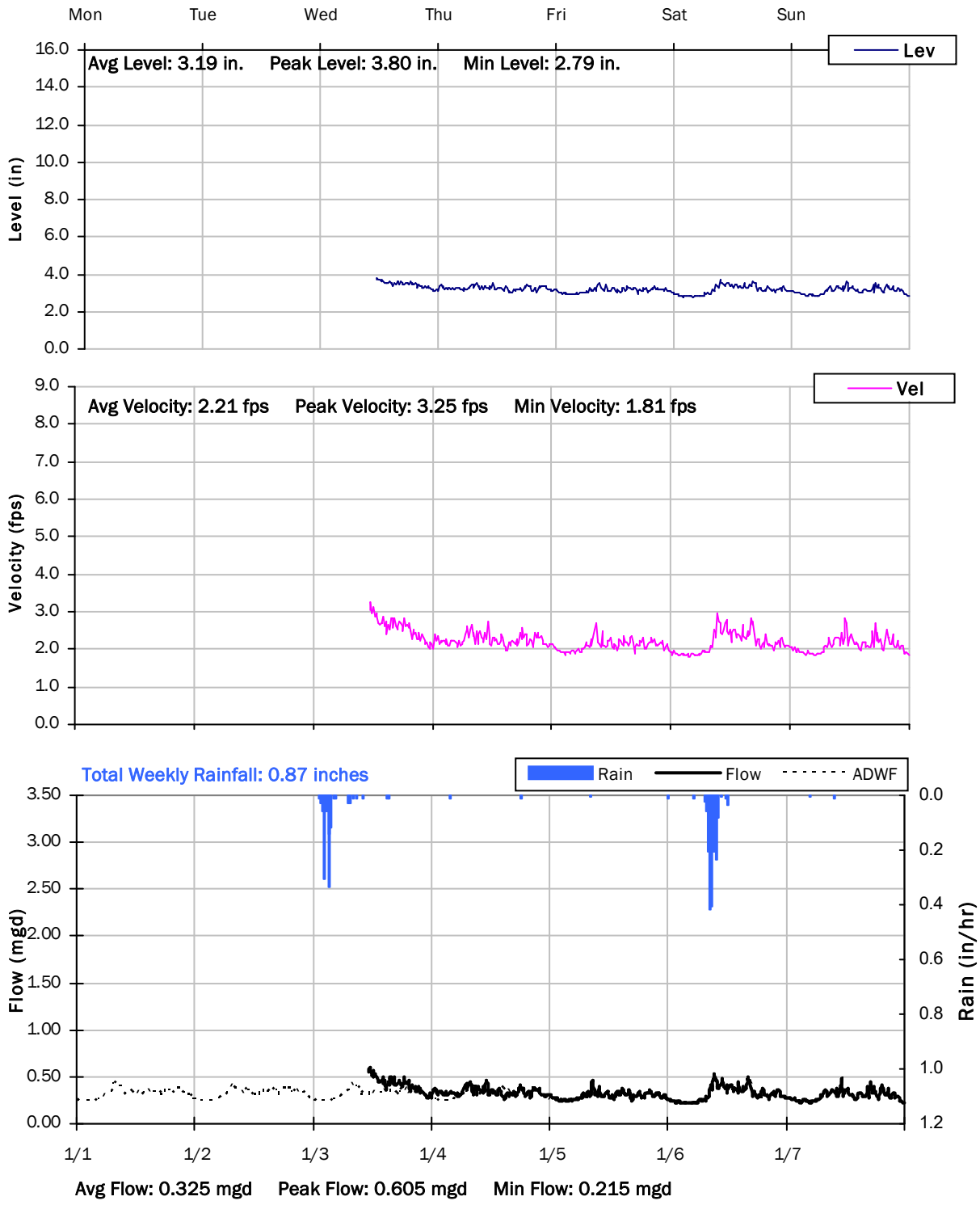
Storm Event I/I Analysis (Rain = 2.54 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	1.46 *mgd*	**Peak I/I Rate:**	1.14 *mgd*
PF:	4.63	**Total I/I:**	877,000 *gallons*
Peak Level:	5.40 *in*		
d/D Ratio:	0.54		

FM-04

Weekly Level, Velocity and Flow Hydrographs

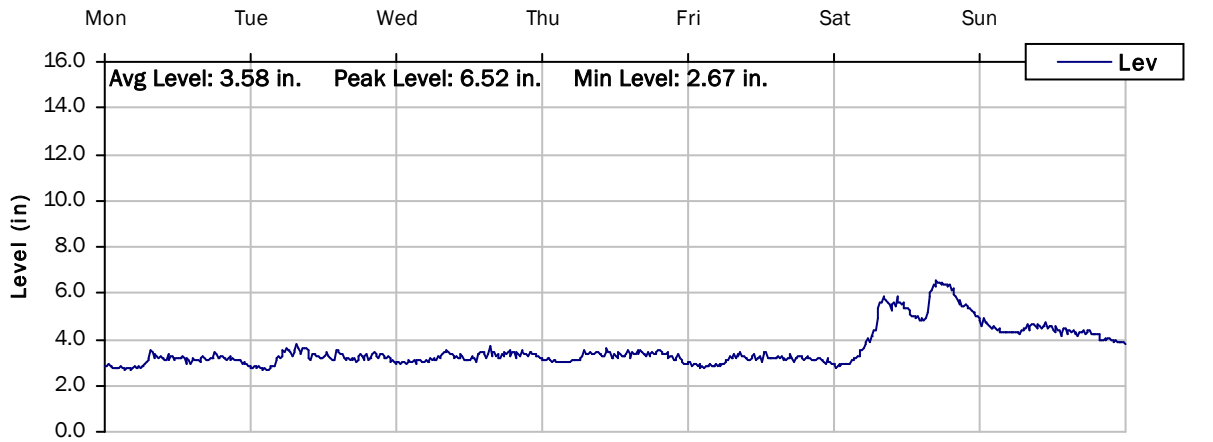
1/1/2024 to 1/8/2024

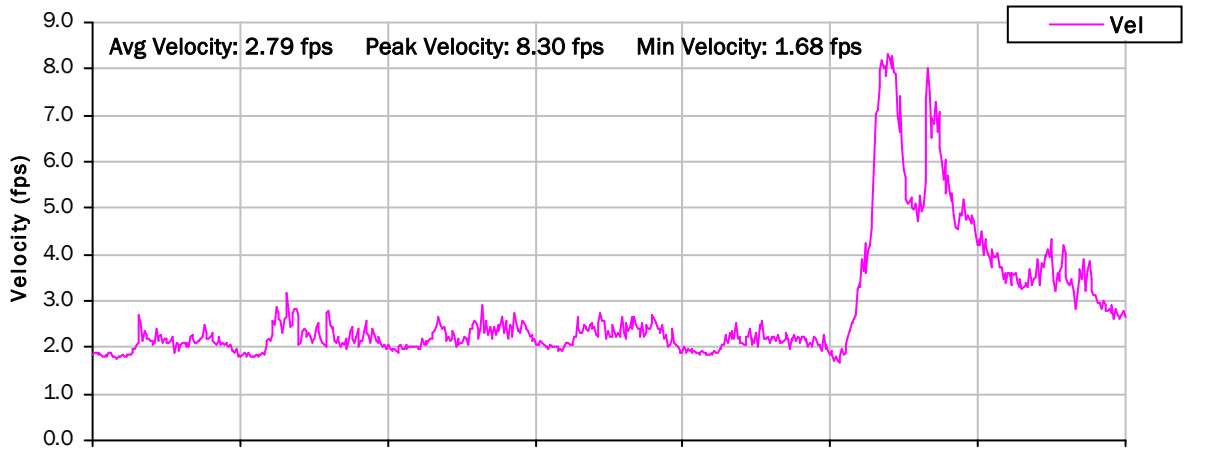


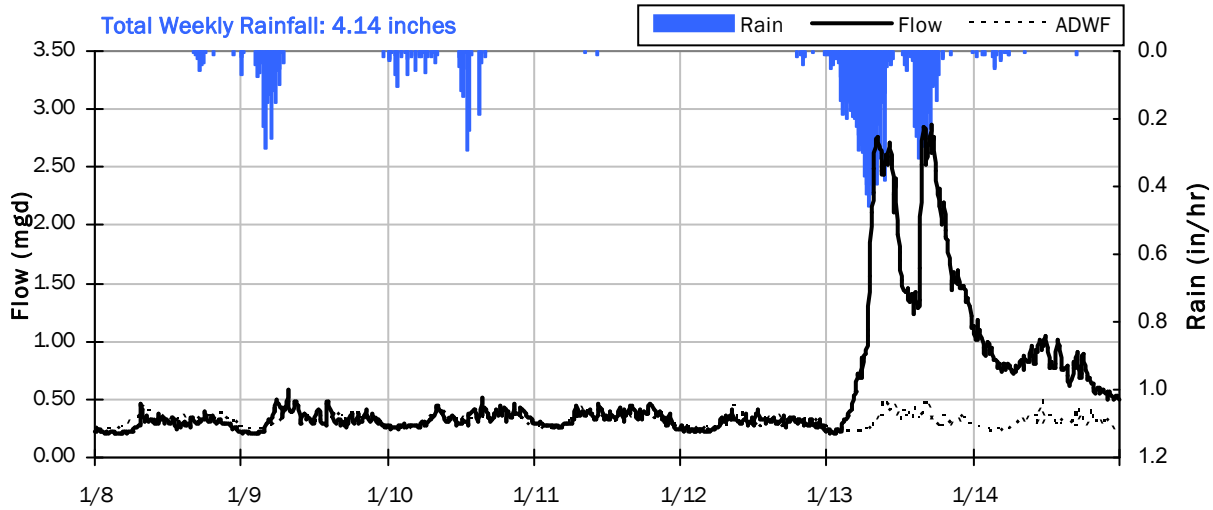
FM-04

Weekly Level, Velocity and Flow Hydrographs

1/8/2024 to 1/15/2024





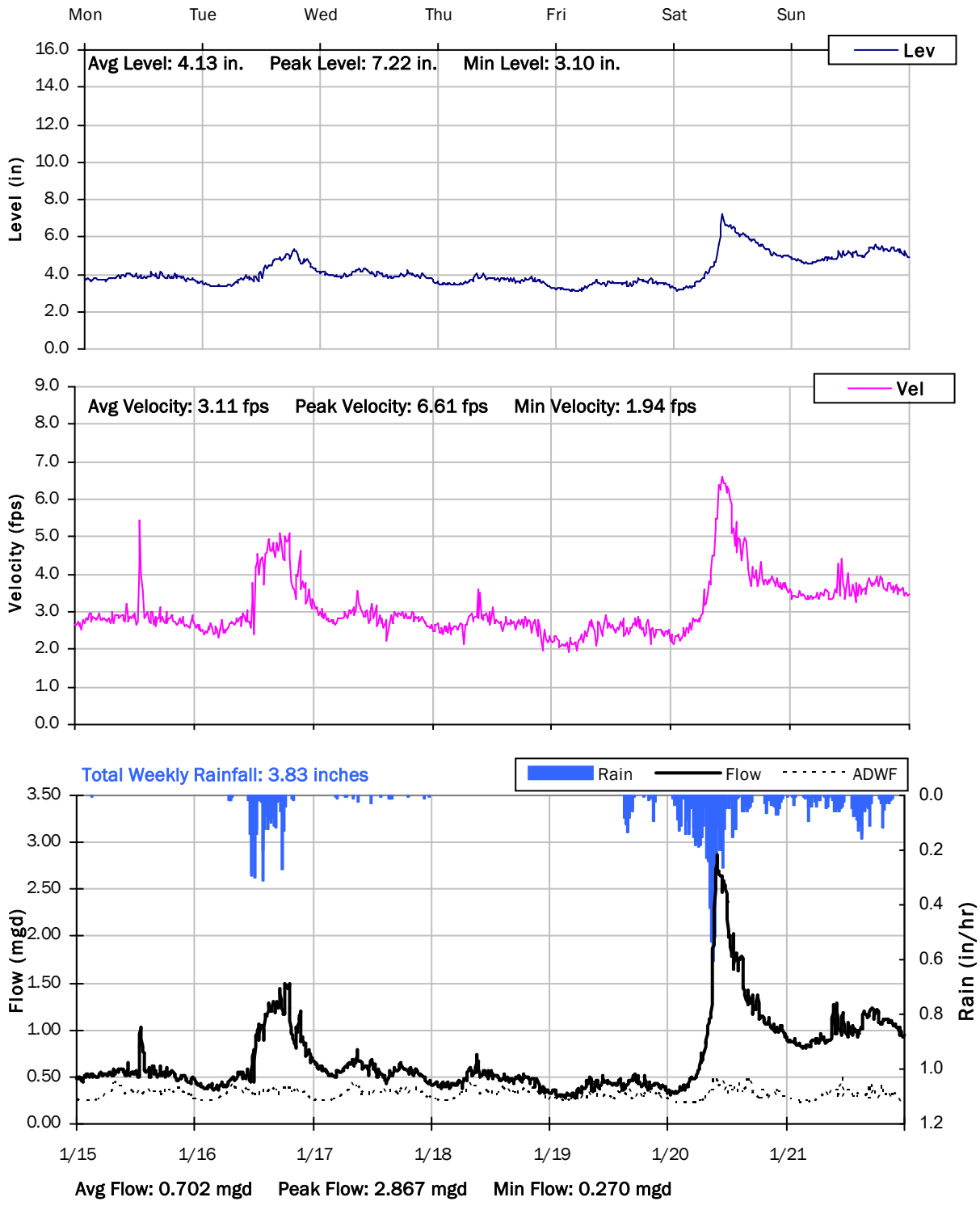


Avg Flow: 0.558 mgd Peak Flow: 2.857 mgd Min Flow: 0.202 mgd

FM-04

Weekly Level, Velocity and Flow Hydrographs

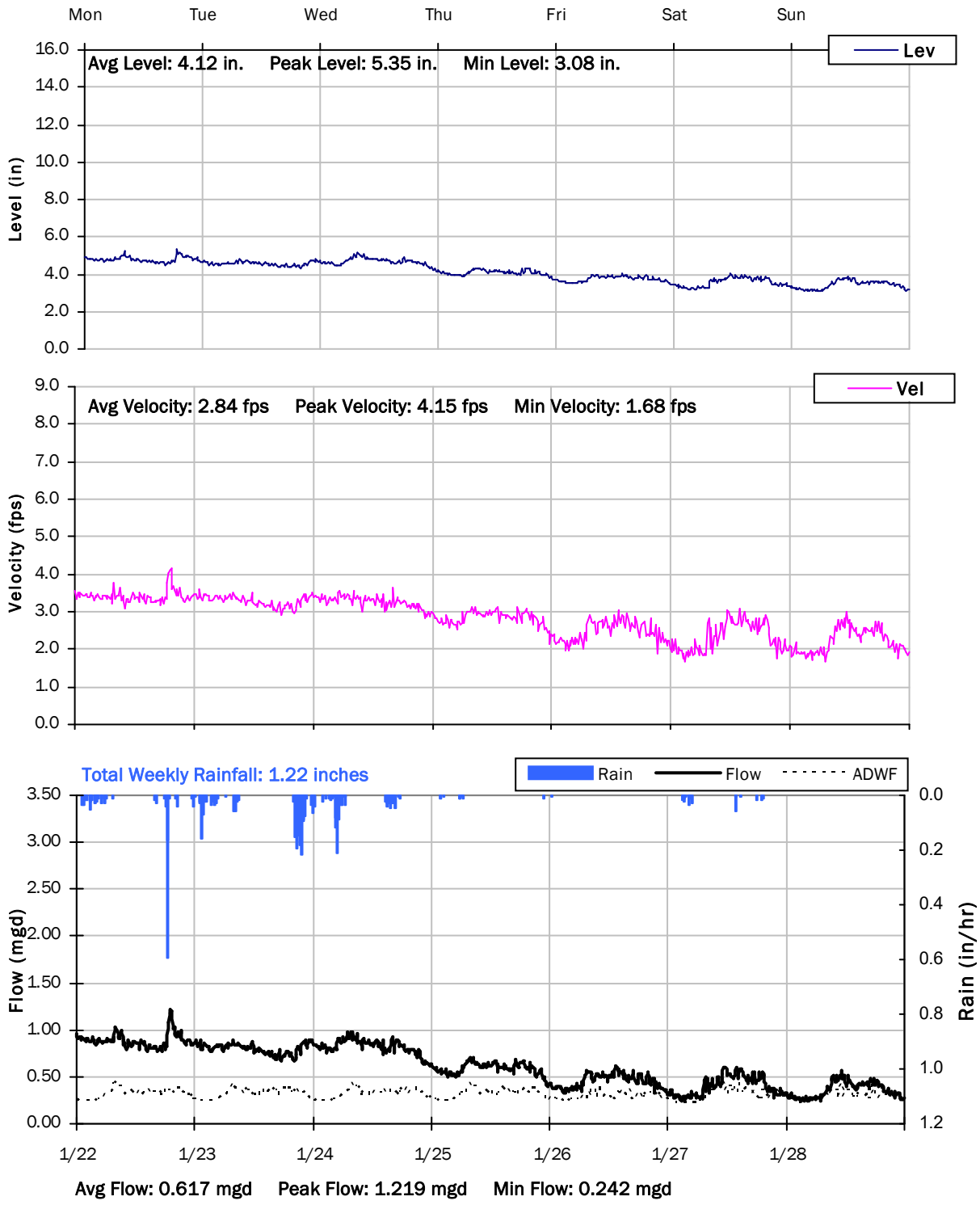
1/15/2024 to 1/22/2024



FM-04

Weekly Level, Velocity and Flow Hydrographs

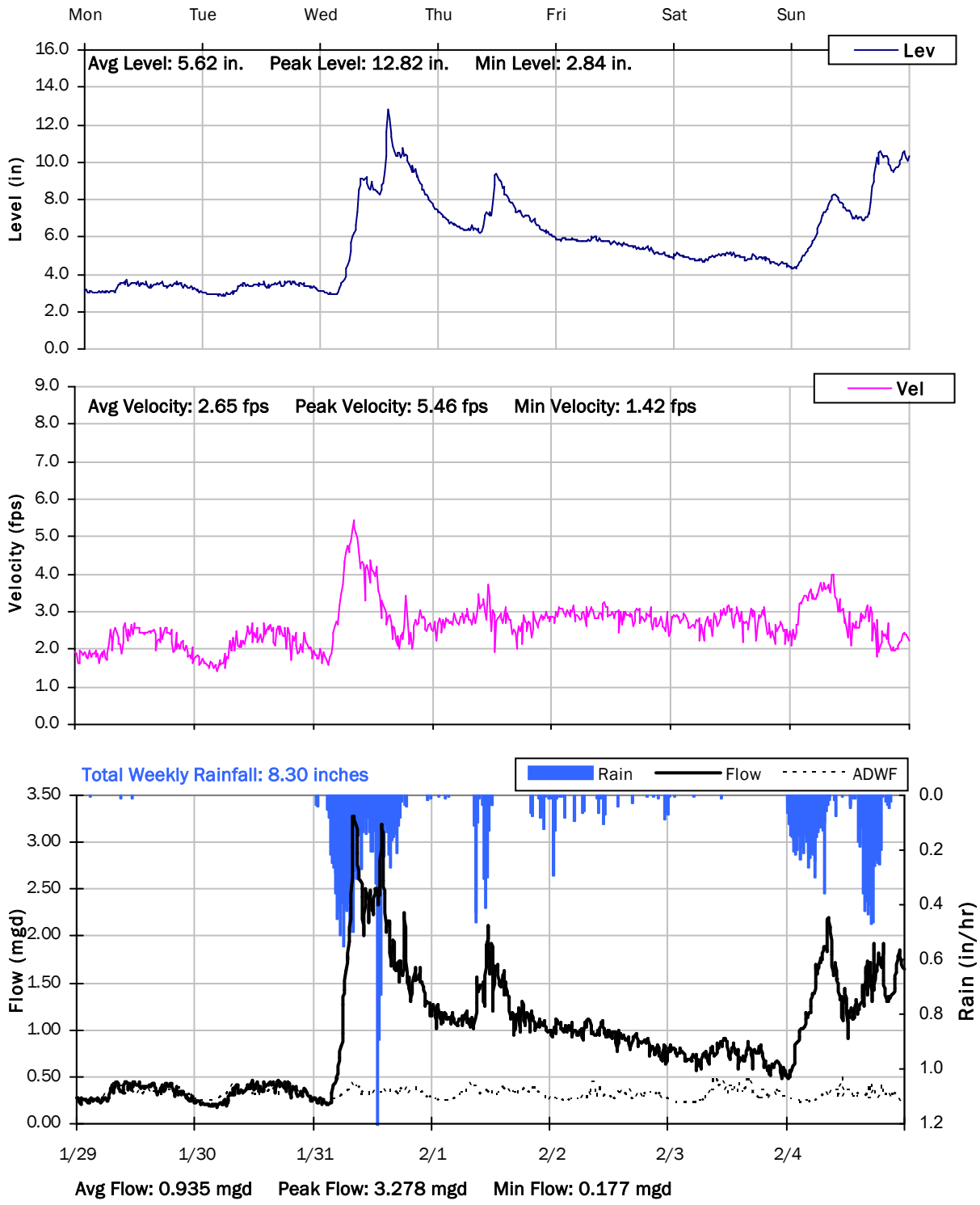
1/22/2024 to 1/29/2024



FM-04

Weekly Level, Velocity and Flow Hydrographs

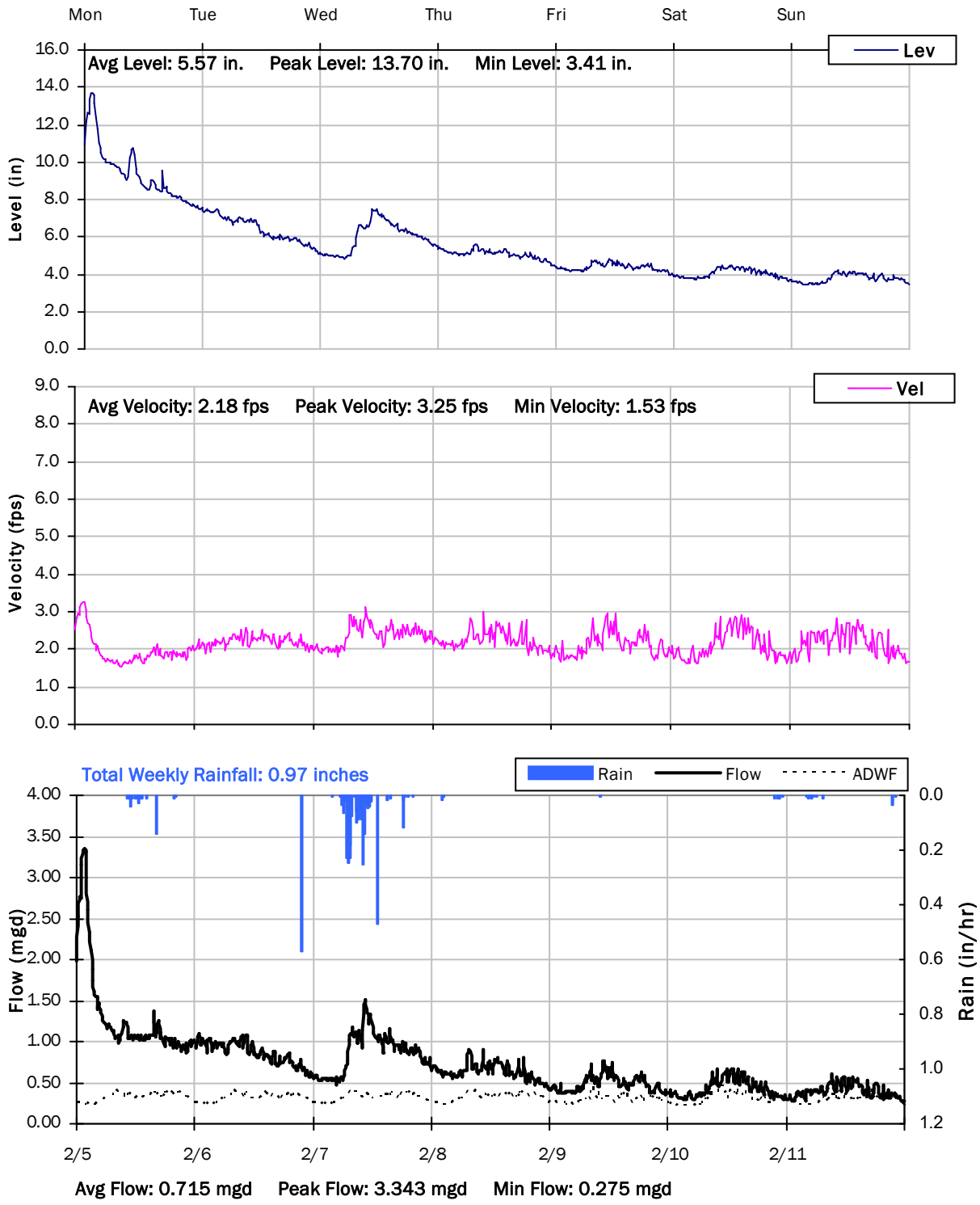
1/29/2024 to 2/5/2024



FM-04

Weekly Level, Velocity and Flow Hydrographs

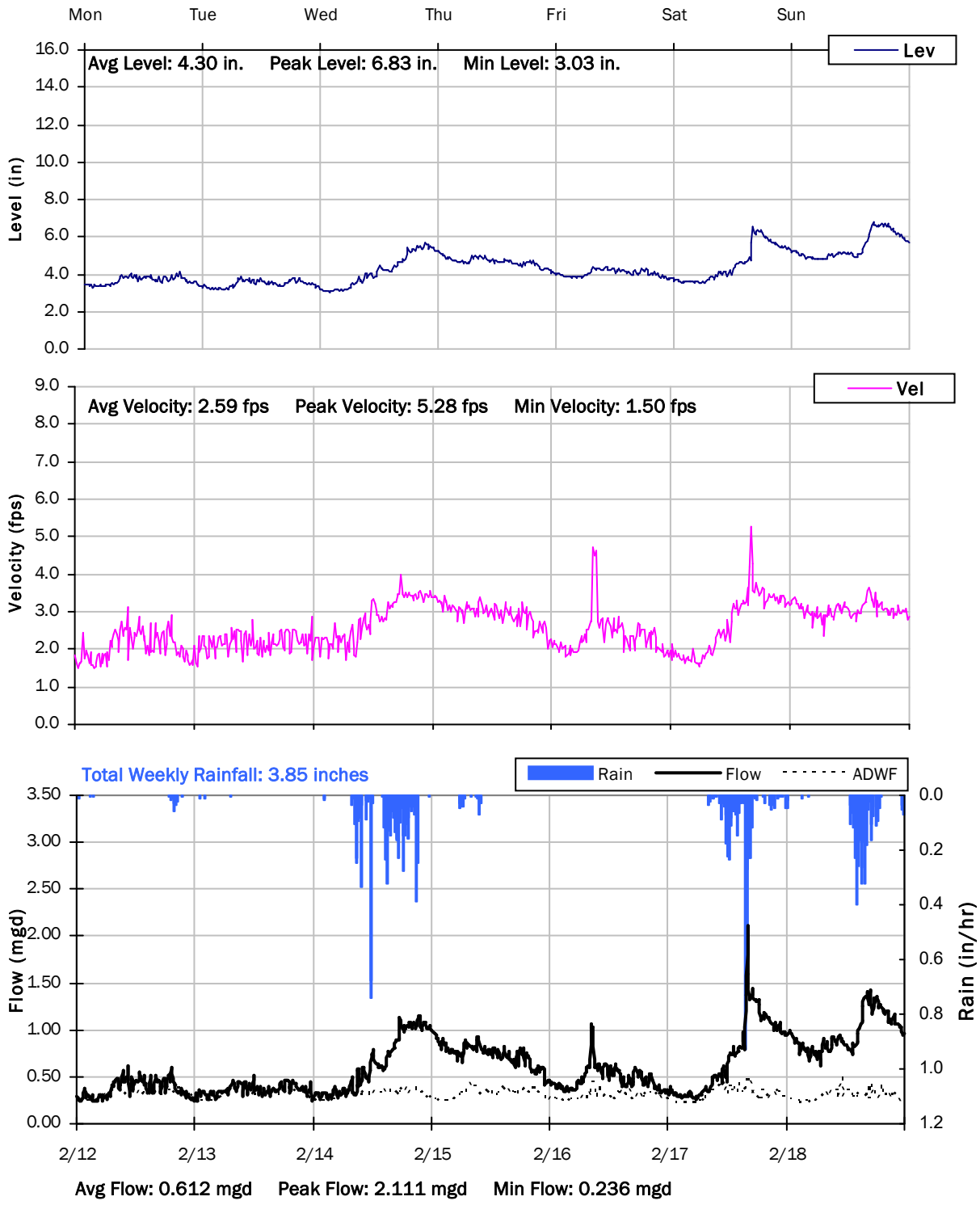
2/5/2024 to 2/12/2024



FM-04

Weekly Level, Velocity and Flow Hydrographs

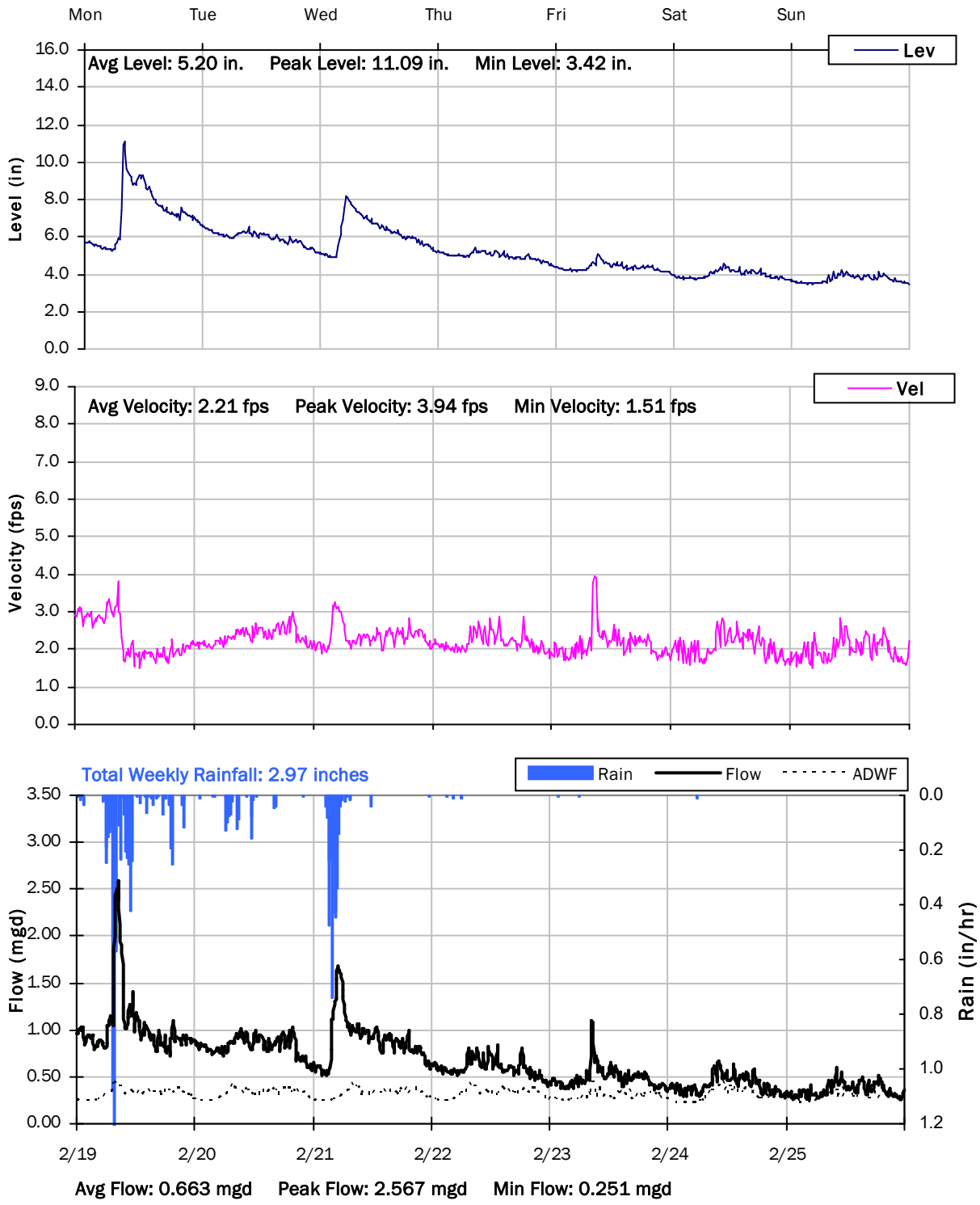
2/12/2024 to 2/19/2024



FM-04

Weekly Level, Velocity and Flow Hydrographs

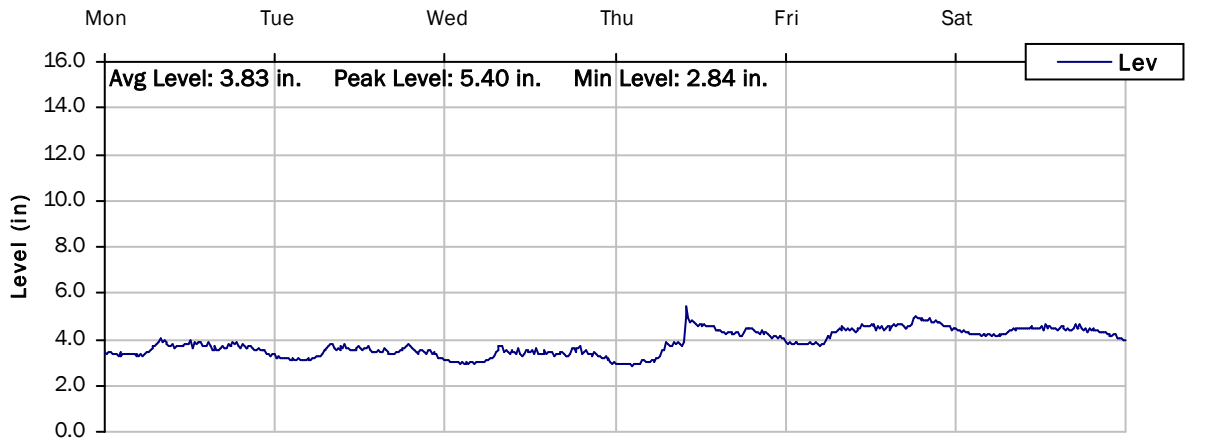
2/19/2024 to 2/26/2024

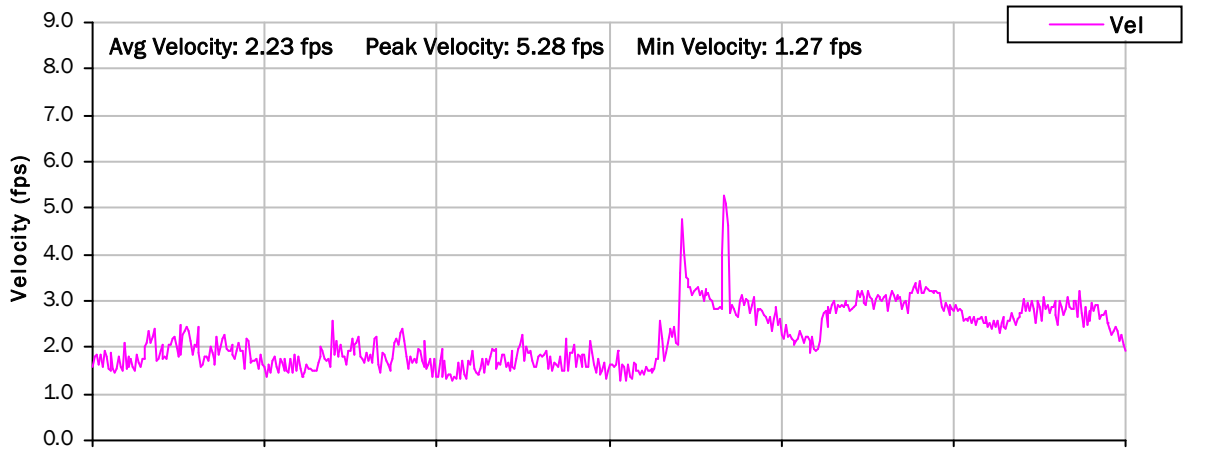


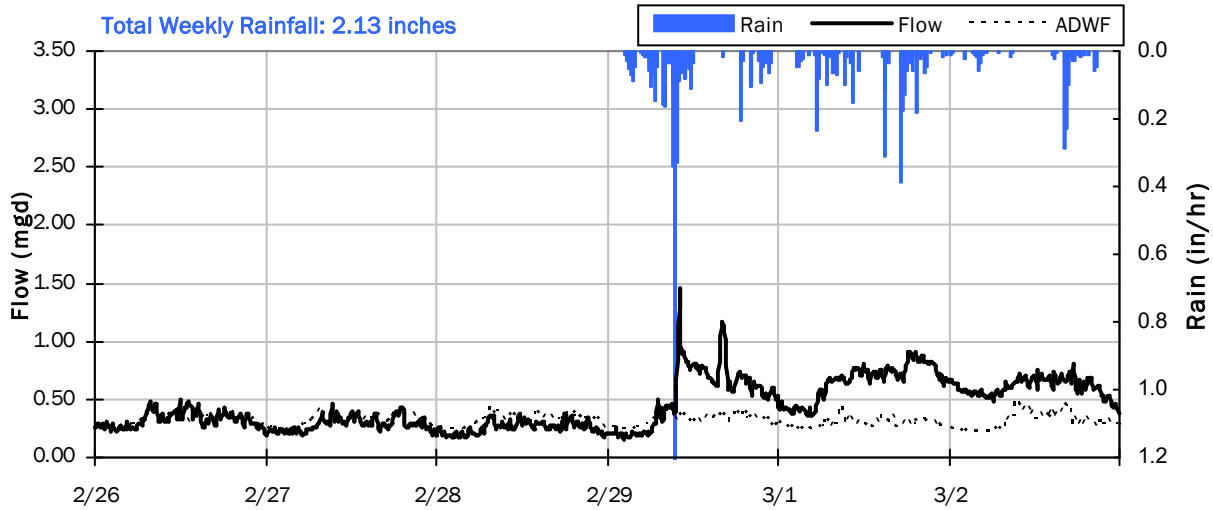
FM-04

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024







Avg Flow: 0.445 mgd Peak Flow: 1.459 mgd Min Flow: 0.156 mgd

Monitoring Site: FM-05

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: 246 Maple St

Data Summary Report

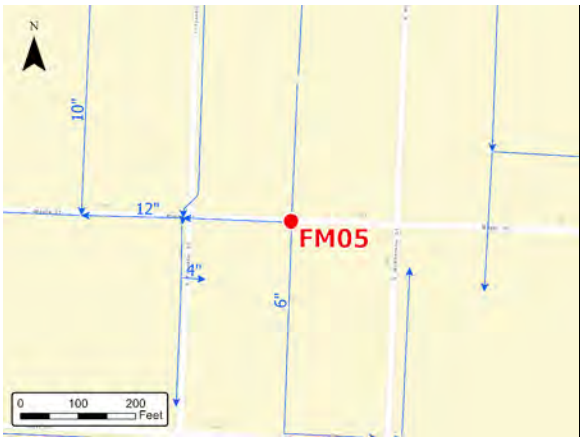
Vicinity Map: FM-05

FM-05

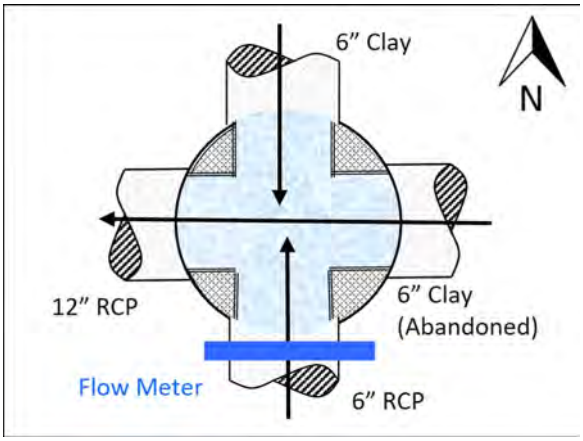
Site Information MH ID: Mnhl-Chnnl-4117

Location:	246 Maple St
Coordinates:	123.8040° W, 39.4392° N
Rim Elevation:	84 feet
Expected Pipe Diameter:	6 inches
Measured Pipe Diameter:	6 inches
ADWF:	0.032 mgd
Peak Measured Flow:	0.087 mgd
Sediment:	None

Satellite Map



Sanitary Map



Flow Sketch

Street View

Plan View

FM-05

Additional Site Photos

West Outlet Pipe

North Inlet Pipe

FM-05

Additional Site Photos

Northeast Inlet Pipe

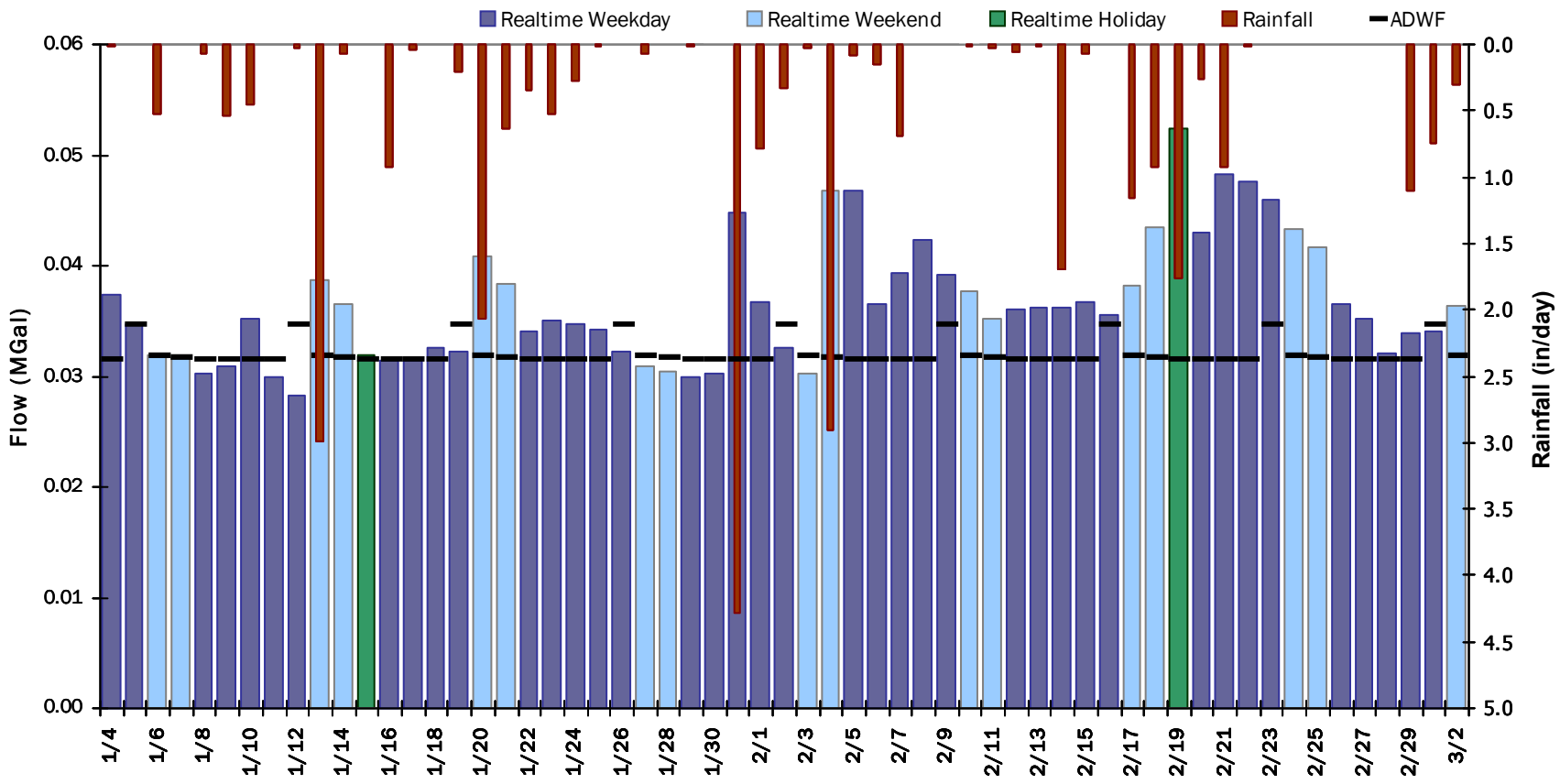
Monitored Southeast Inlet Pipe

FM-05

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.037 MGal Peak Daily Flow: 0.052 MGal Min Daily Flow: 0.028 MGal

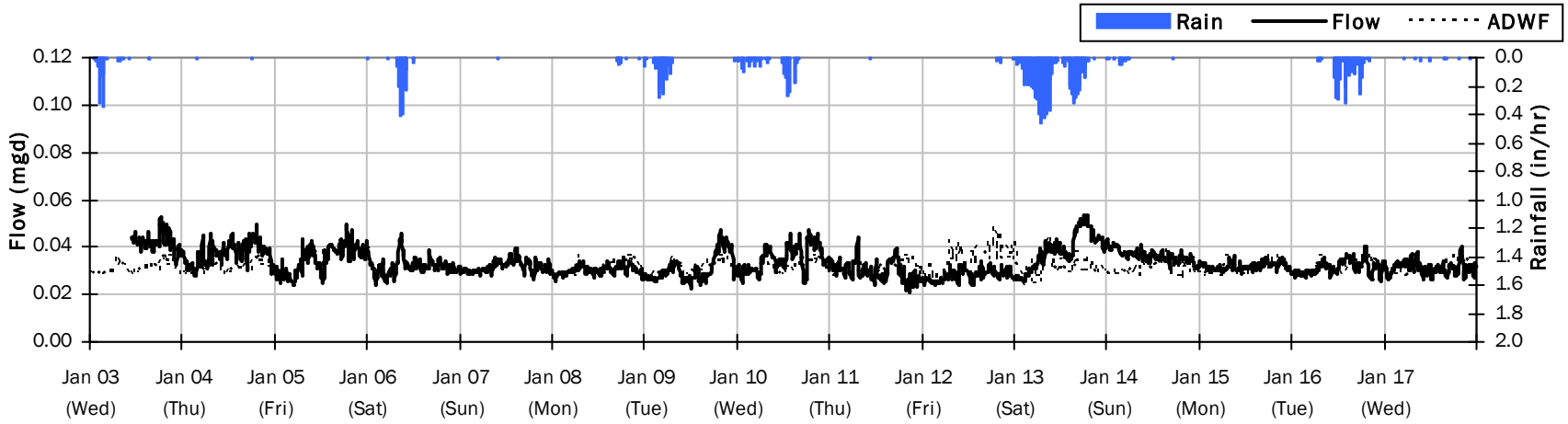
Total Rainfall: 28.13 inches

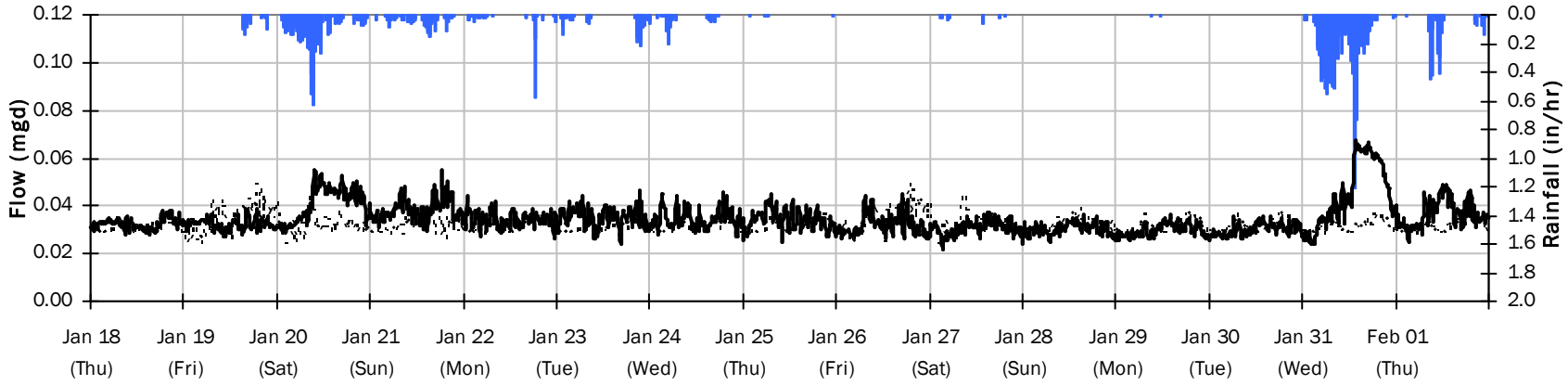


FM-05

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 15.20 inches Period Avg Flow: 0.034 mgd Period Peak Flow: 0.067 mgd Period Min Flow: 0.021 mgd

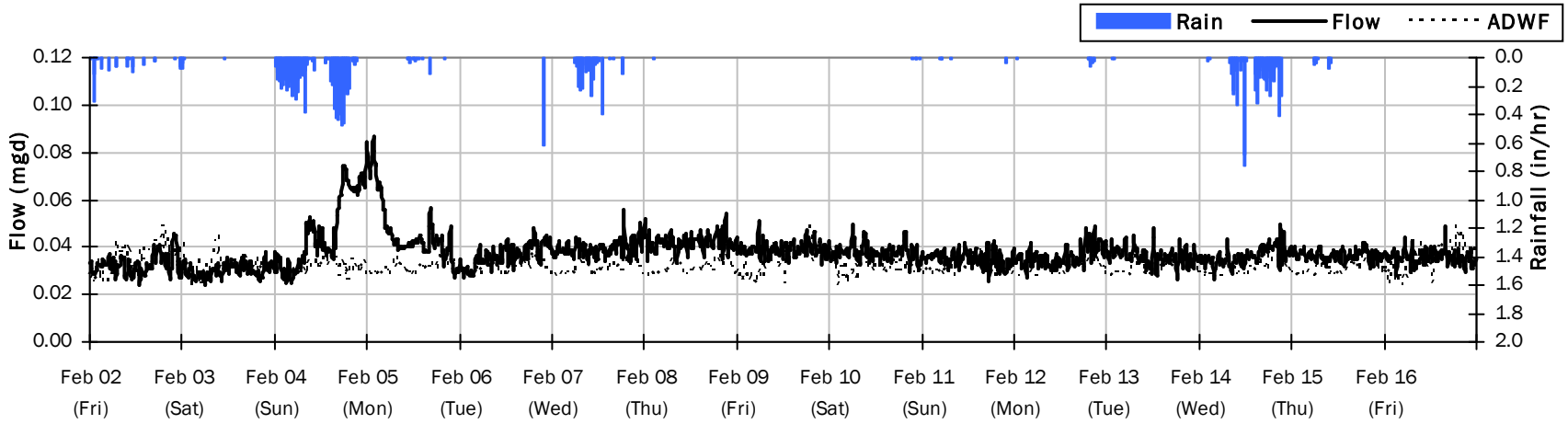


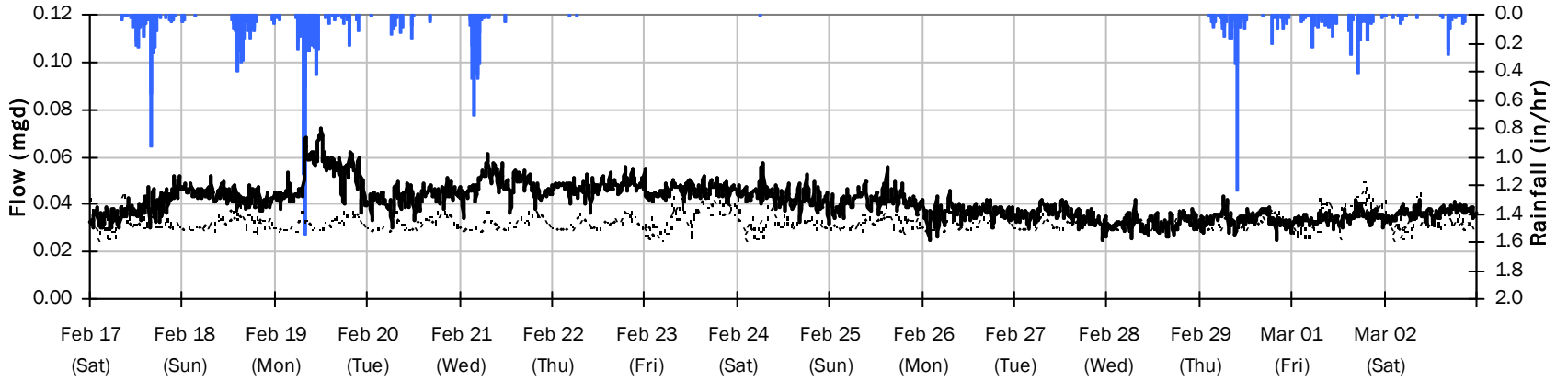


FM-05

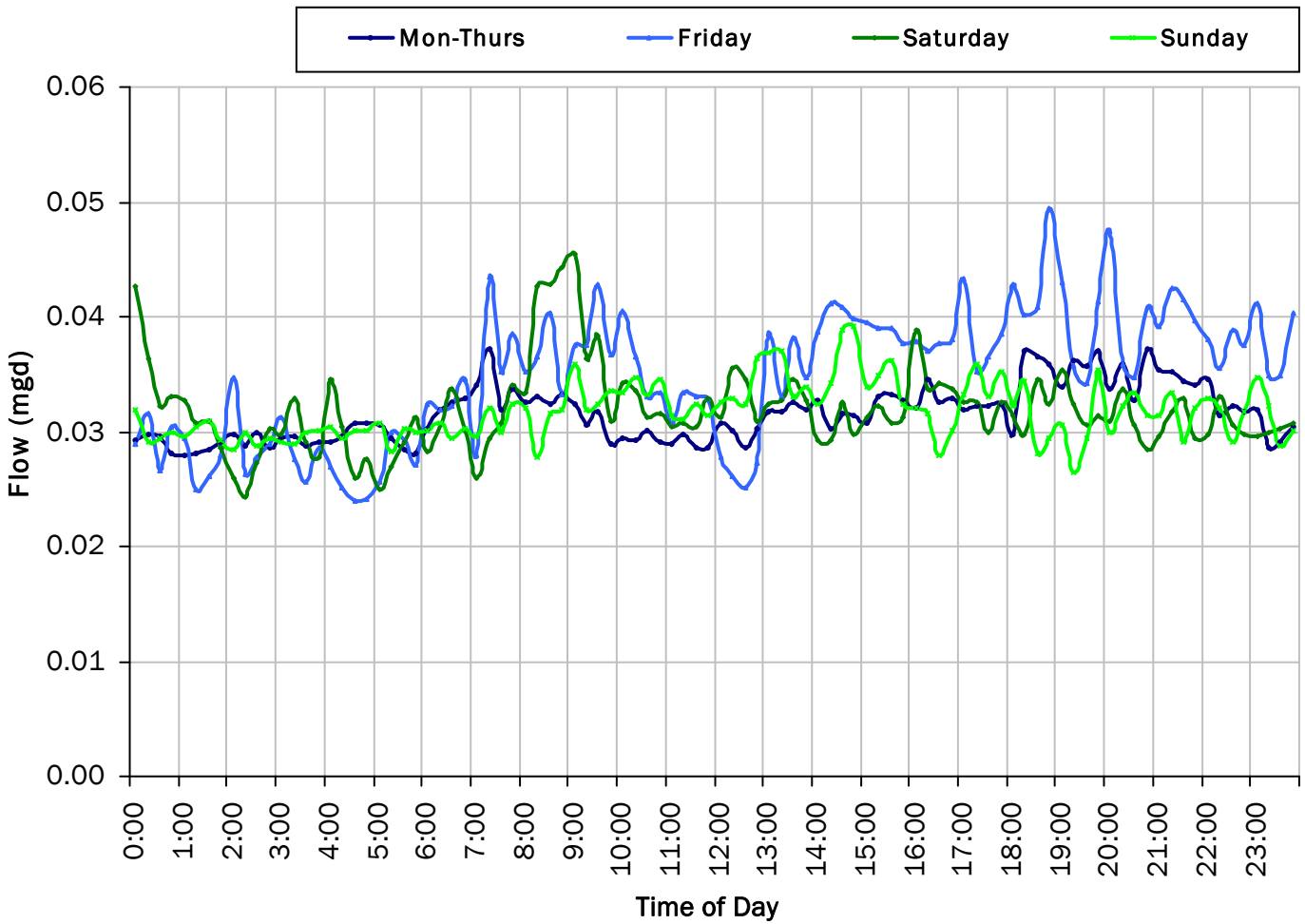
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 13.26 inches Period Avg Flow: 0.039 mgd Period Peak Flow: 0.087 mgd Period Min Flow: 0.024 mgd



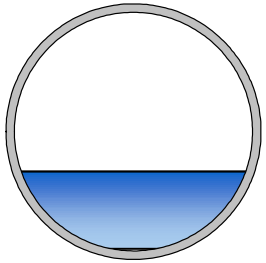


FM-05
Average Dry Weather Flow Hydrographs



ADWF:

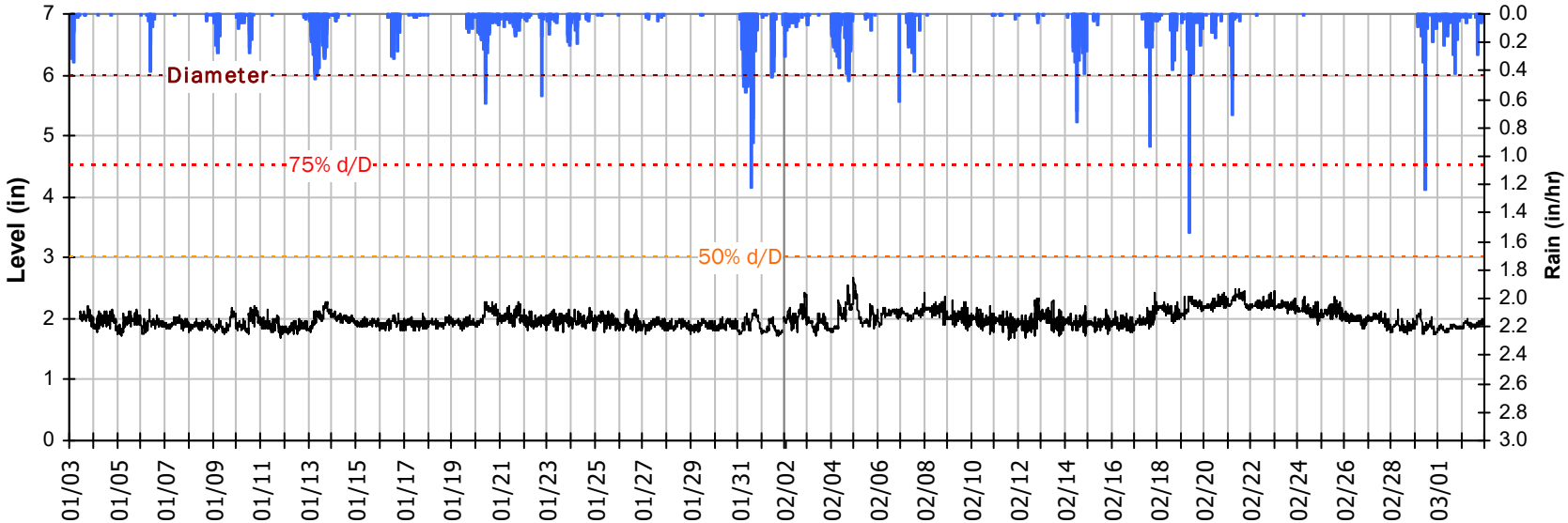
0.032 *mgd*

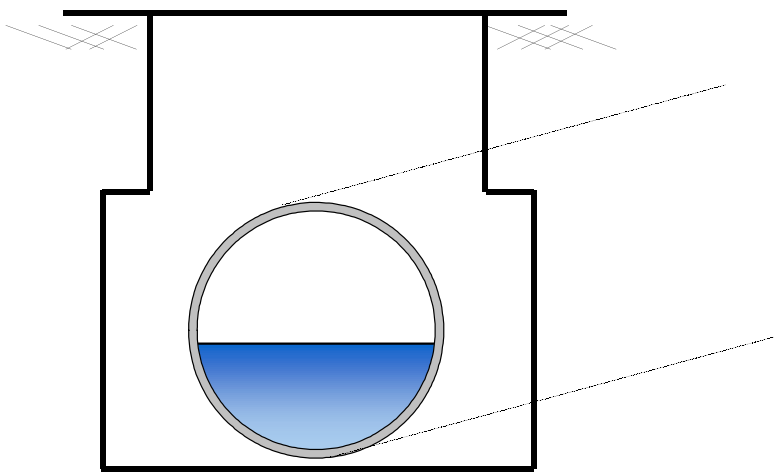


FM-05

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period

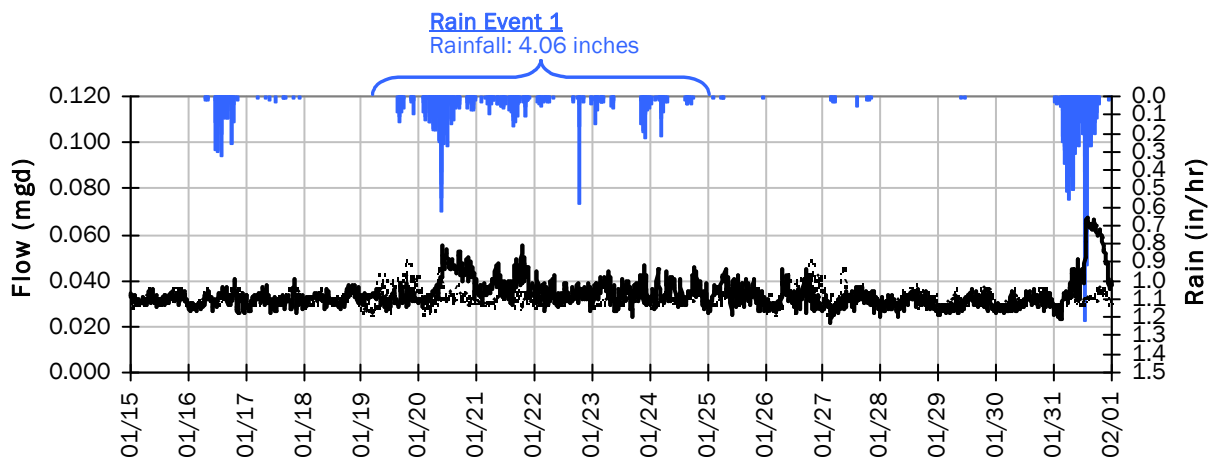




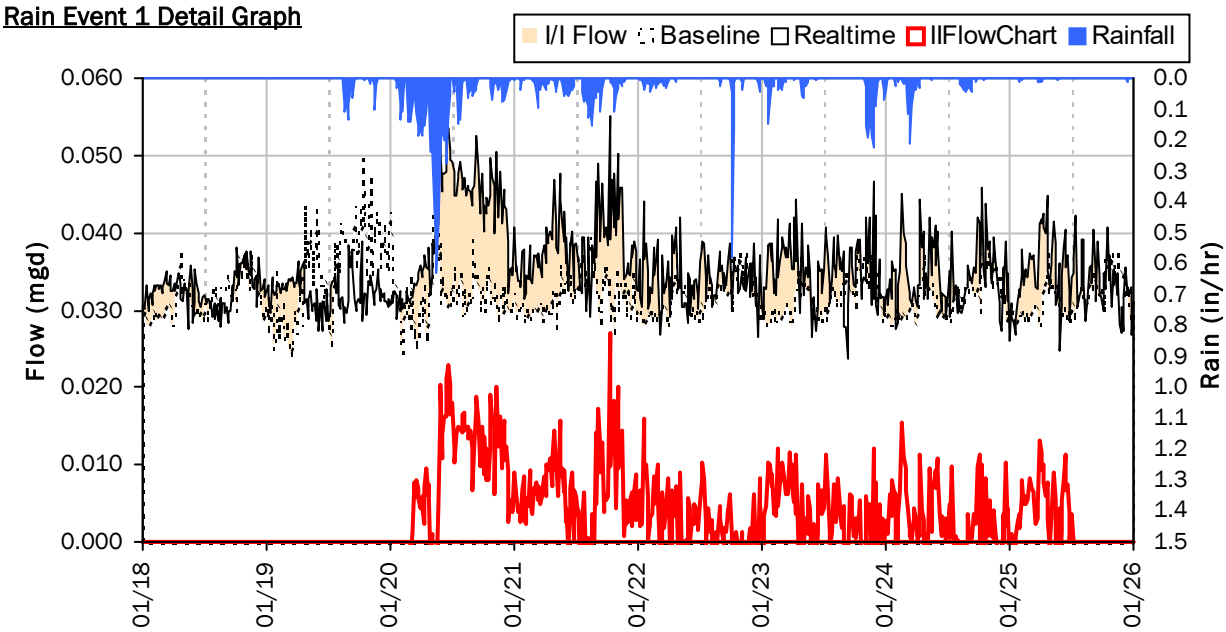
Pipe Diameter:	6	*inches*
Peak Measured Level:	2.68	*inches*
Peak d/D Ratio:	0.45	

FM-05
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

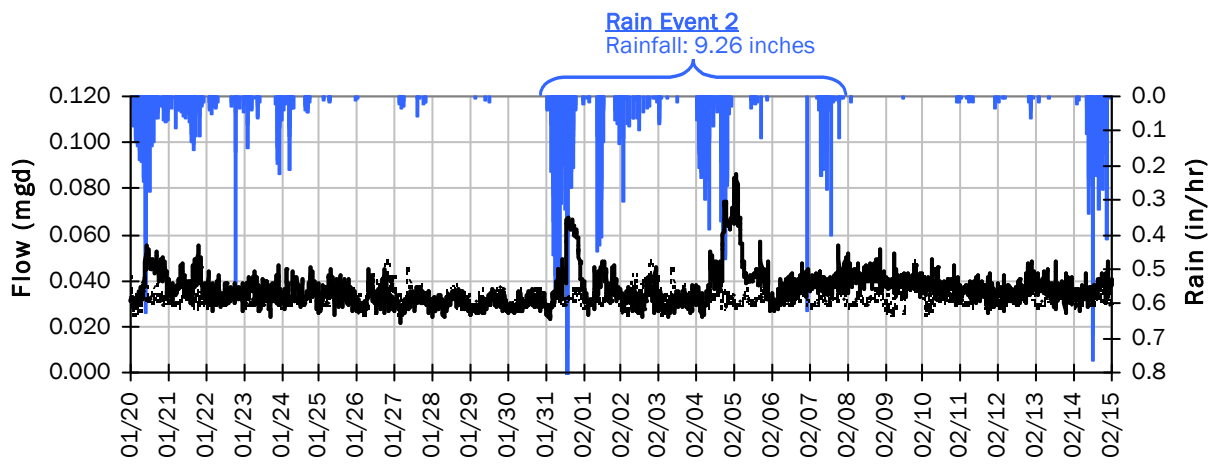


Storm Event I/I Analysis (Rain = 4.06 inches)

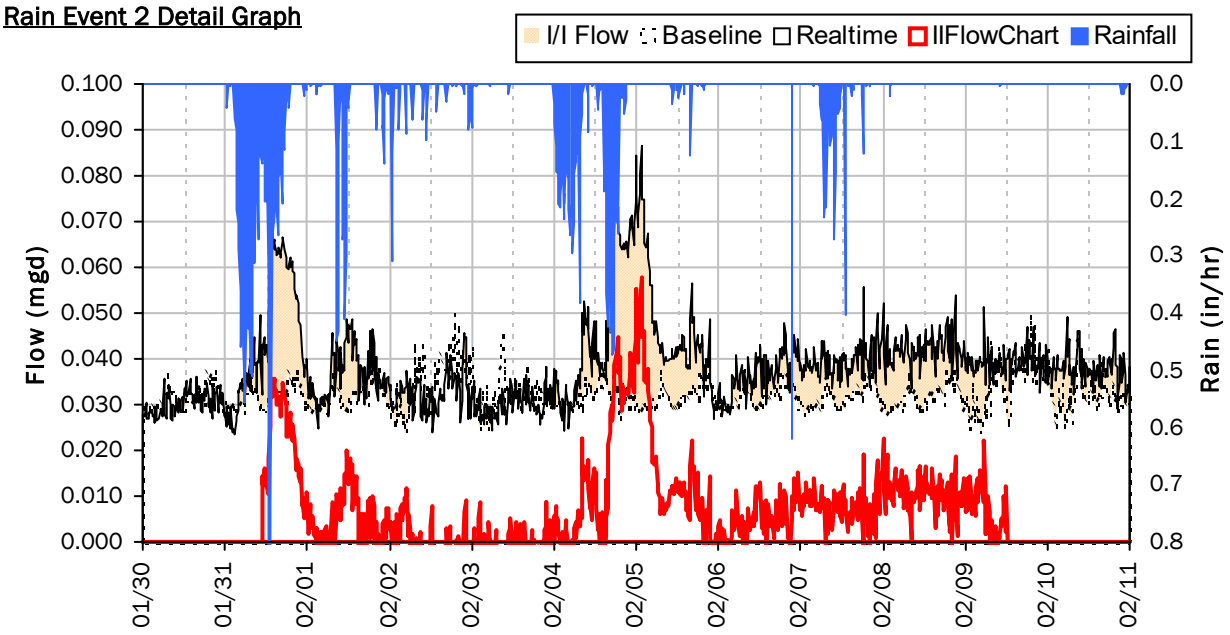
Capacity		Inflow / Infiltration	
Peak Flow:	0.055 *mgd*	**Peak I/I Rate:**	0.027 *mgd*
PF:	1.72	**Total I/I:**	27,000 *gallons*
Peak Level:	2.29 *in*		
d/D Ratio:	0.38		

FM-05
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

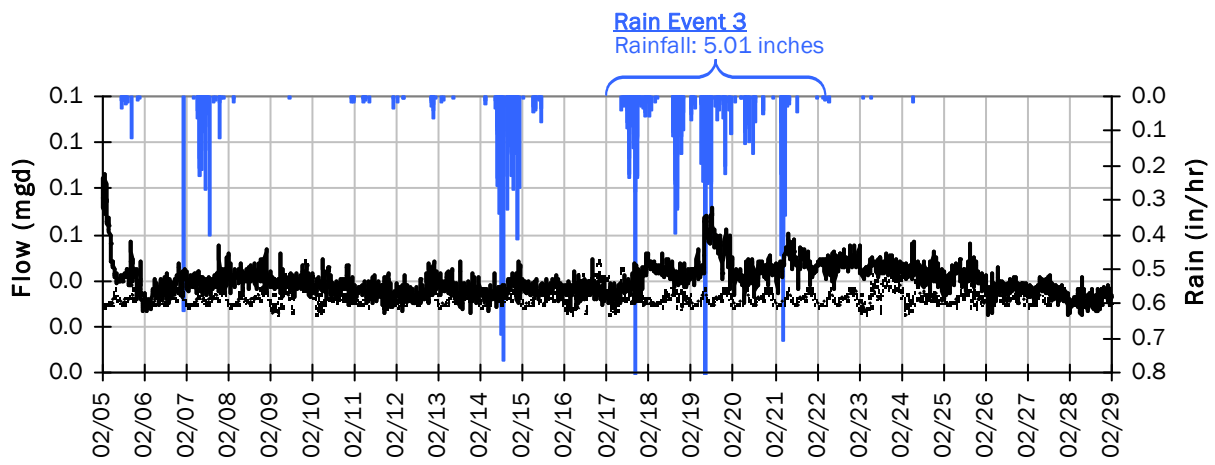


Storm Event I/I Analysis (Rain = 9.26 inches)

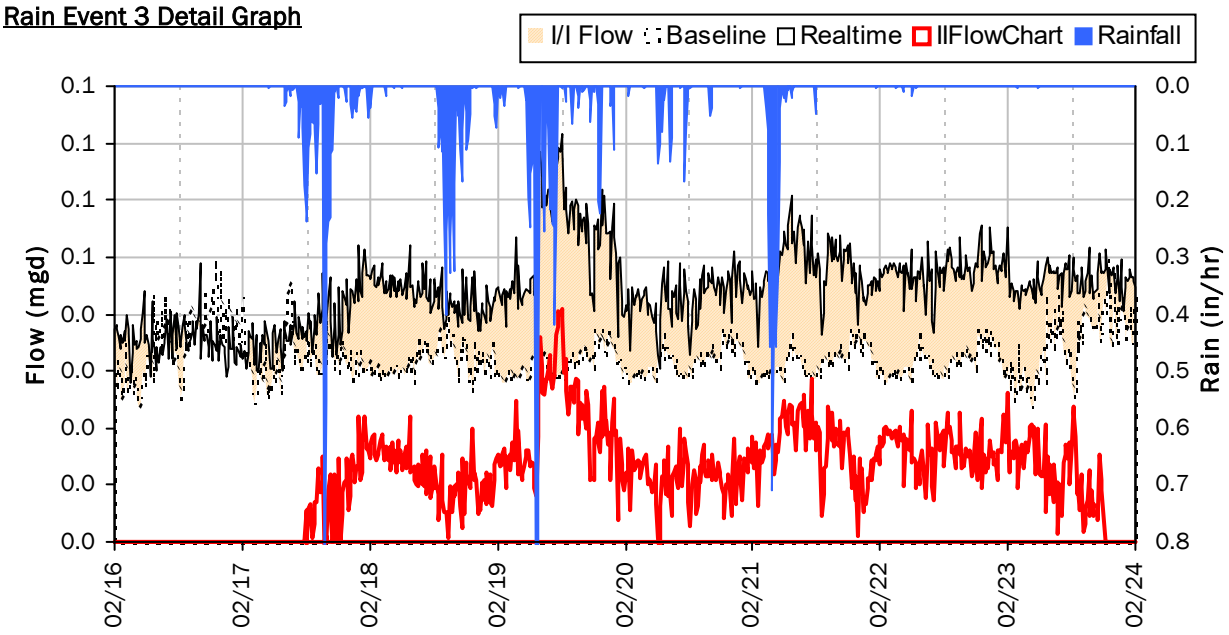
Capacity		Inflow / Infiltration	
Peak Flow:	0.087 *mgd*	**Peak I/I Rate:**	0.058 *mgd*
PF:	2.70	**Total I/I:**	71,000 *gallons*
Peak Level:	2.68 *in*		
d/D Ratio:	0.45		

FM-05
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

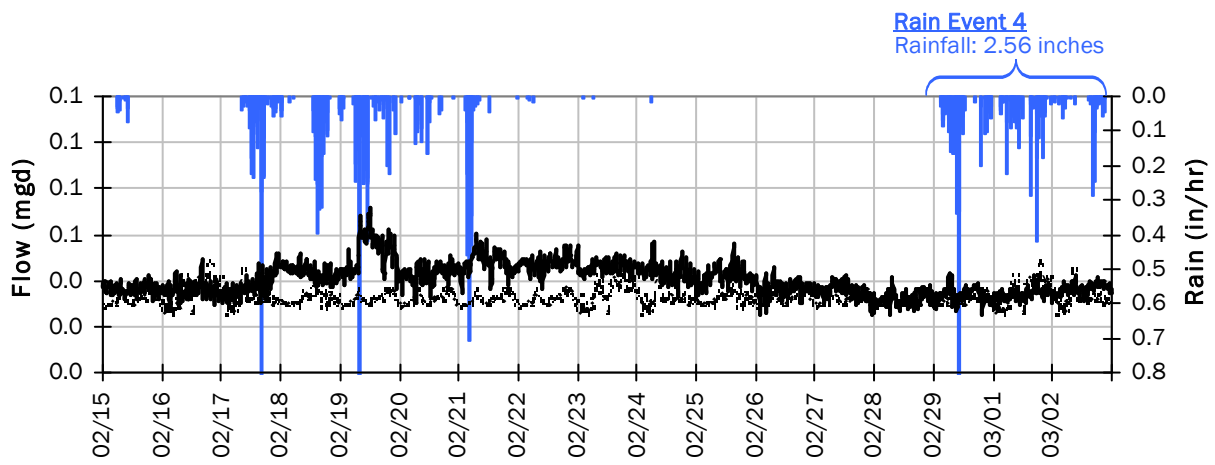


Storm Event I/I Analysis (Rain = 5.01 inches)

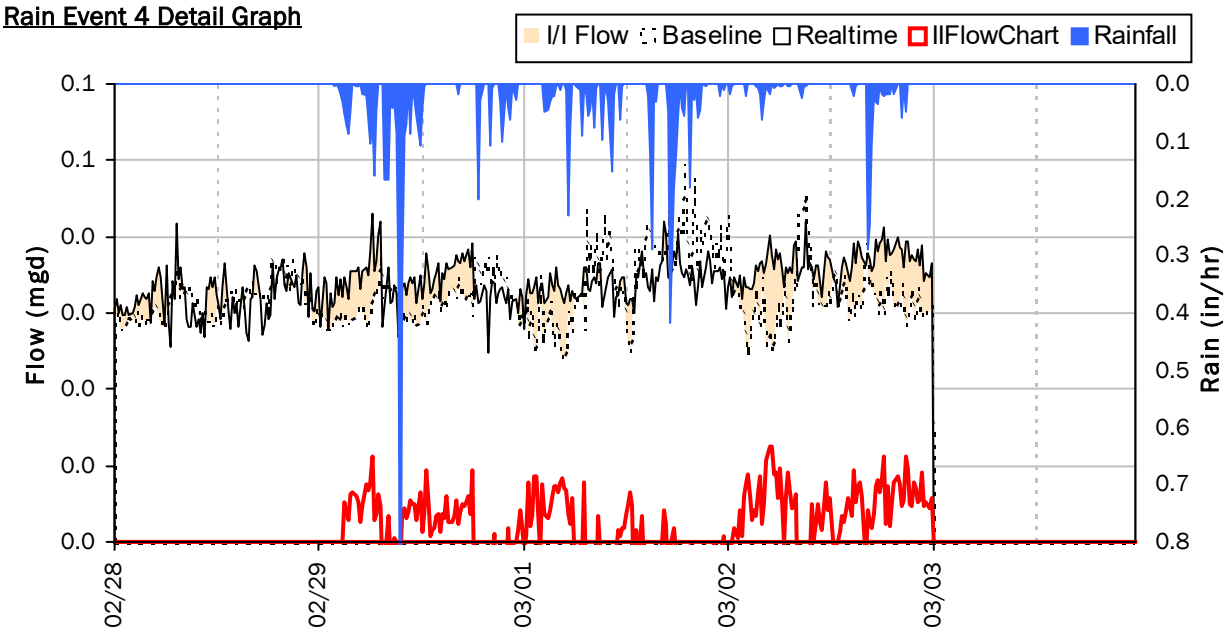
Capacity		Inflow / Infiltration	
Peak Flow:	0.07 *mgd*	**Peak I/I Rate:**	0.04 *mgd*
PF:	2.23	**Total I/I:**	91,000 *gallons*
Peak Level:	2.49 *in*		
d/D Ratio:	0.42		

FM-05
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



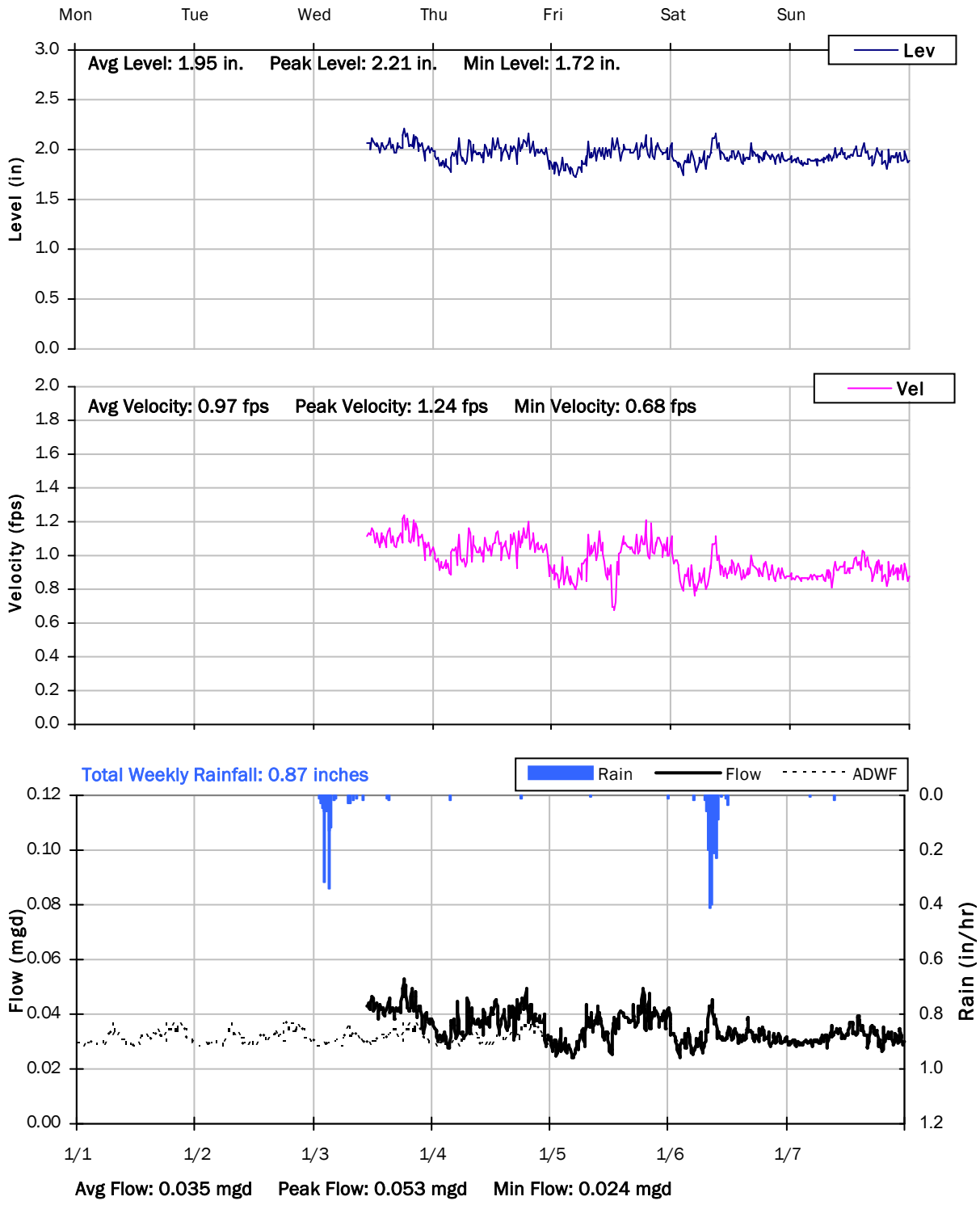
Storm Event I/I Analysis (Rain = 2.56 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.04 *mgd*	**Peak I/I Rate:**	0.01 *mgd*
PF:	1.34	**Total I/I:**	6,000 *gallons*
Peak Level:	2.14 *in*		
d/D Ratio:	0.36		

FM-05

Weekly Level, Velocity and Flow Hydrographs

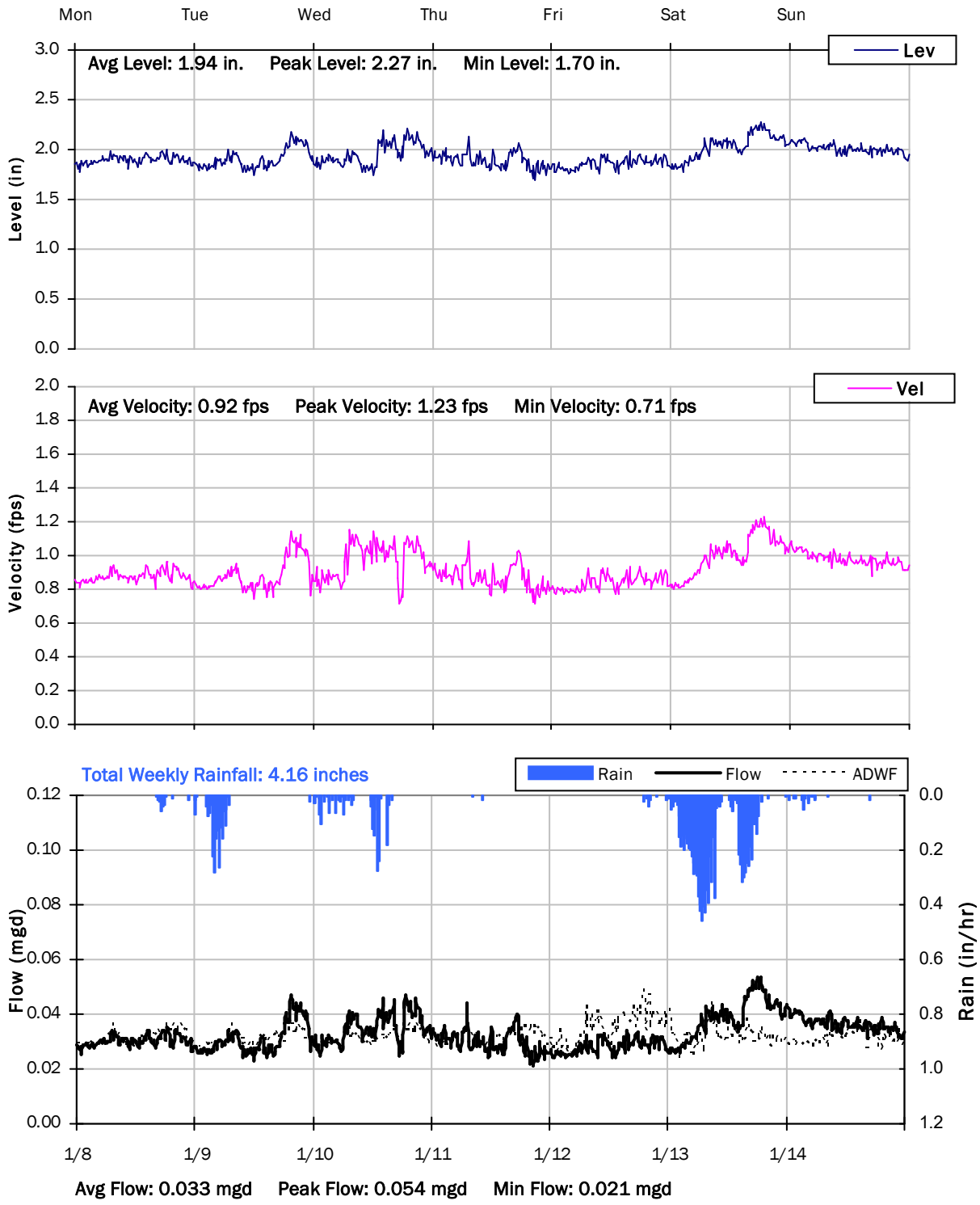
1/1/2024 to 1/8/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

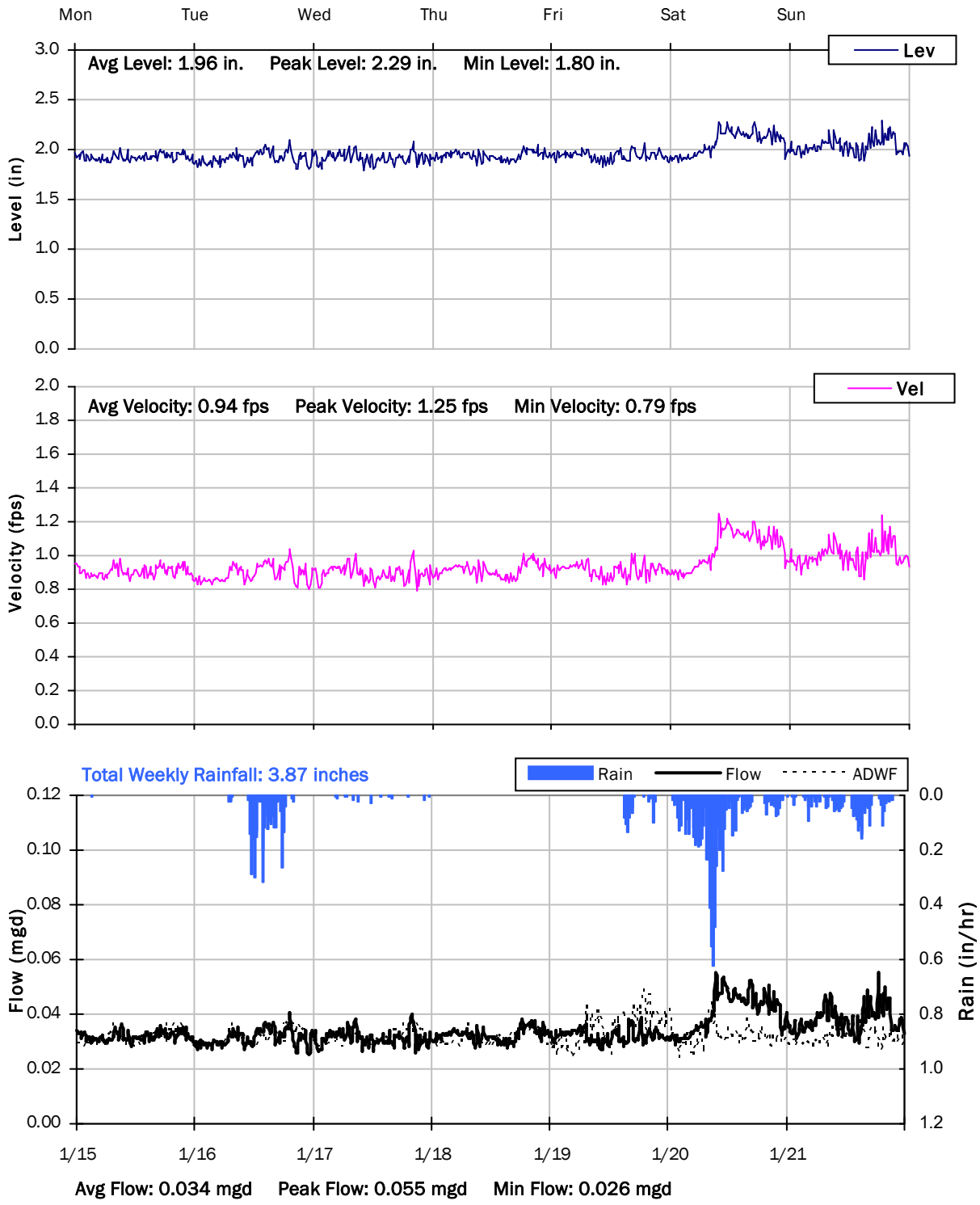
1/8/2024 to 1/15/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

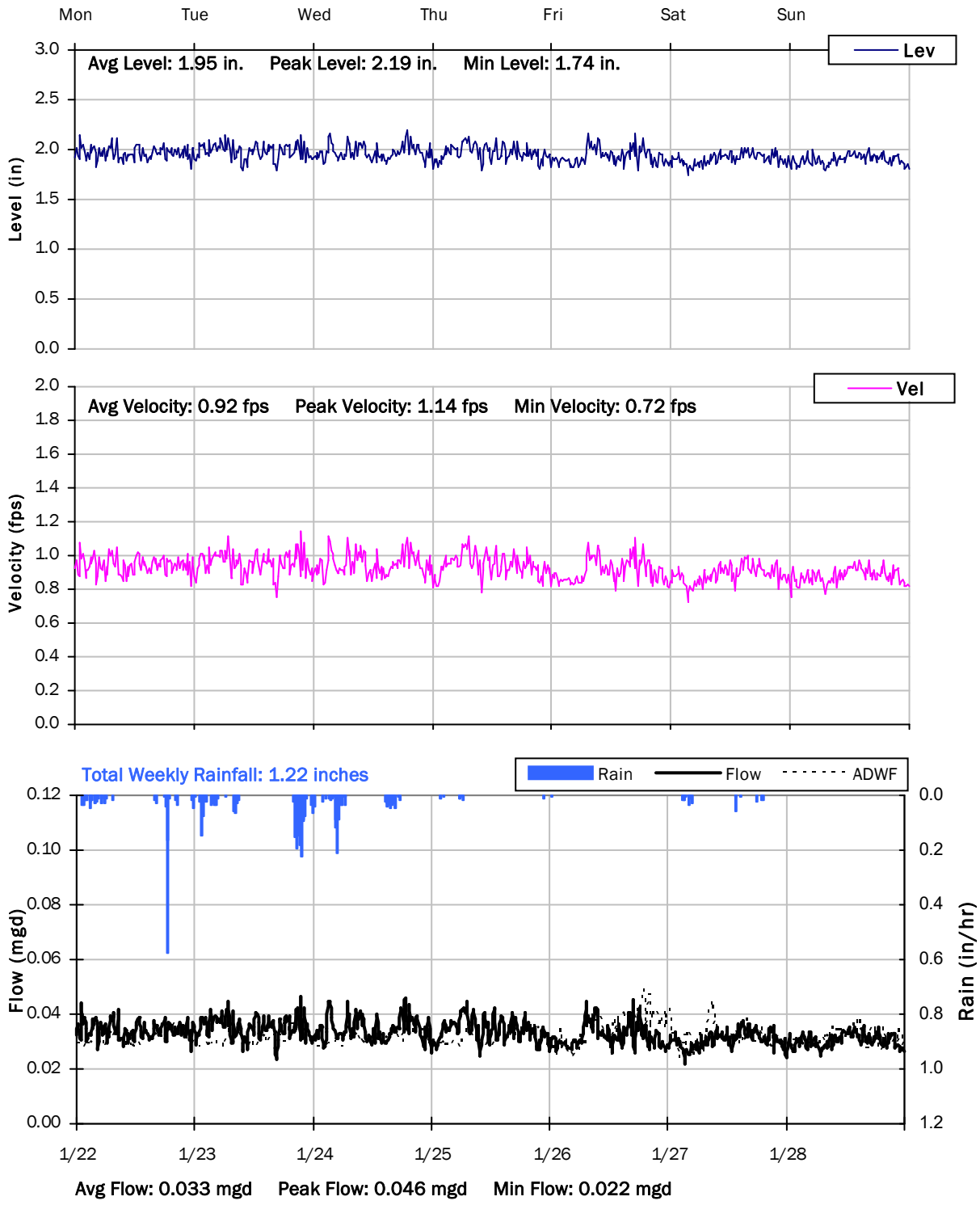
1/15/2024 to 1/22/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

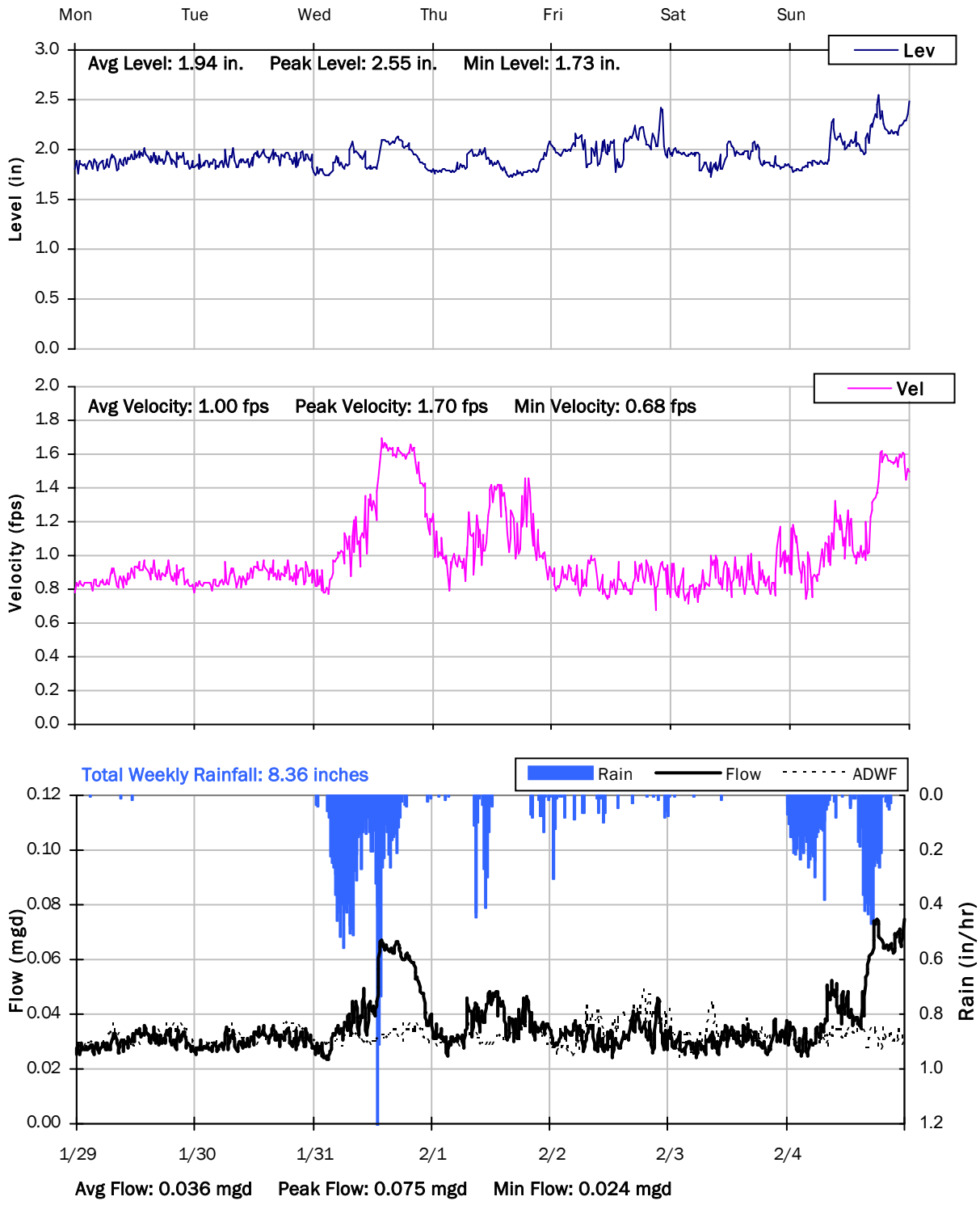
1/22/2024 to 1/29/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

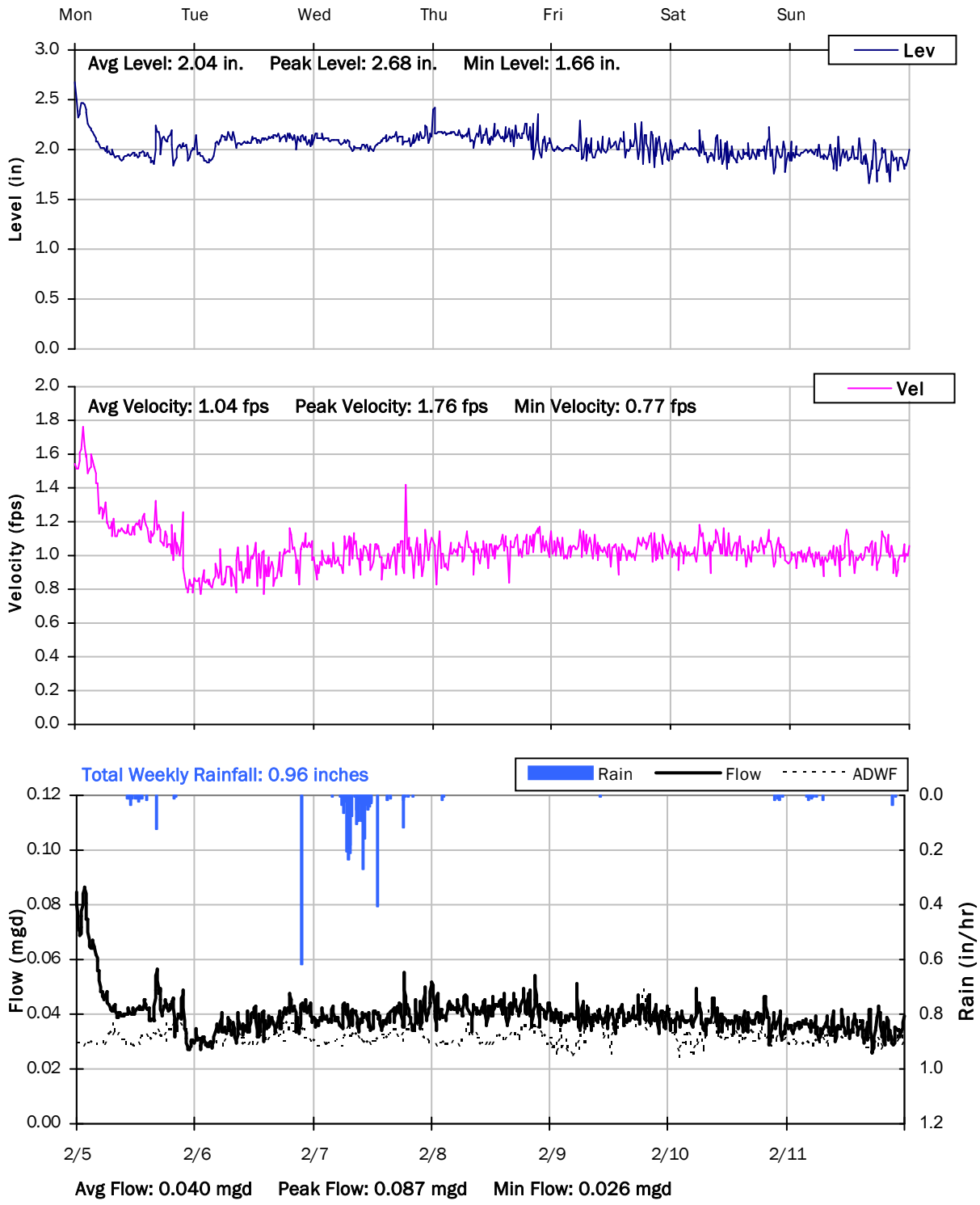
1/29/2024 to 2/5/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

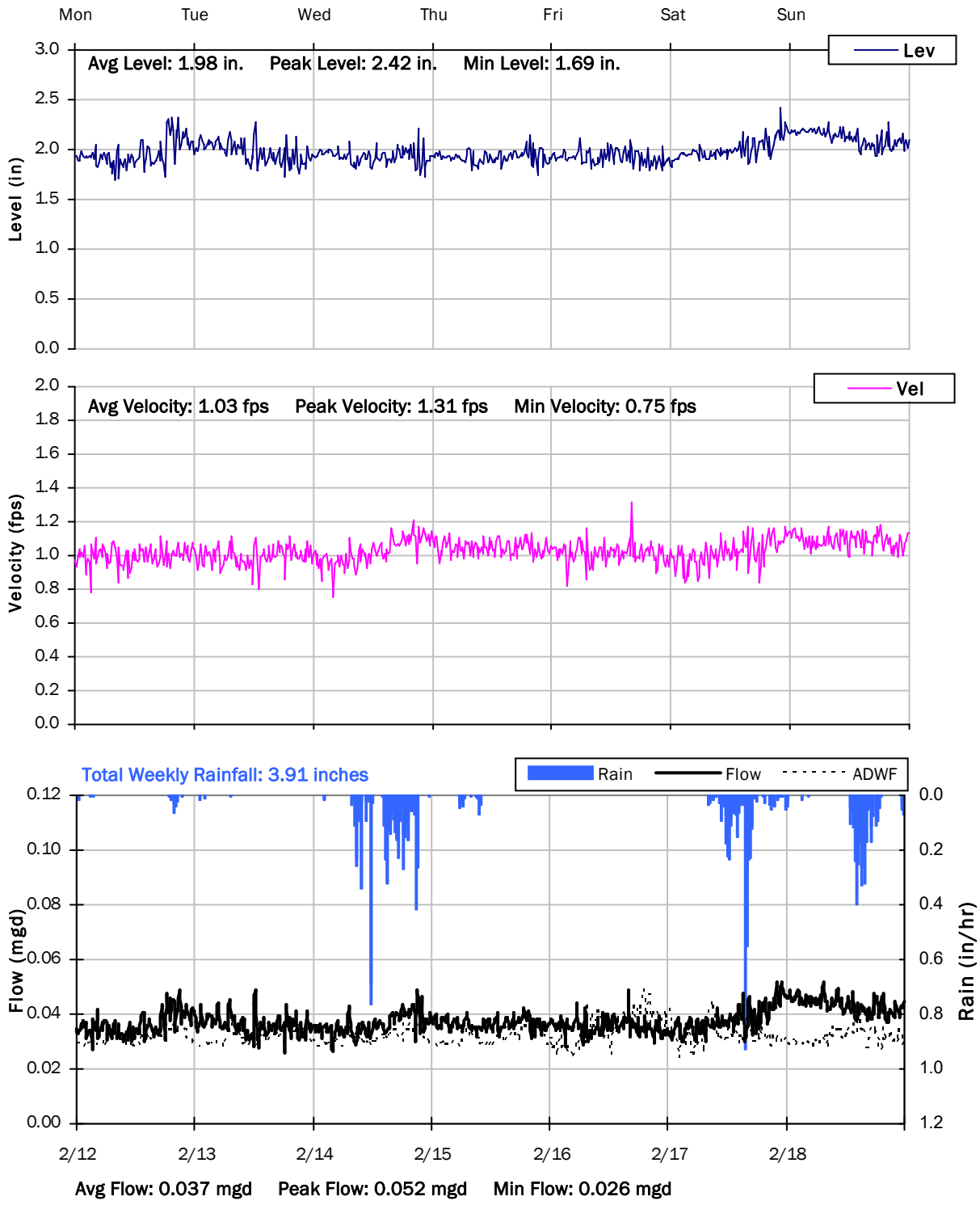
2/5/2024 to 2/12/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

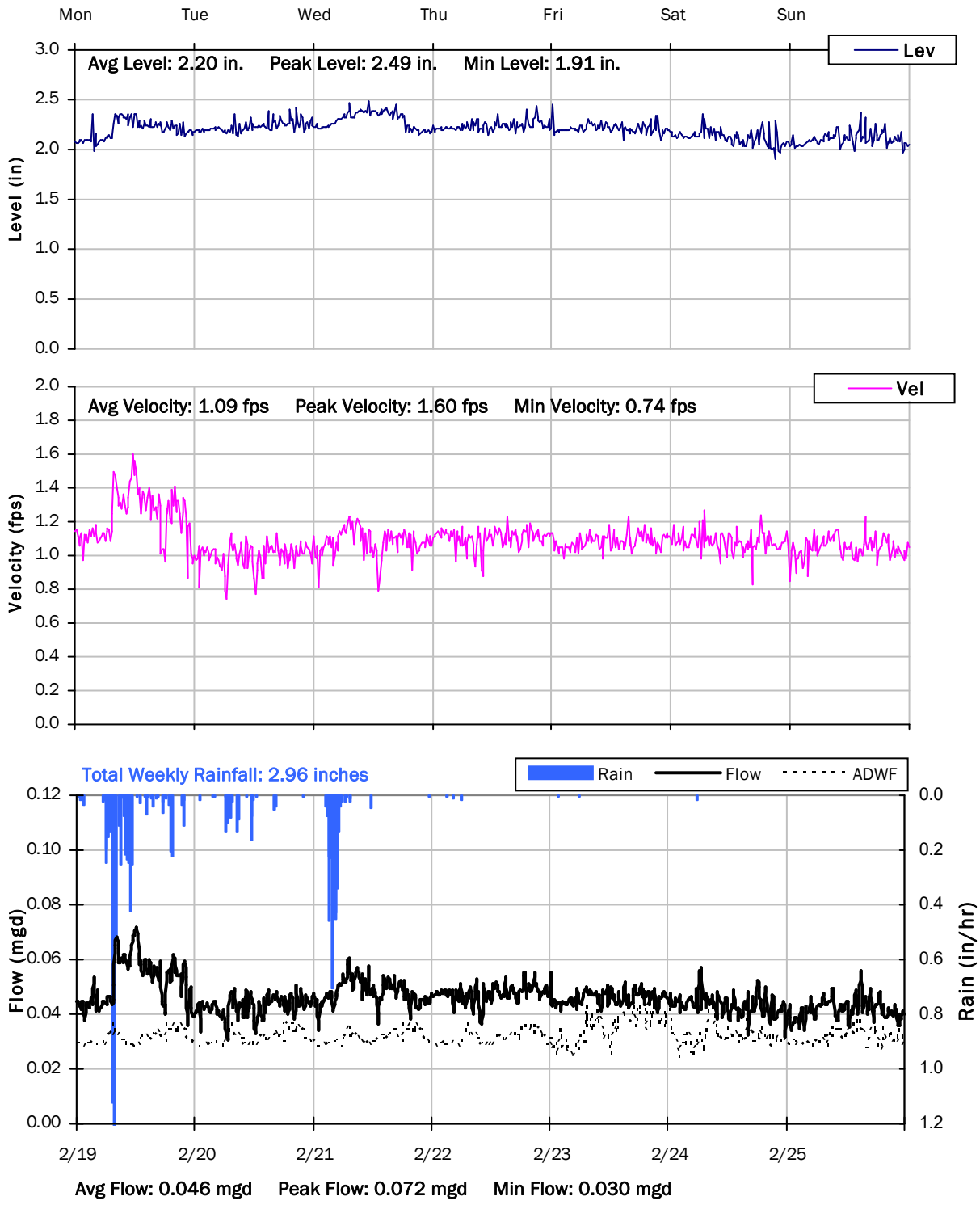
2/12/2024 to 2/19/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

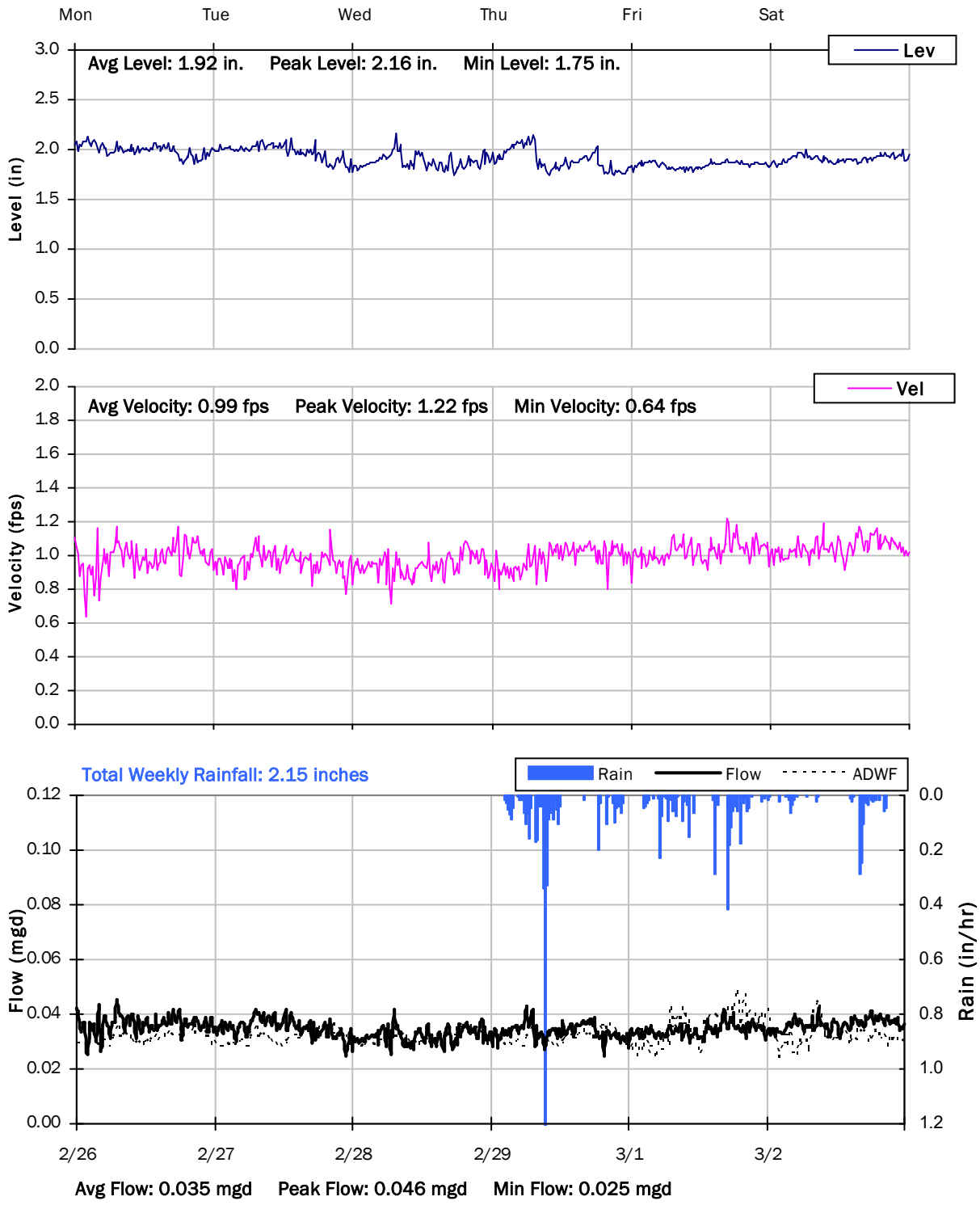
2/19/2024 to 2/26/2024



FM-05

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



Monitoring Site: FM-06

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: Walnut St x Dubois Ln

Data Summary Report

Vicinity Map: FM-06

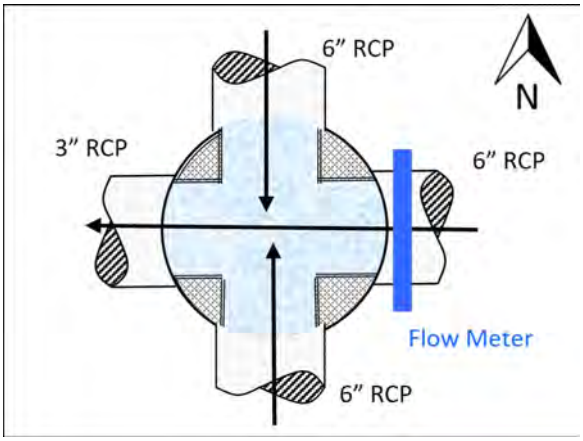
FM-06

Site Information MH ID: Mnhl-Chnnl-4284

Location:	Walnut St x Dubois Ln
Coordinates:	123.8003° W, 39.4345° N
Rim Elevation:	109 feet
Expected Pipe Diameter:	6 inches
Measured Pipe Diameter:	6 inches
ADWF:	0.011 mgd
Peak Measured Flow:	0.122 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

Plan View

FM-06

Additional Site Photos

West Outlet Pipe

North Inlet Pipe

FM-06

Additional Site Photos

Monitored East Inlet Pipe

South Inlet Pipe

FM-06

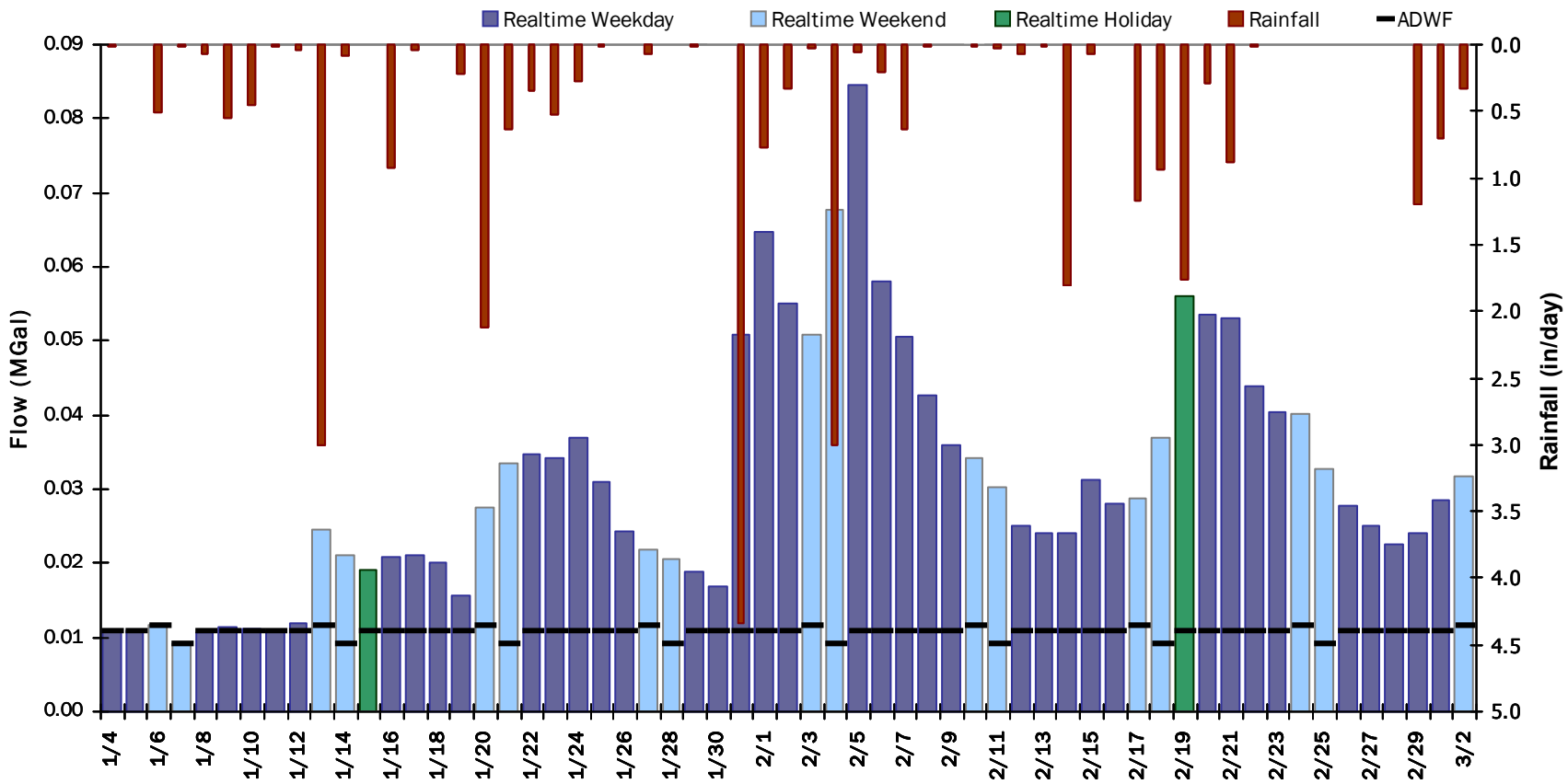
Additional Site Photos

FM-06

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.031 MGal Peak Daily Flow: 0.084 MGal Min Daily Flow: 0.009 MGal

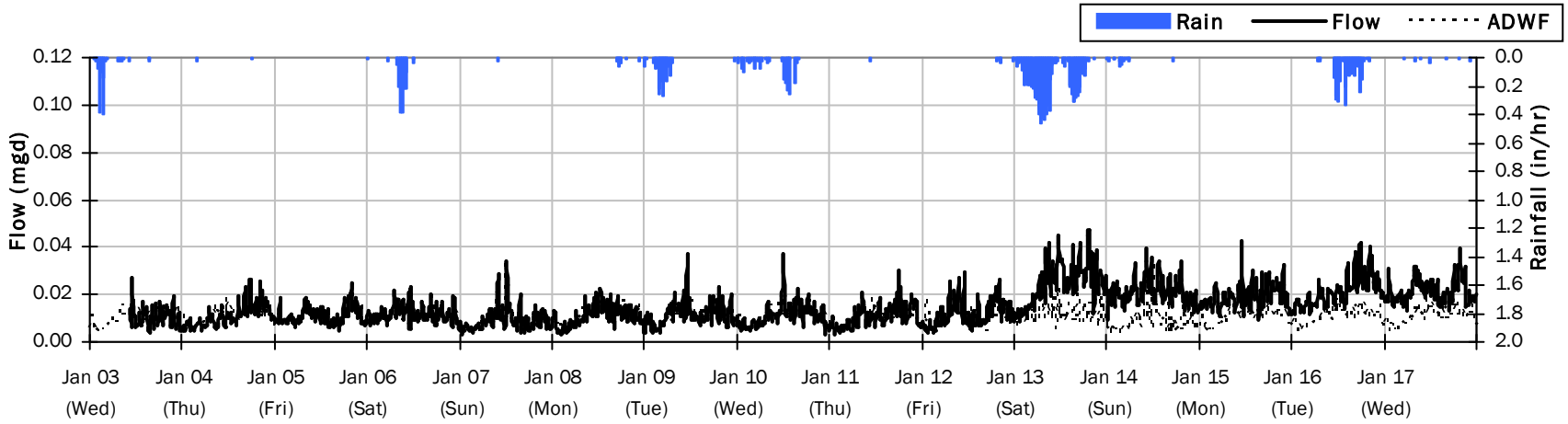
Total Rainfall: 28.60 inches

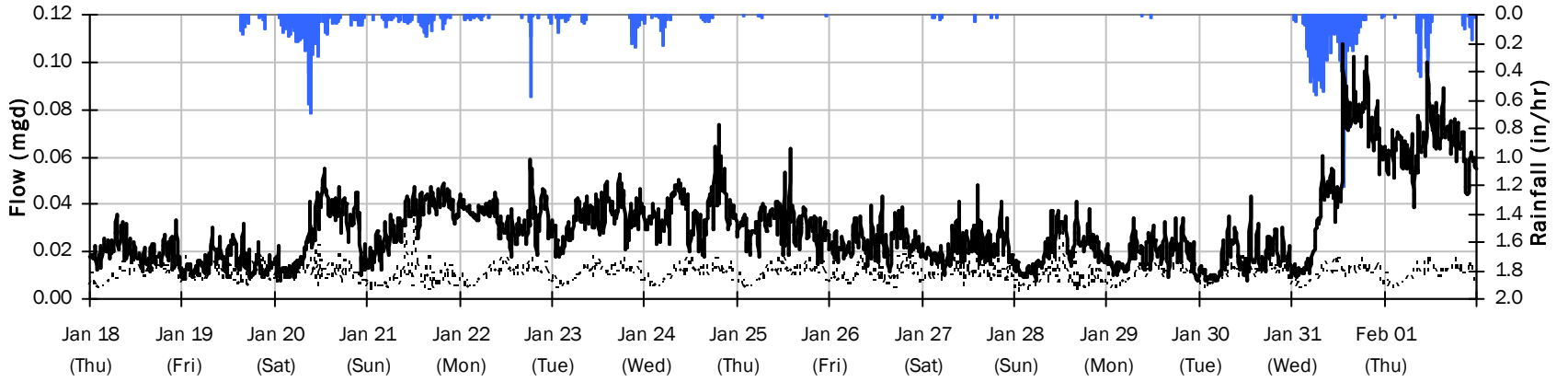


FM-06

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 15.40 inches Period Avg Flow: 0.022 mgd Period Peak Flow: 0.107 mgd Period Min Flow: 0.003 mgd

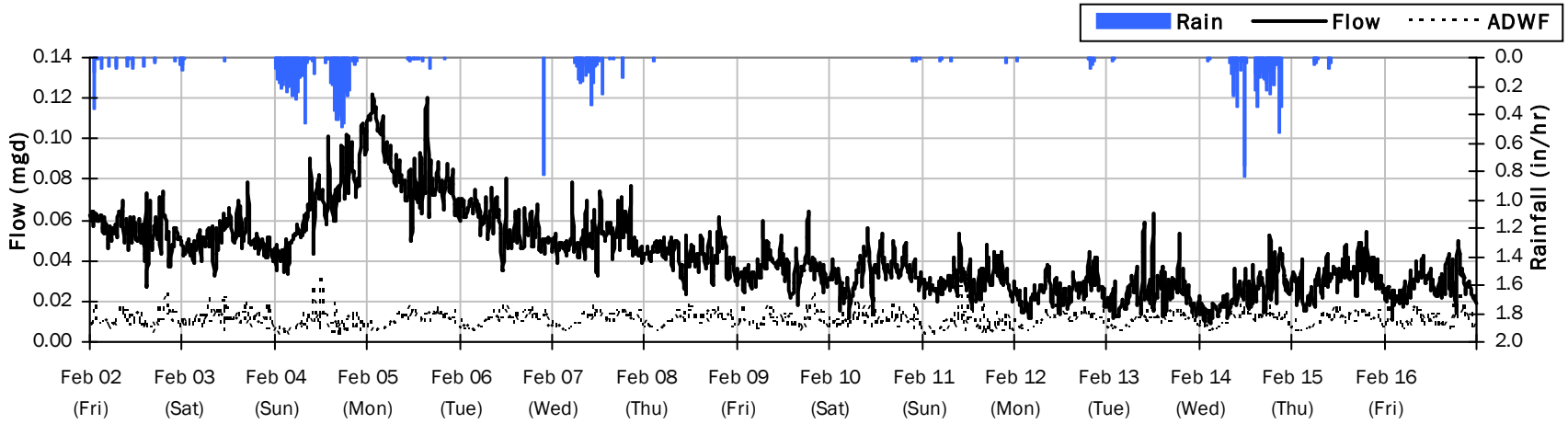


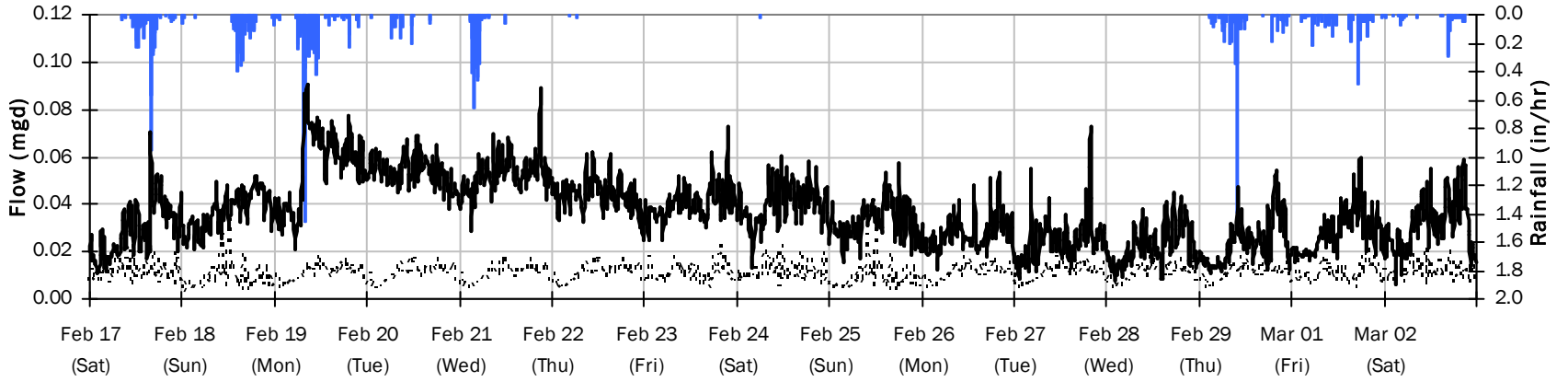


FM-06

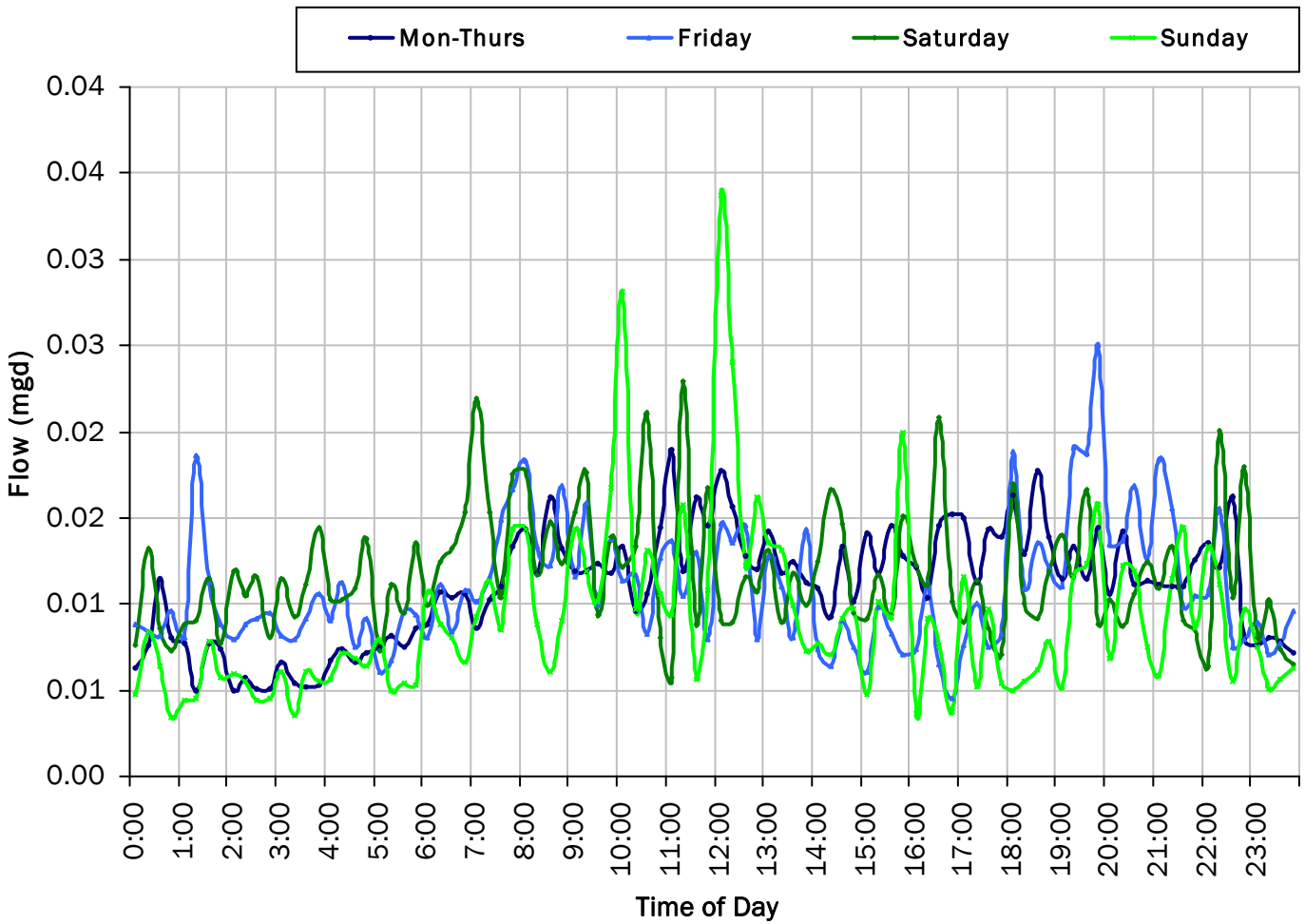
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 13.56 inches Period Avg Flow: 0.040 mgd Period Peak Flow: 0.122 mgd Period Min Flow: 0.007 mgd



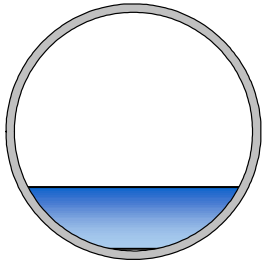


FM-06
Average Dry Weather Flow Hydrographs



ADWF:

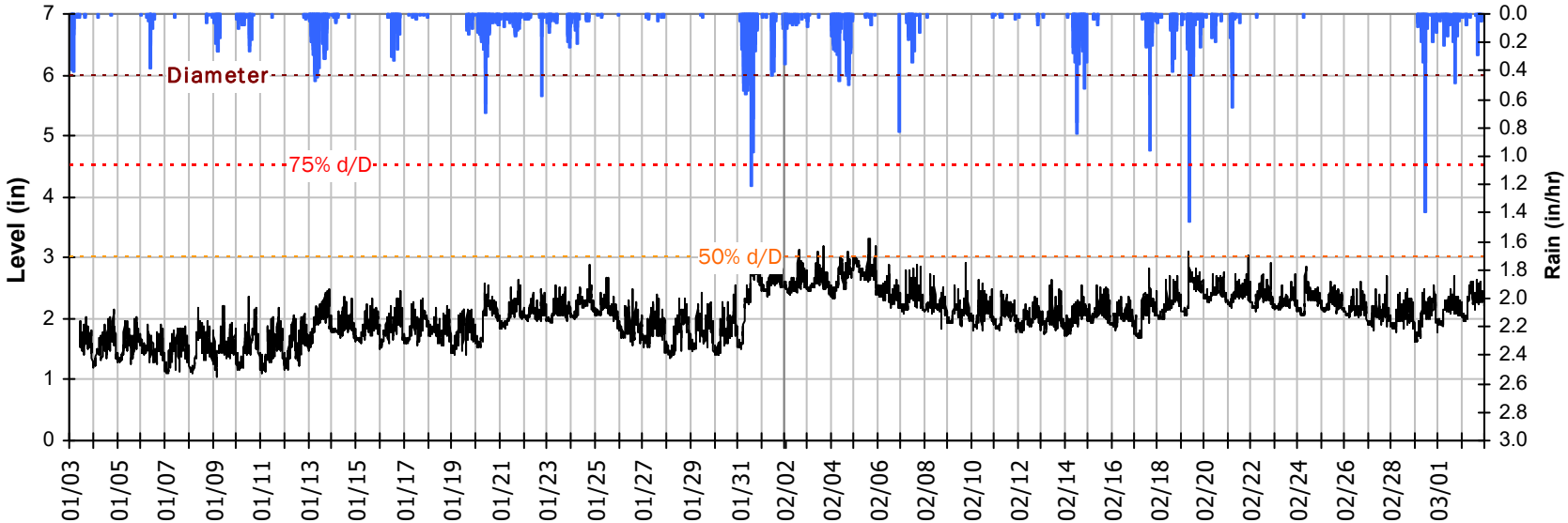
0.011 *mgd*

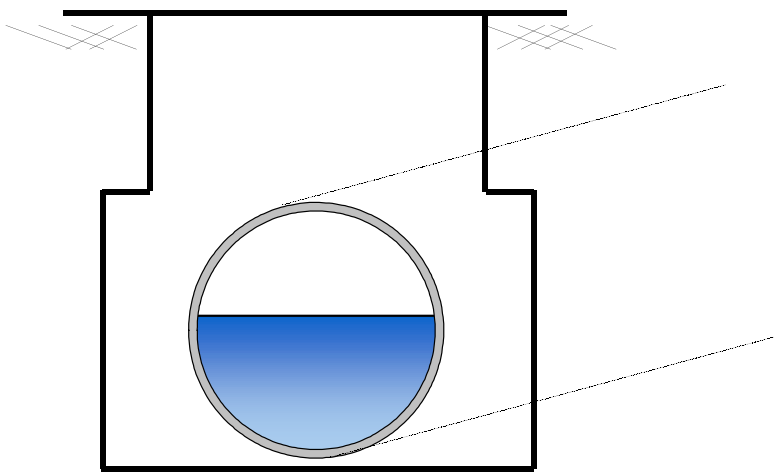


FM-06

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period

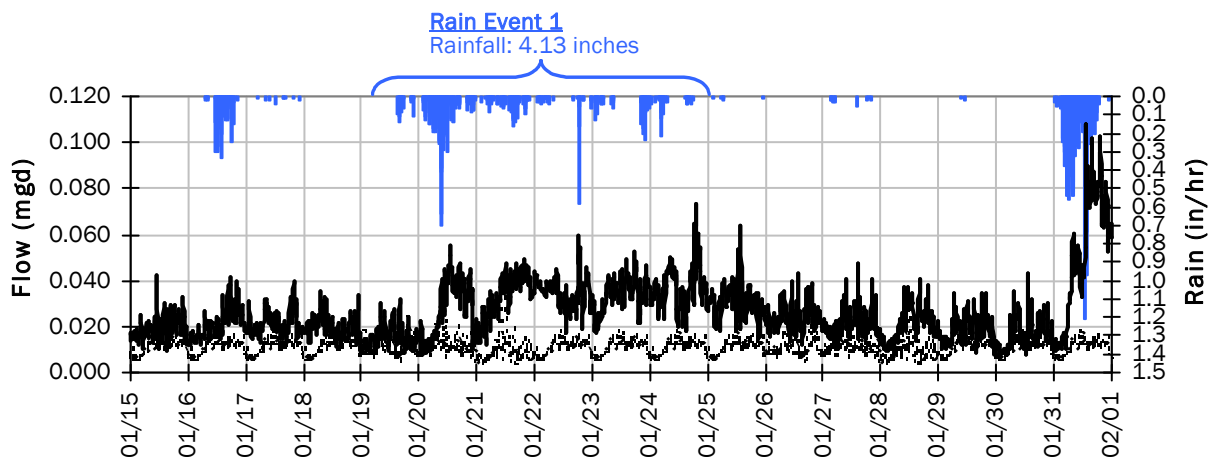




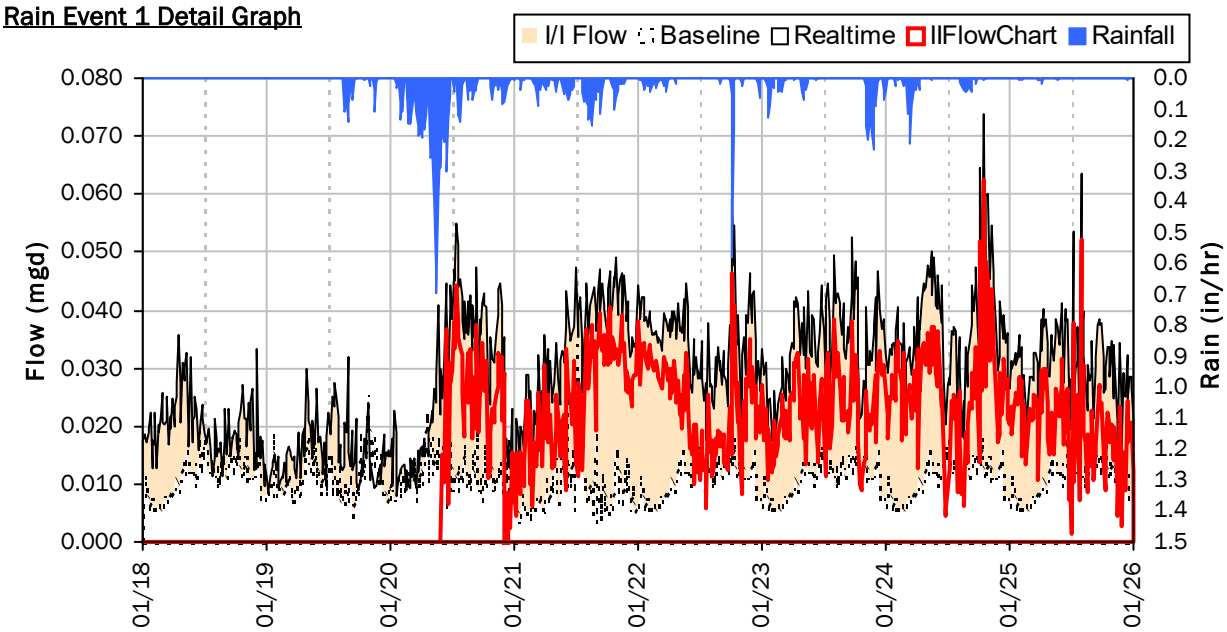
Pipe Diameter:	6	*inches*
Peak Measured Level:	3.33	*inches*
Peak d/D Ratio:	0.55	

FM-06
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

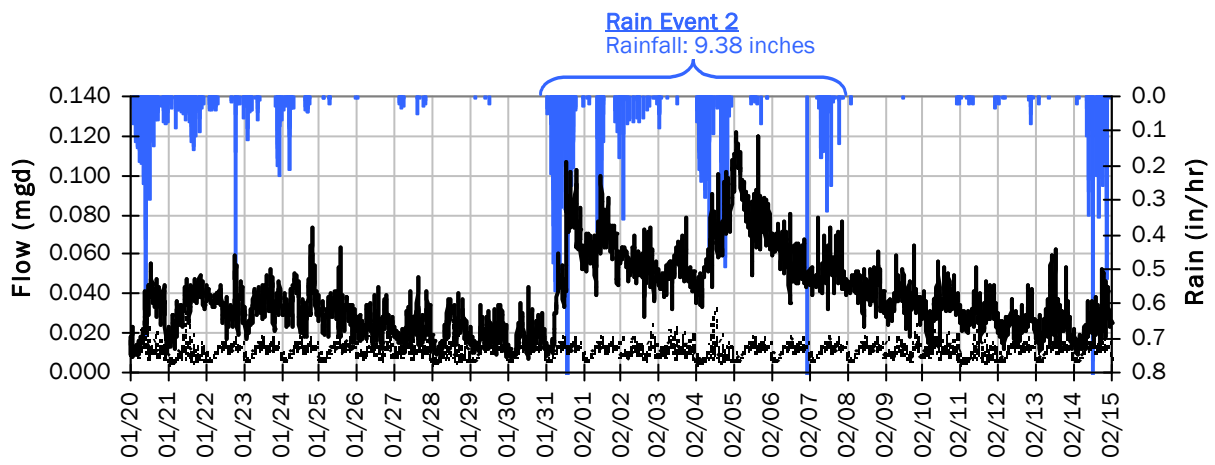


Storm Event I/I Analysis (Rain = 4.13 inches)

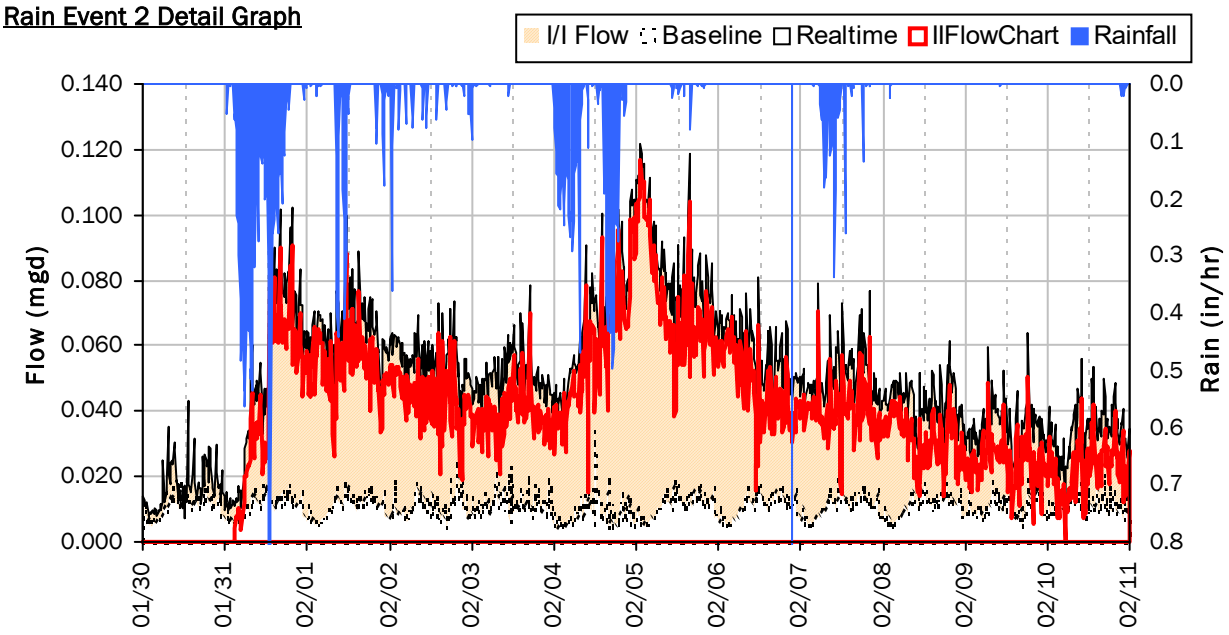
Capacity		Inflow / Infiltration	
Peak Flow:	0.074 *mgd*	**Peak I/I Rate:**	0.062 *mgd*
PF:	6.80	**Total I/I:**	131,000 *gallons*
Peak Level:	2.90 *in*		
d/D Ratio:	0.48		

FM-06
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

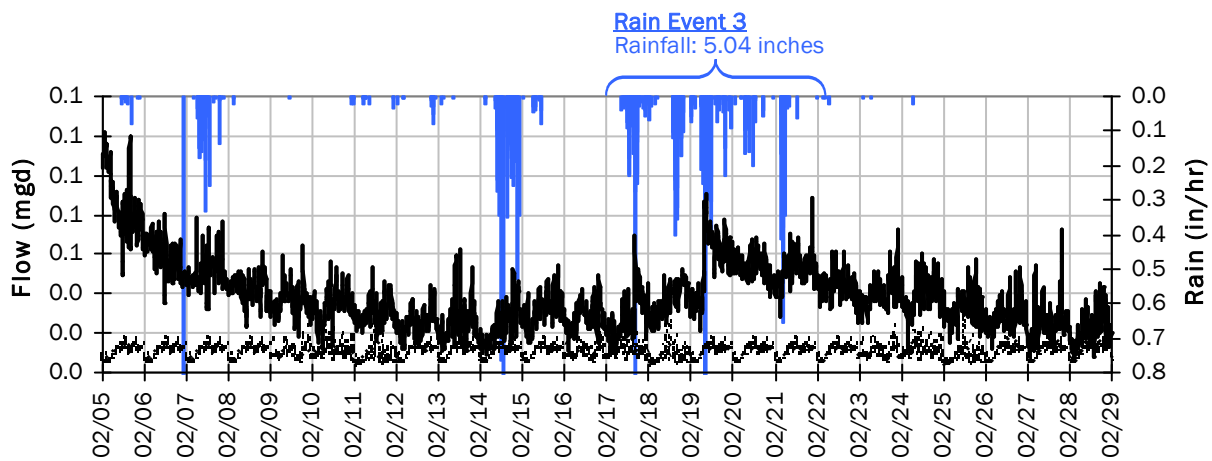


Storm Event I/I Analysis (Rain = 9.38 inches)

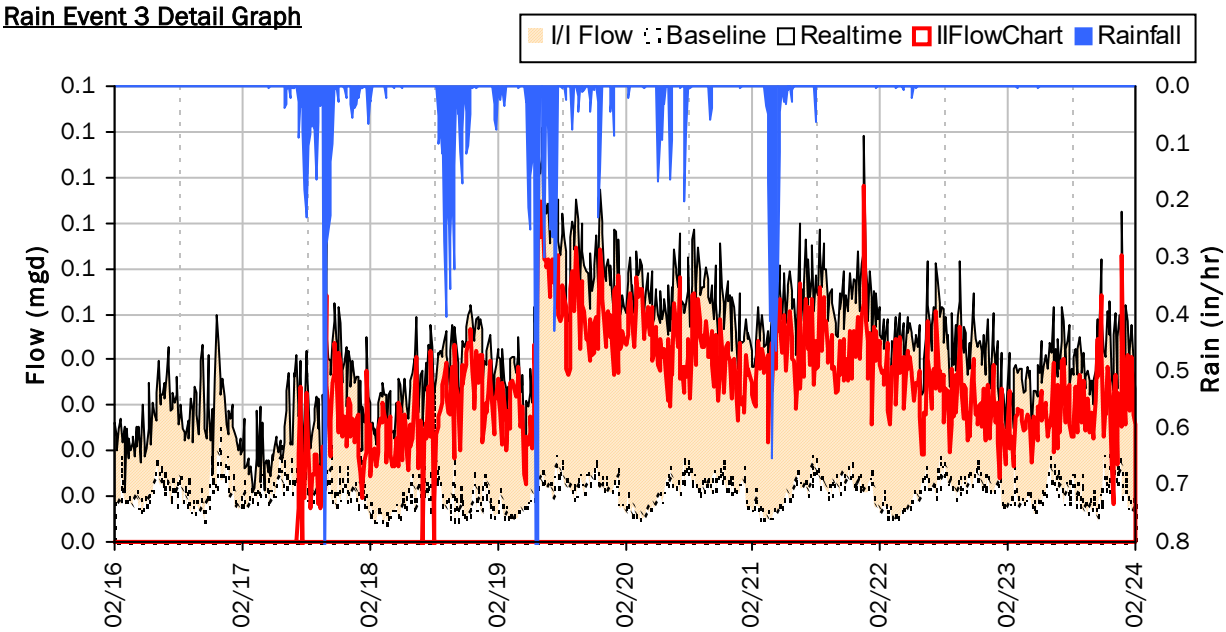
Capacity		Inflow / Infiltration	
Peak Flow:	0.122 *mgd*	**Peak I/I Rate:**	0.117 *mgd*
PF:	11.21	**Total I/I:**	474,000 *gallons*
Peak Level:	3.33 *in*		
d/D Ratio:	0.55		

FM-06
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

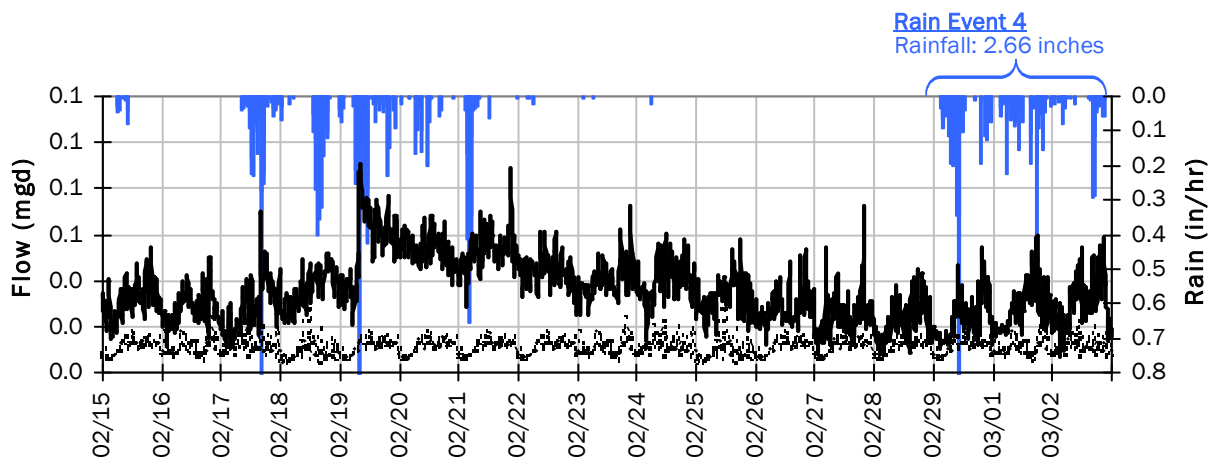


Storm Event I/I Analysis (Rain = 5.04 inches)

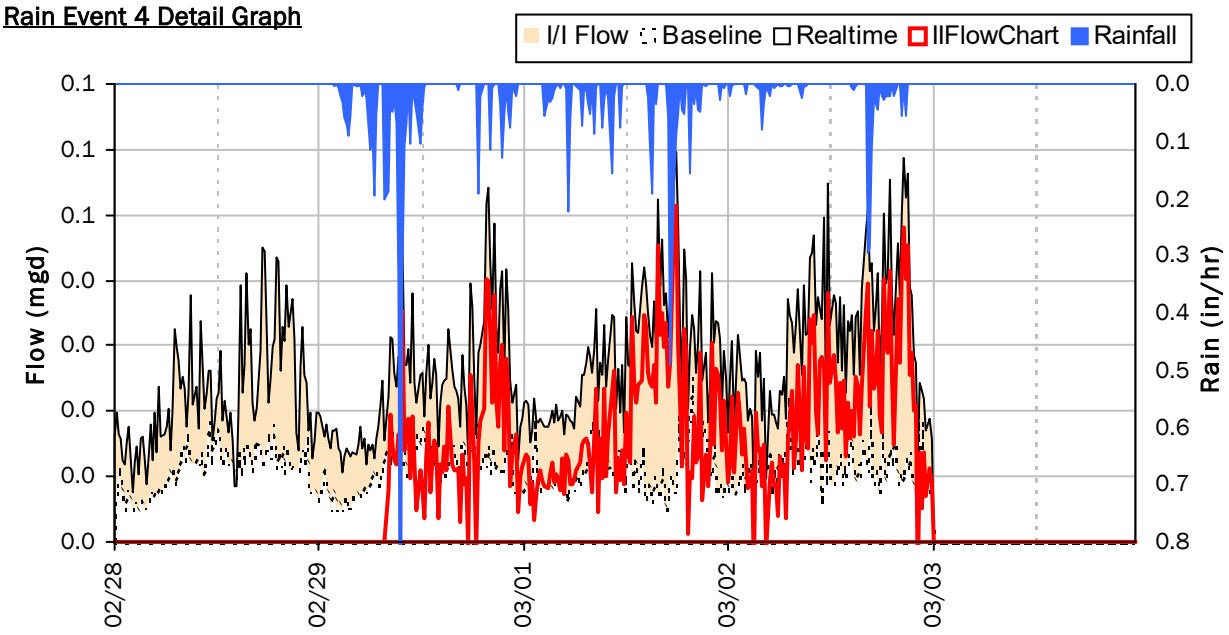
Capacity		Inflow / Infiltration	
Peak Flow:	0.09 *mgd*	Peak I/I Rate:	0.08 *mgd*
PF:	8.37	Total I/I:	232,000 *gallons*
Peak Level:	3.09 *in*		
d/D Ratio:	0.52		

FM-06
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



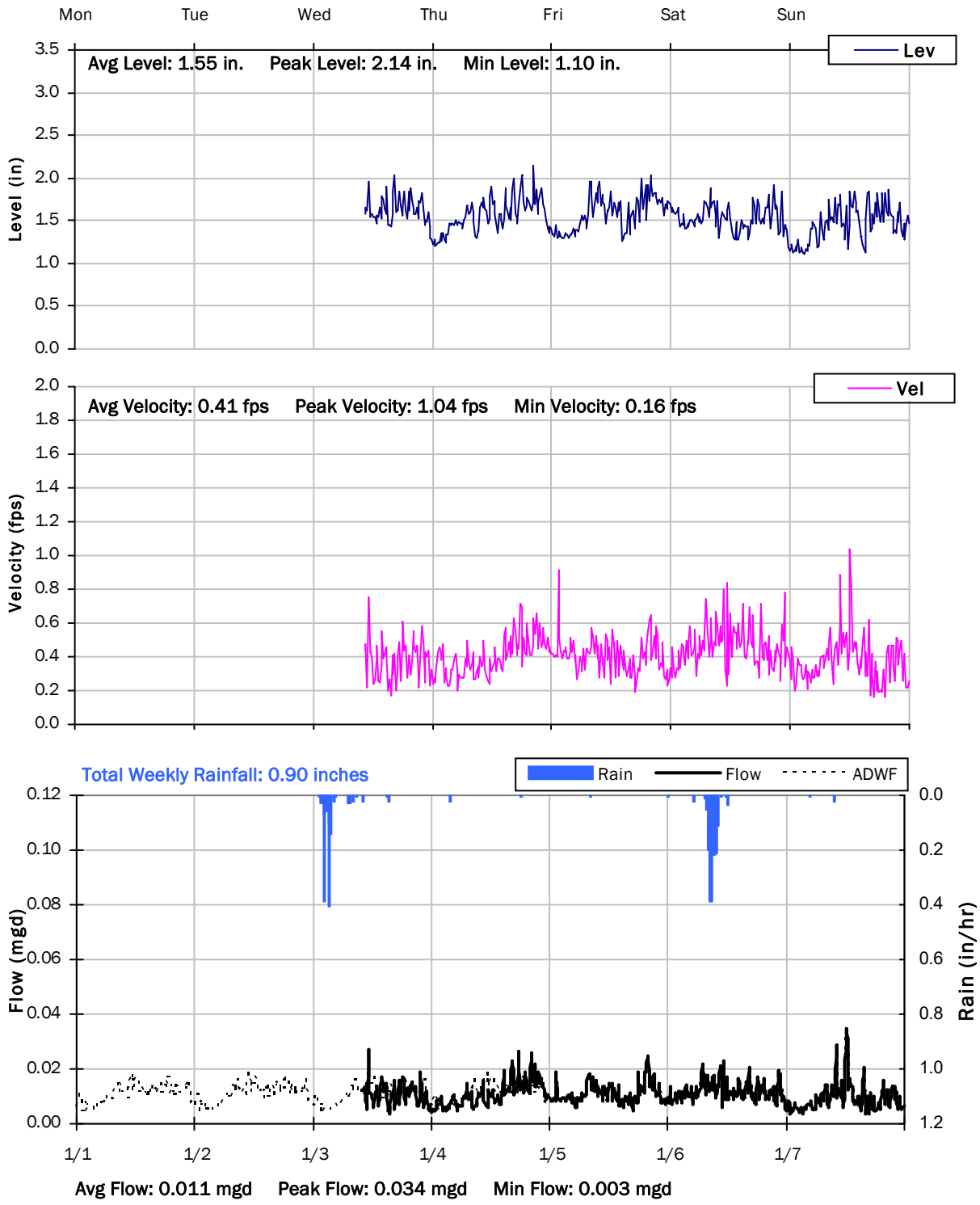
Storm Event I/I Analysis (Rain = 2.66 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.06 *mgd*	**Peak I/I Rate:**	0.05 *mgd*
PF:	5.49	**Total I/I:**	48,000 *gallons*
Peak Level:	2.71 *in*		
d/D Ratio:	0.45		

FM-06

Weekly Level, Velocity and Flow Hydrographs

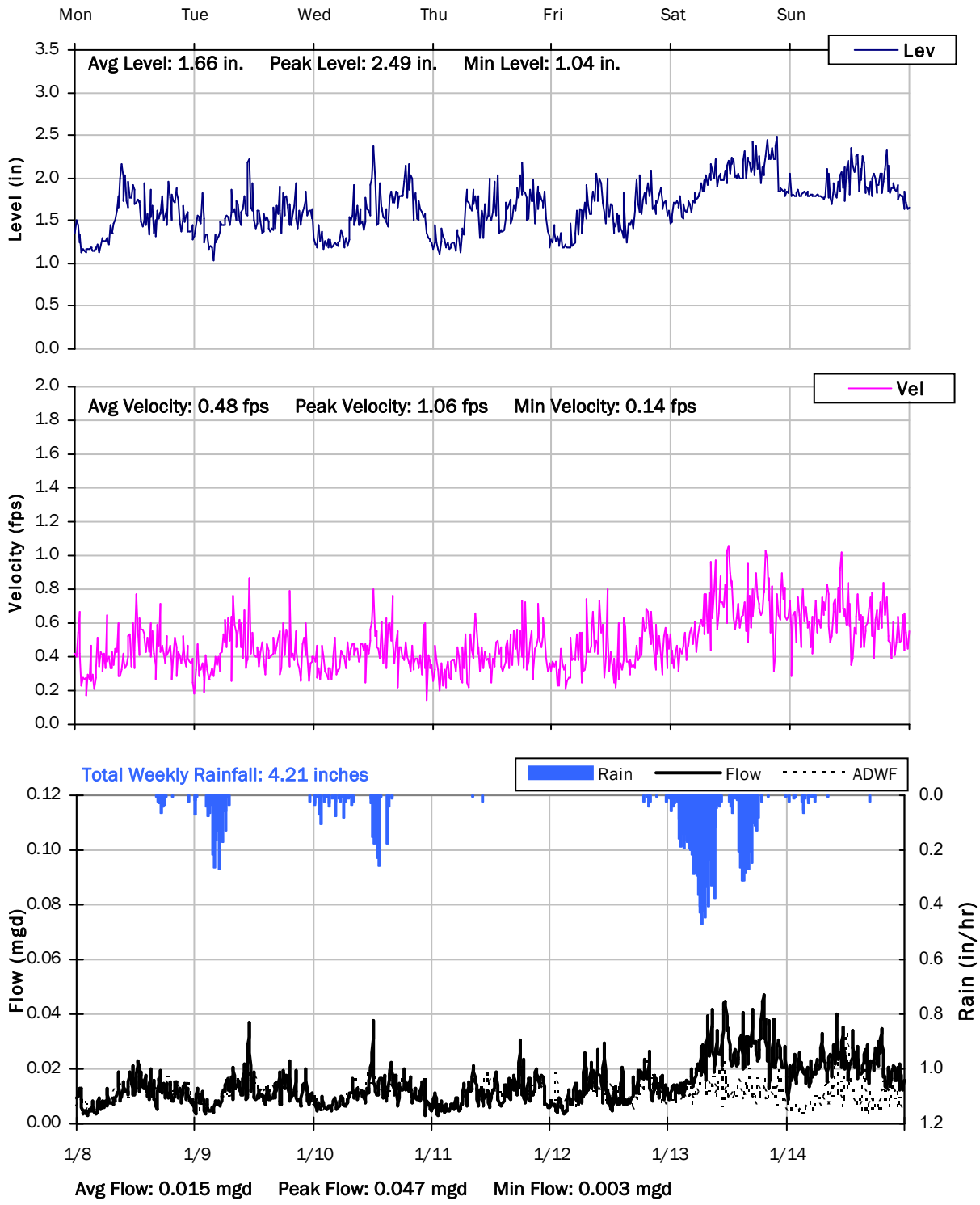
1/1/2024 to 1/8/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

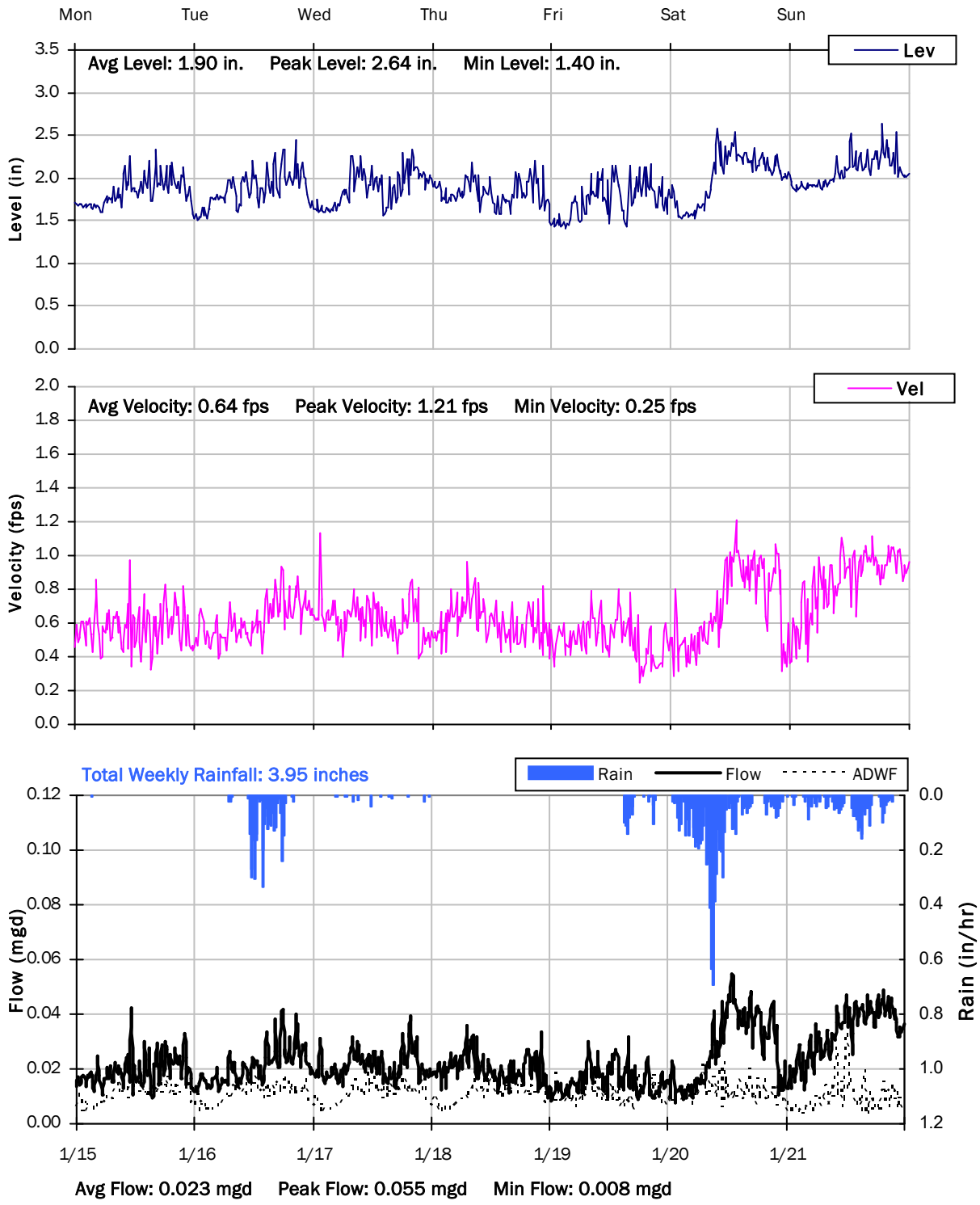
1/8/2024 to 1/15/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

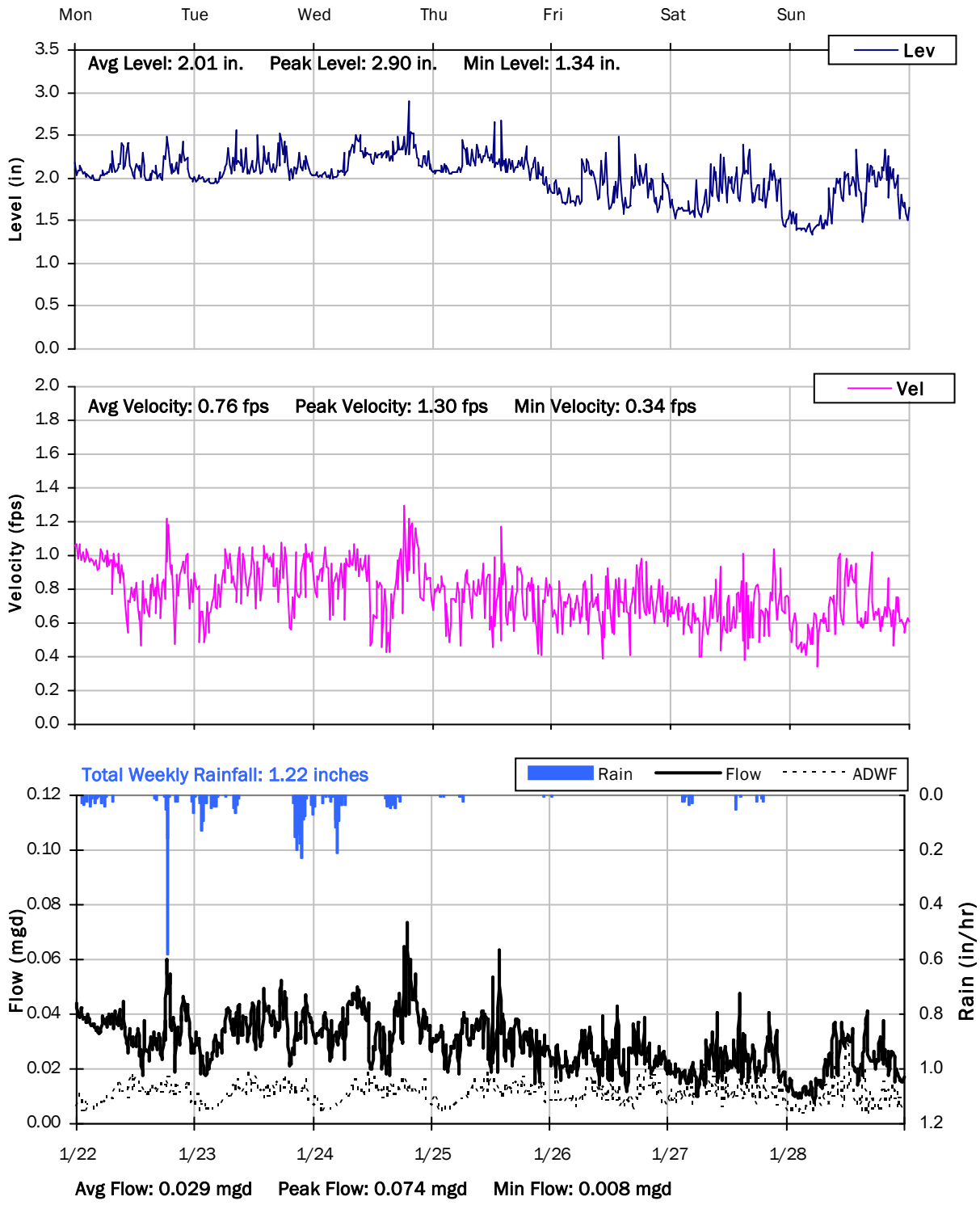
1/15/2024 to 1/22/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

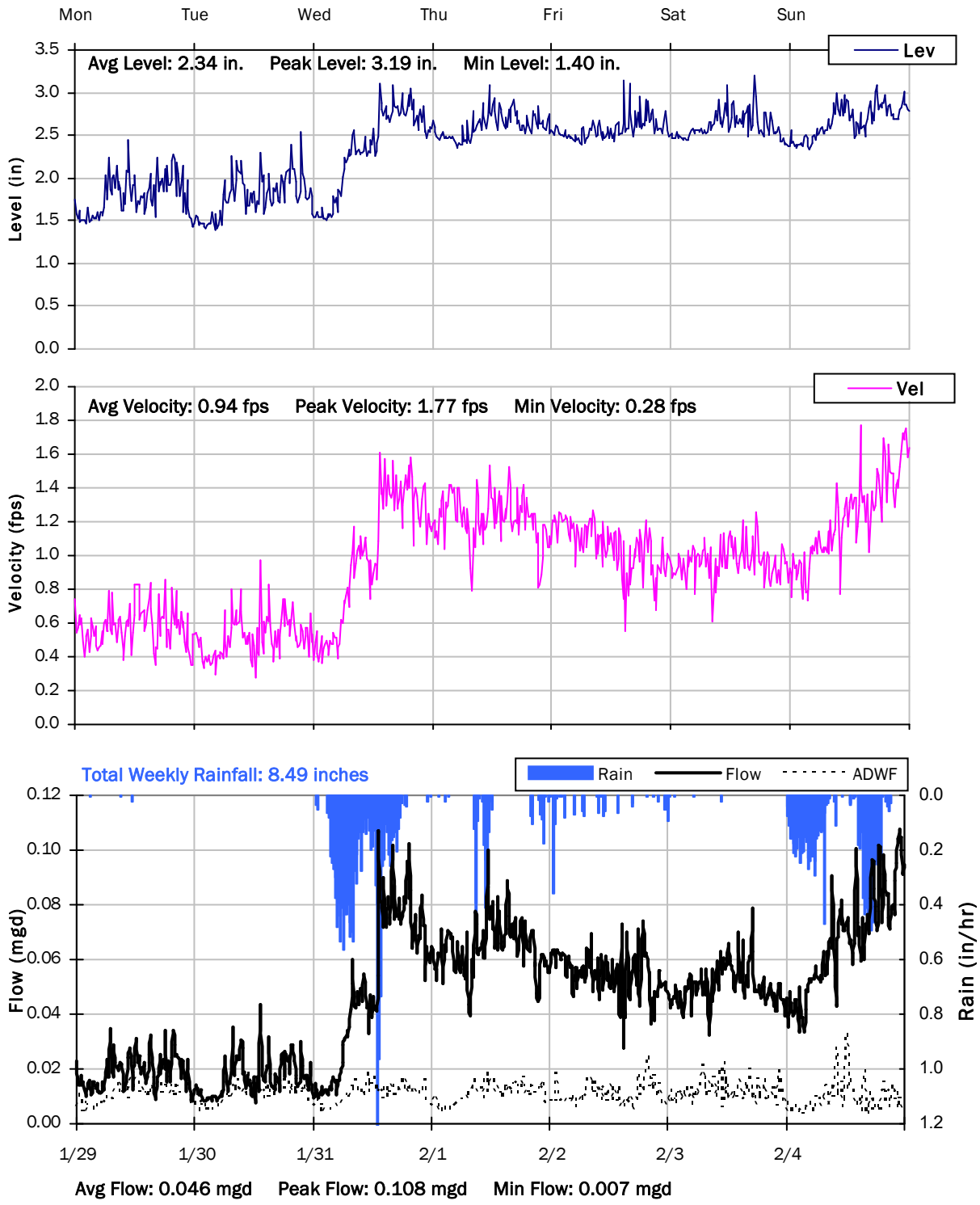
1/22/2024 to 1/29/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

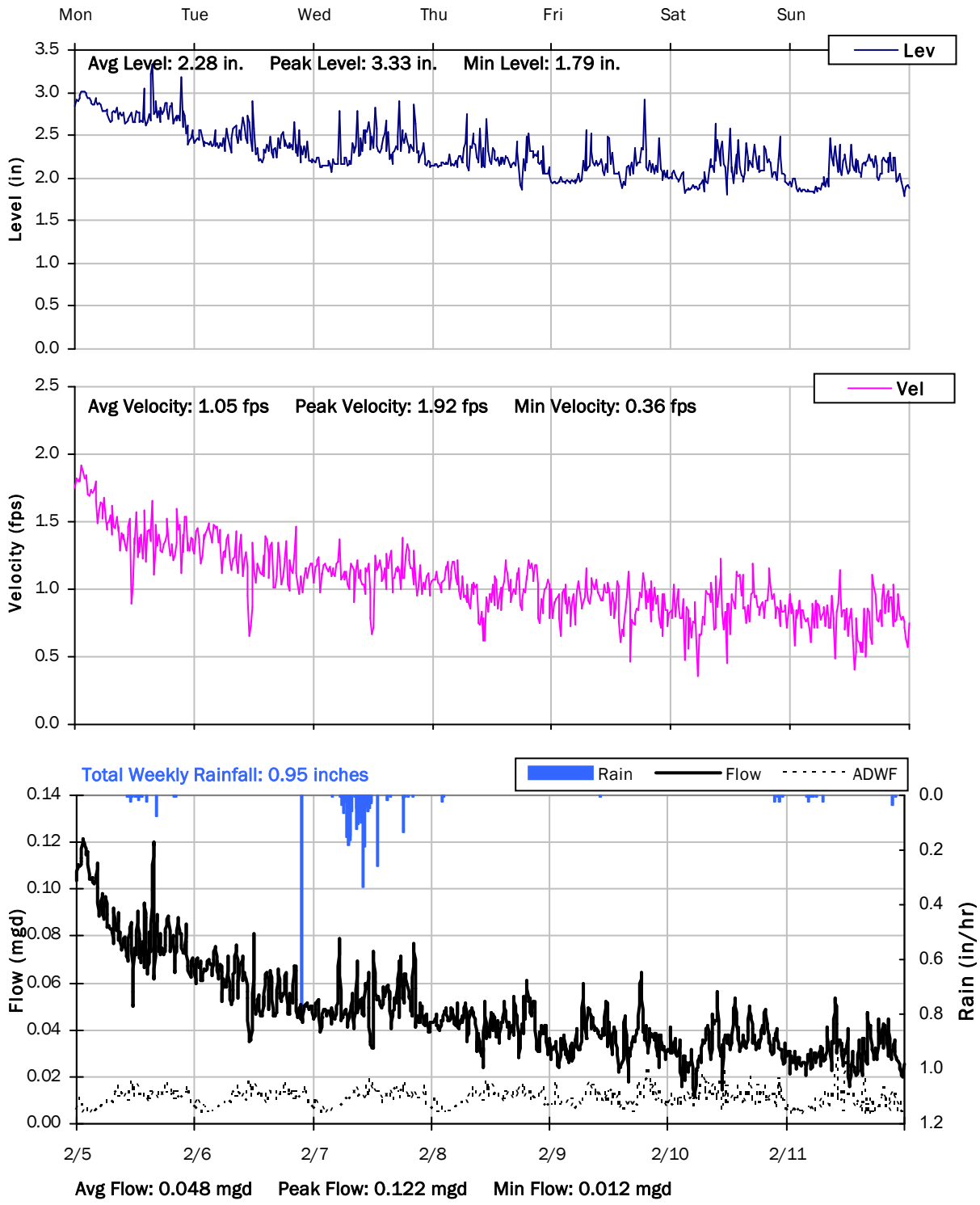
1/29/2024 to 2/5/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

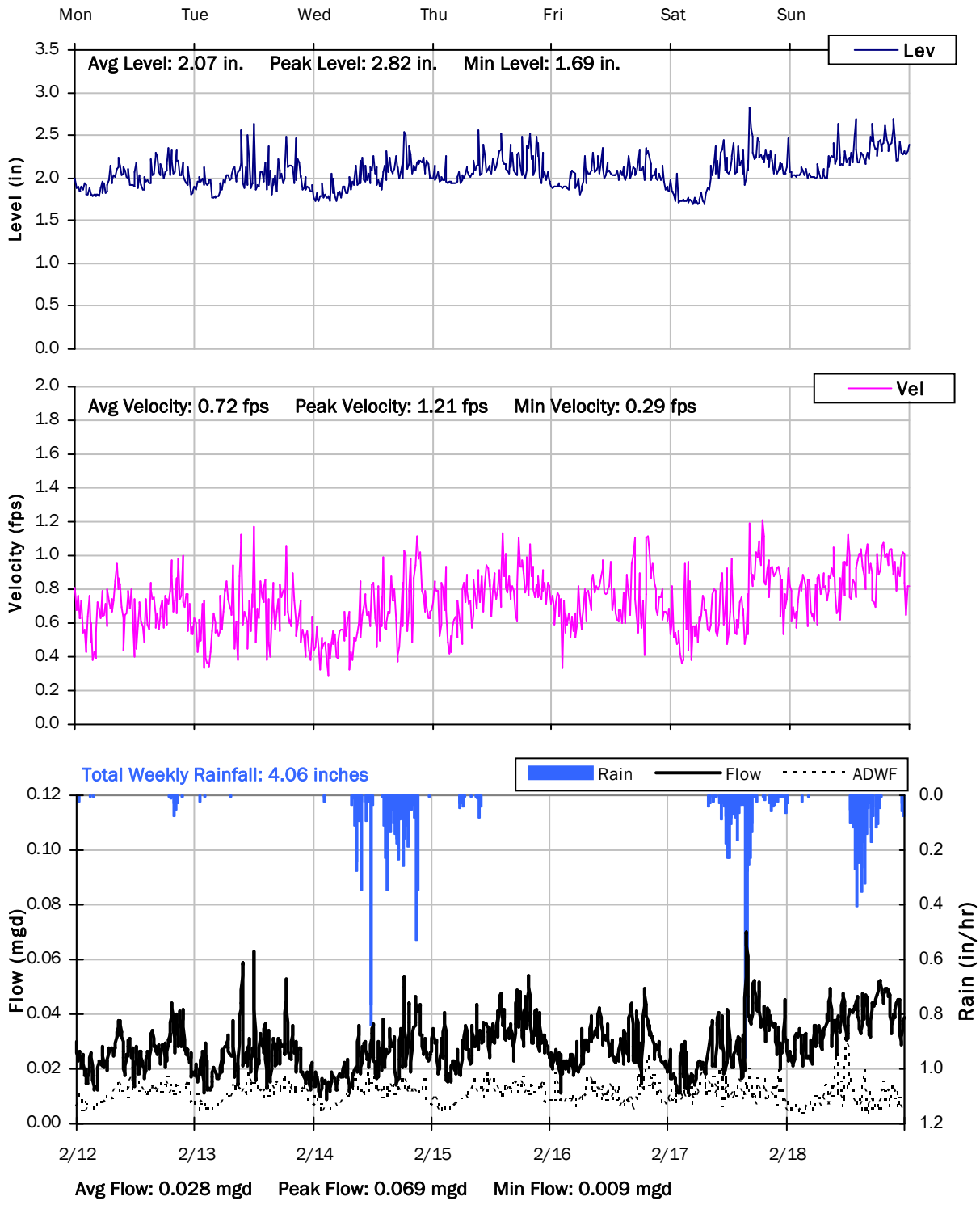
2/5/2024 to 2/12/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

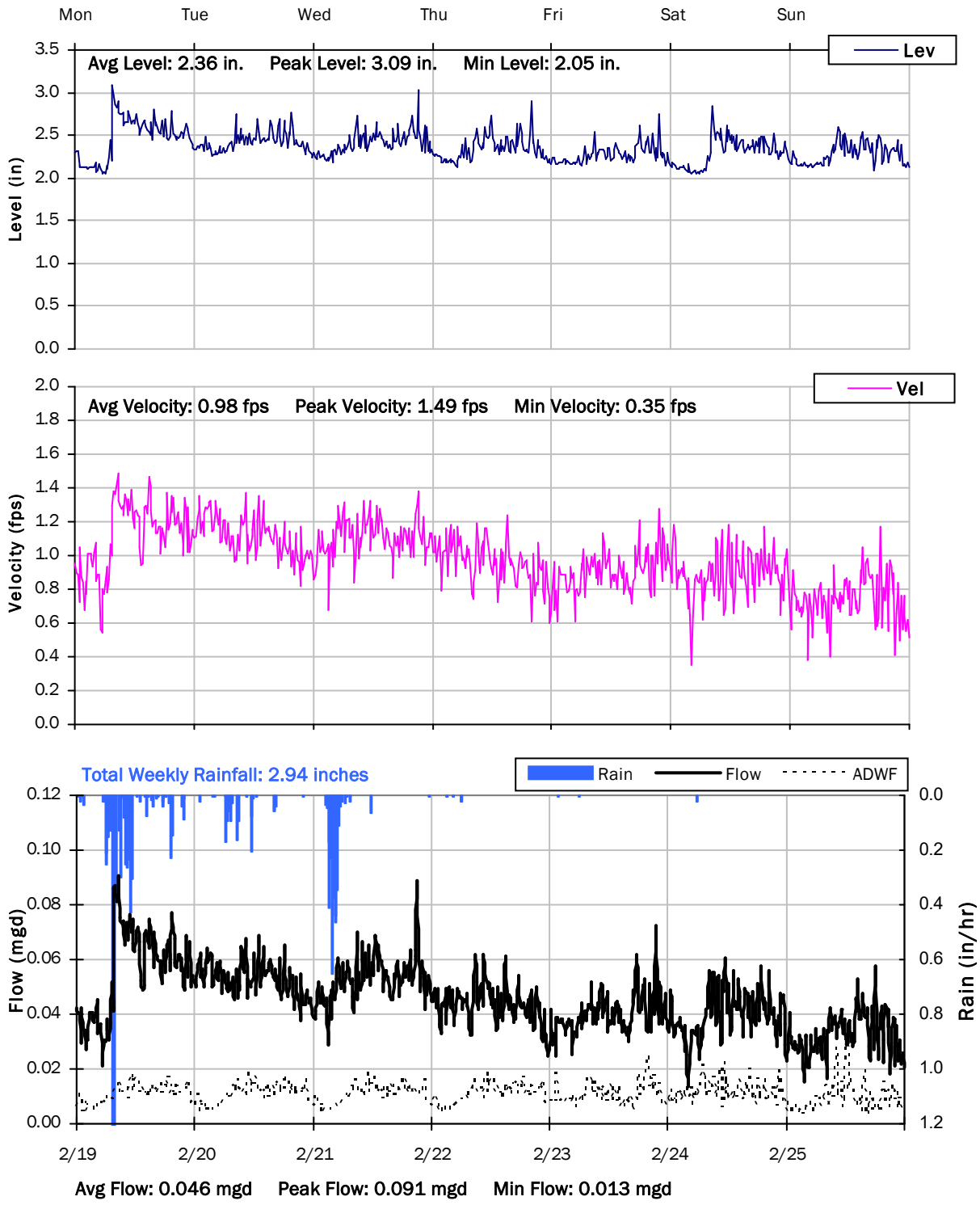
2/12/2024 to 2/19/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

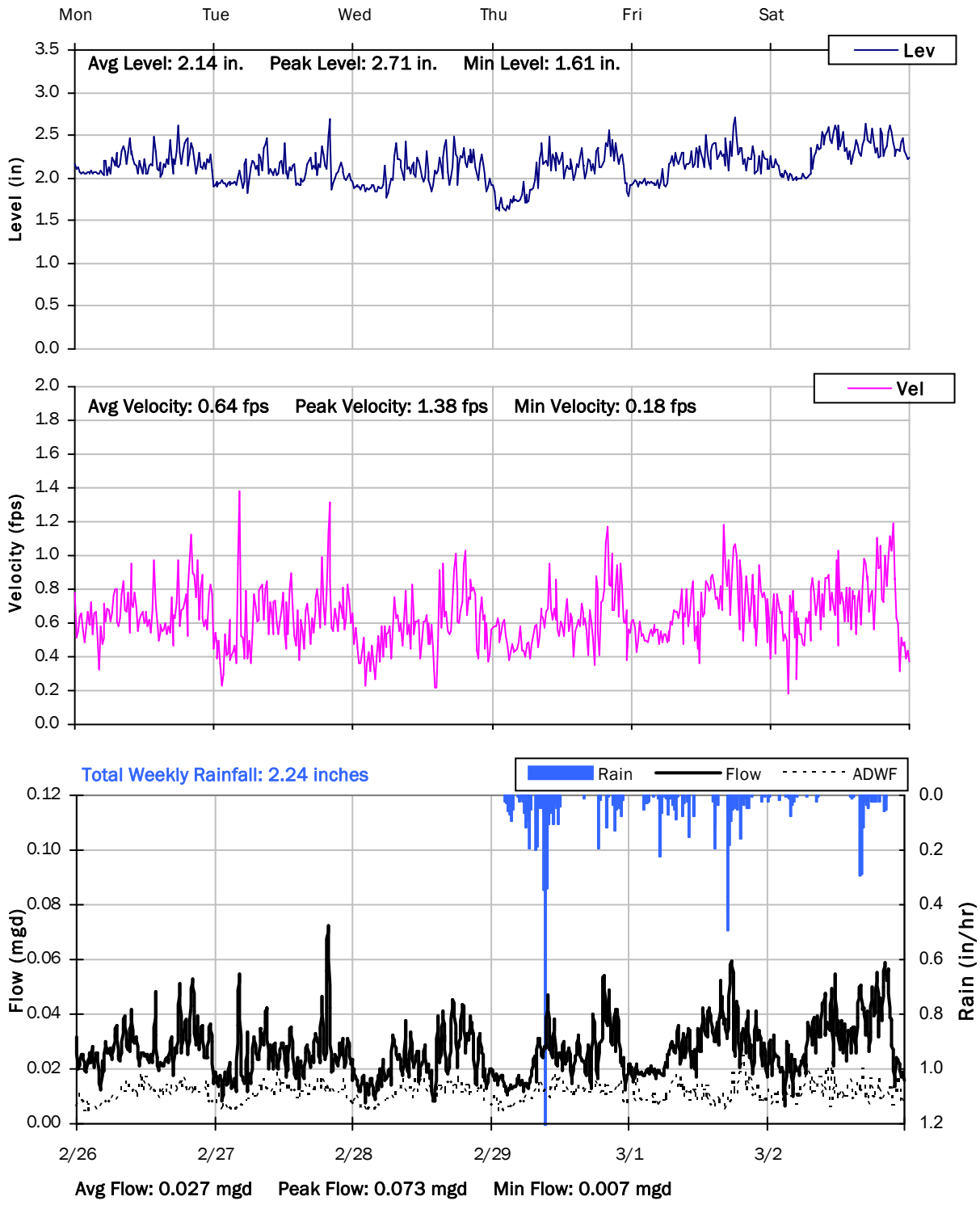
2/19/2024 to 2/26/2024



FM-06

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



Monitoring Site: FM-07

HDR | Fort Bragg, California

Sanitary Sewer Flow Monitoring

January 03, 2024 - March 02, 2024

Location: 19498 Coast Rd

Data Summary Report

Vicinity Map: FM-07

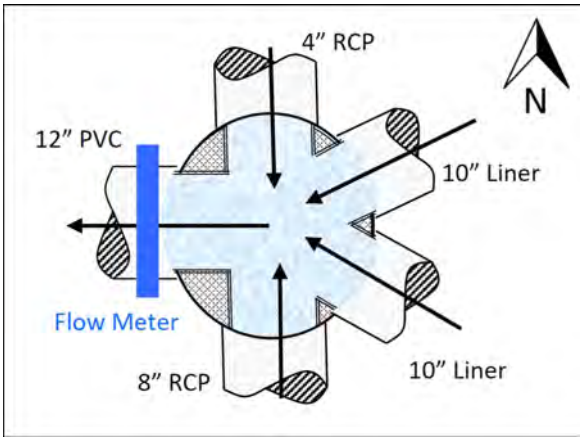
FM-07

Site Information MH ID: Mnhl-Chnnl-4264

Location:	19498 Coast Rd
Coordinates:	123.8037° W, 39.4226° N
Rim Elevation:	15 feet
Expected Pipe Diameter:	10 inches
Measured Pipe Diameter:	12 inches
ADWF:	0.038 mgd
Peak Measured Flow:	0.395 mgd
Sediment:	None

Satellite Map

Sanitary Map



Flow Sketch

Street View

Plan View

FM-07

Additional Site Photos

Monitored West Outlet Pipe

North Inlet Pipe

FM-07

Additional Site Photos

Northeast Inlet Pipe

Southeast Inlet Pipe

FM-07

Additional Site Photos

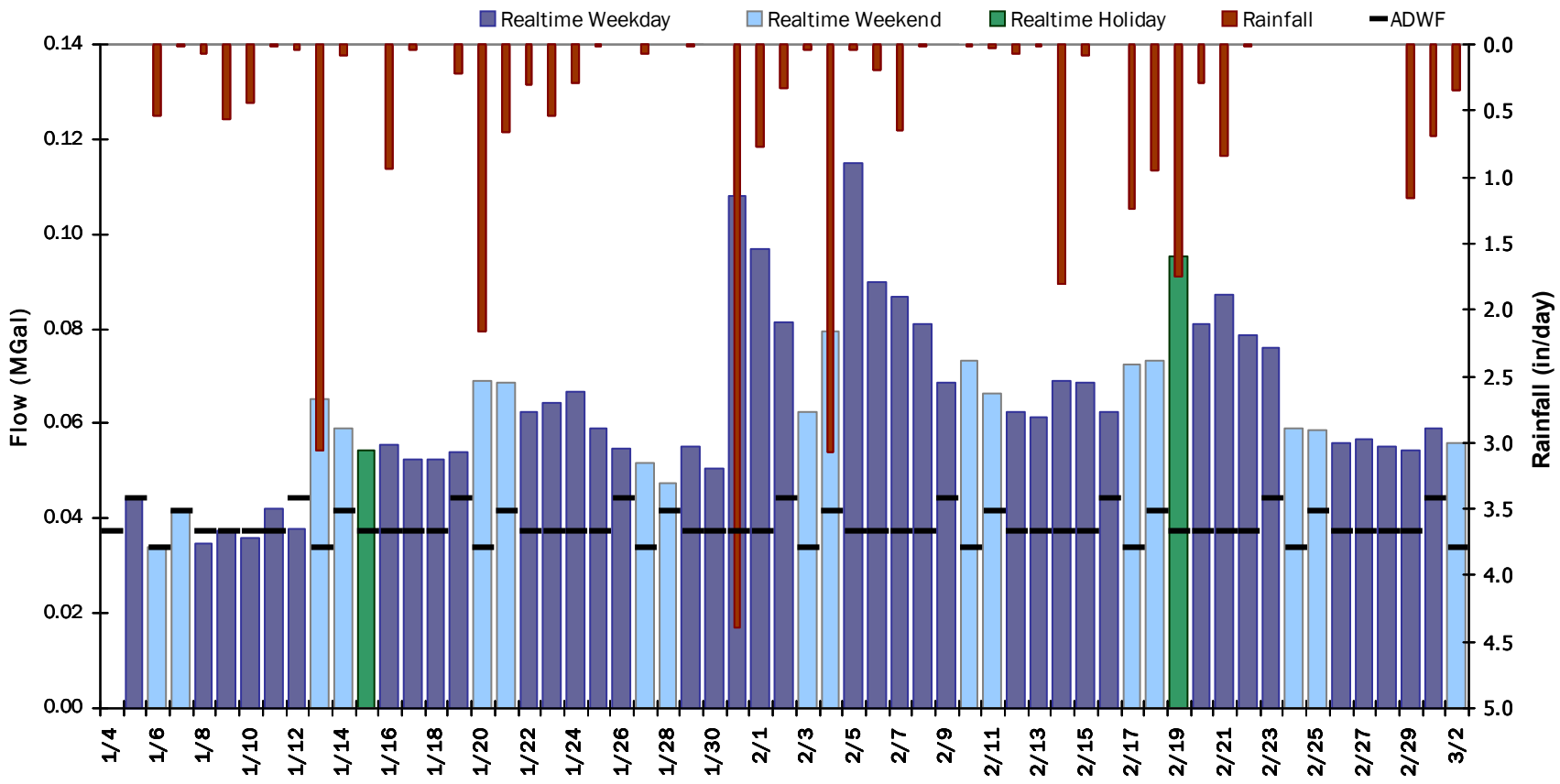
South Inlet Pipe

FM-07

Period Flow Summary: Daily Flow Totals

Avg Daily Flow: 0.064 MGal Peak Daily Flow: 0.115 MGal Min Daily Flow: 0.034 MGal

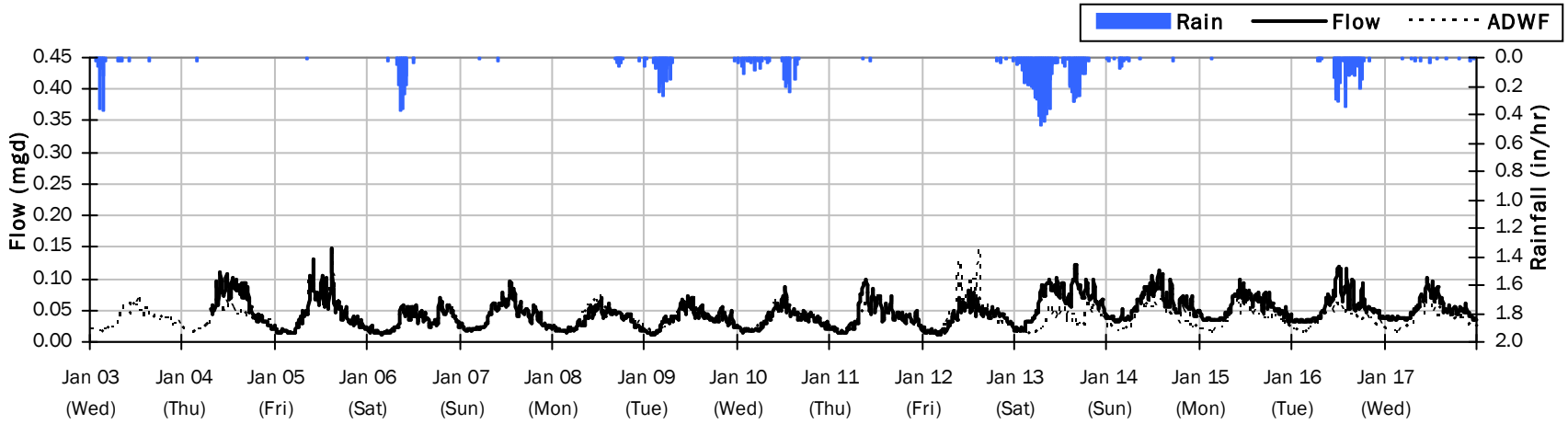
Total Rainfall: 28.85 inches

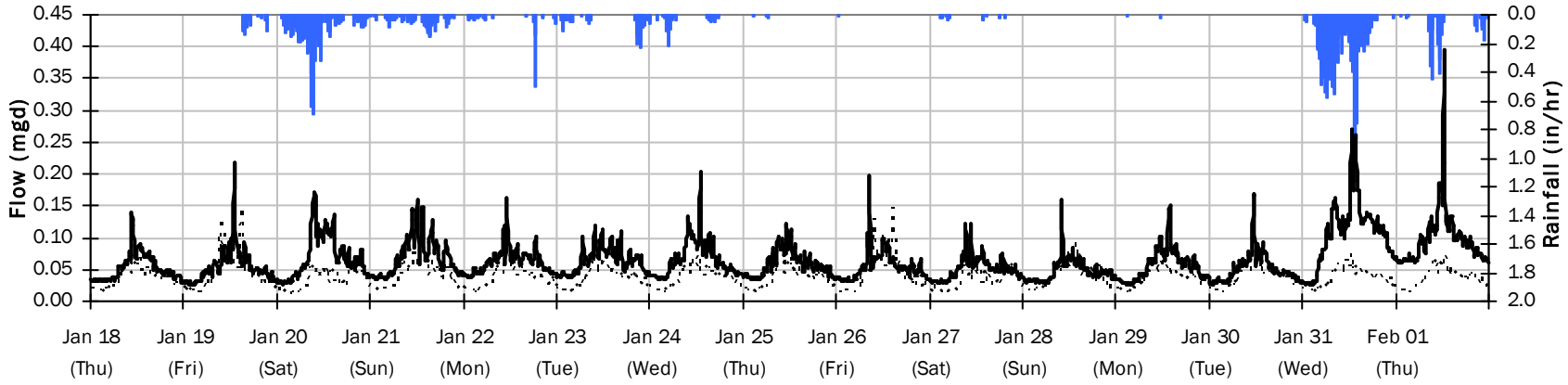


FM-07

Flow Summary: 1/3/2024 to 2/1/2024

Period Rainfall: 15.53 inches Period Avg Flow: 0.056 mgd Period Peak Flow: 0.395 mgd Period Min Flow: 0.011 mgd

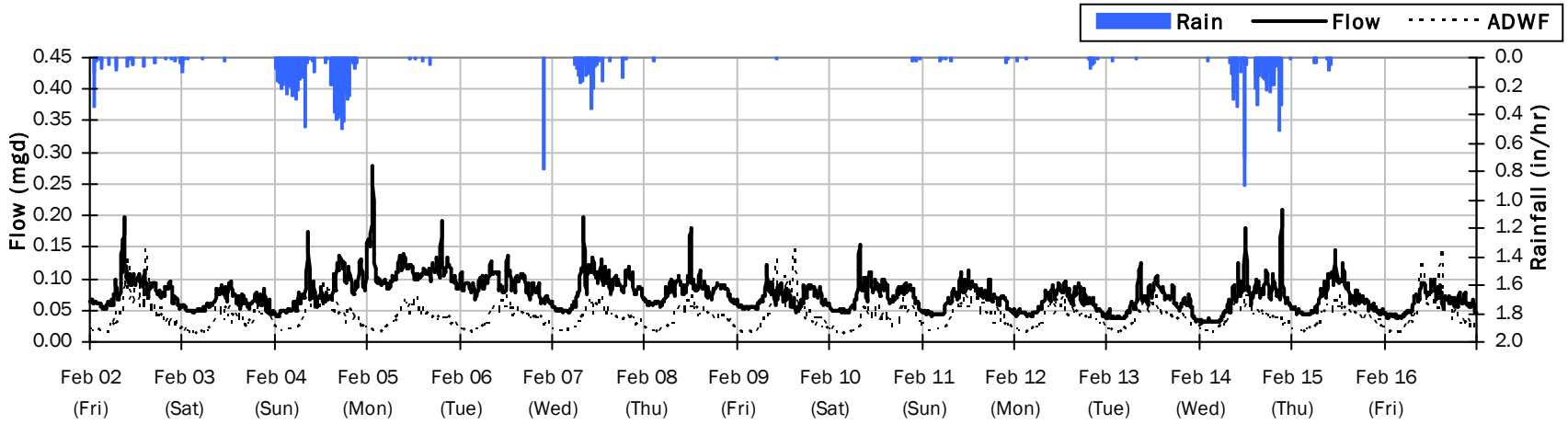


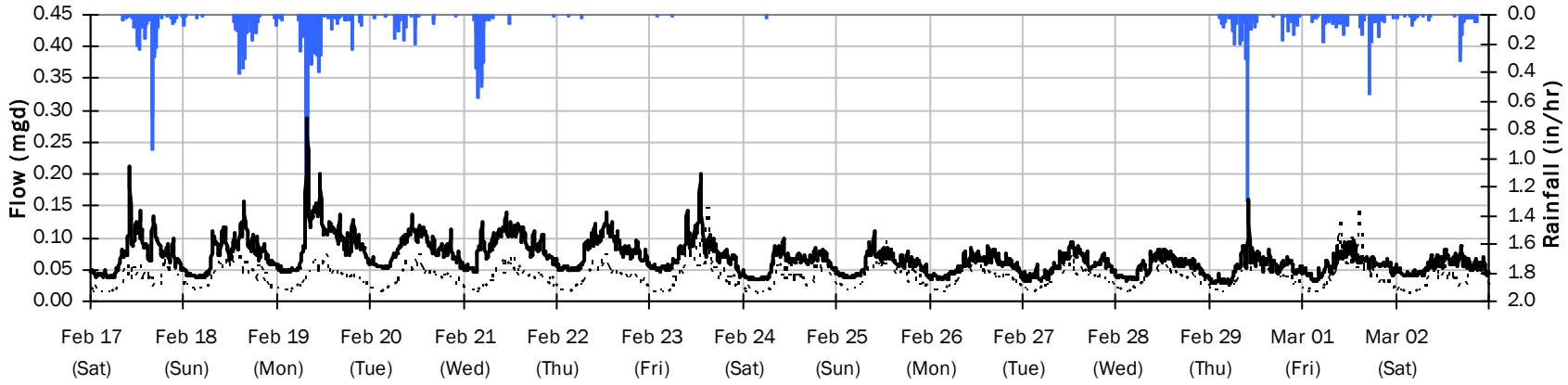


FM-07

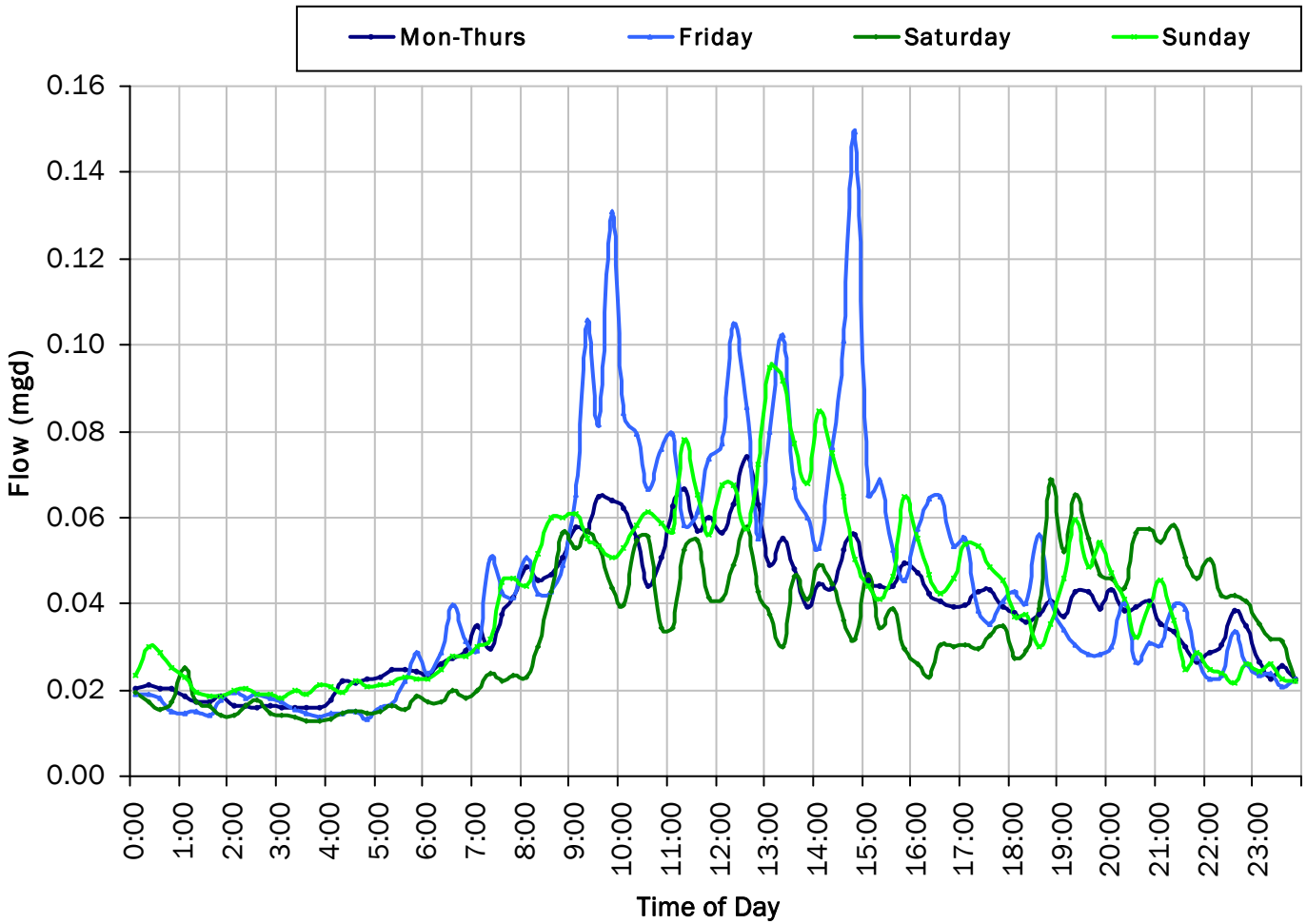
Flow Summary: 2/2/2024 to 3/2/2024

Period Rainfall: 13.65 inches Period Avg Flow: 0.072 mgd Period Peak Flow: 0.288 mgd Period Min Flow: 0.028 mgd



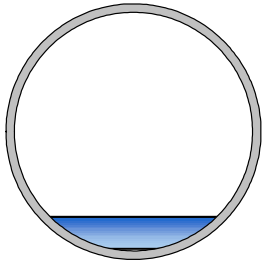


FM-07
Average Dry Weather Flow Hydrographs



ADWF:

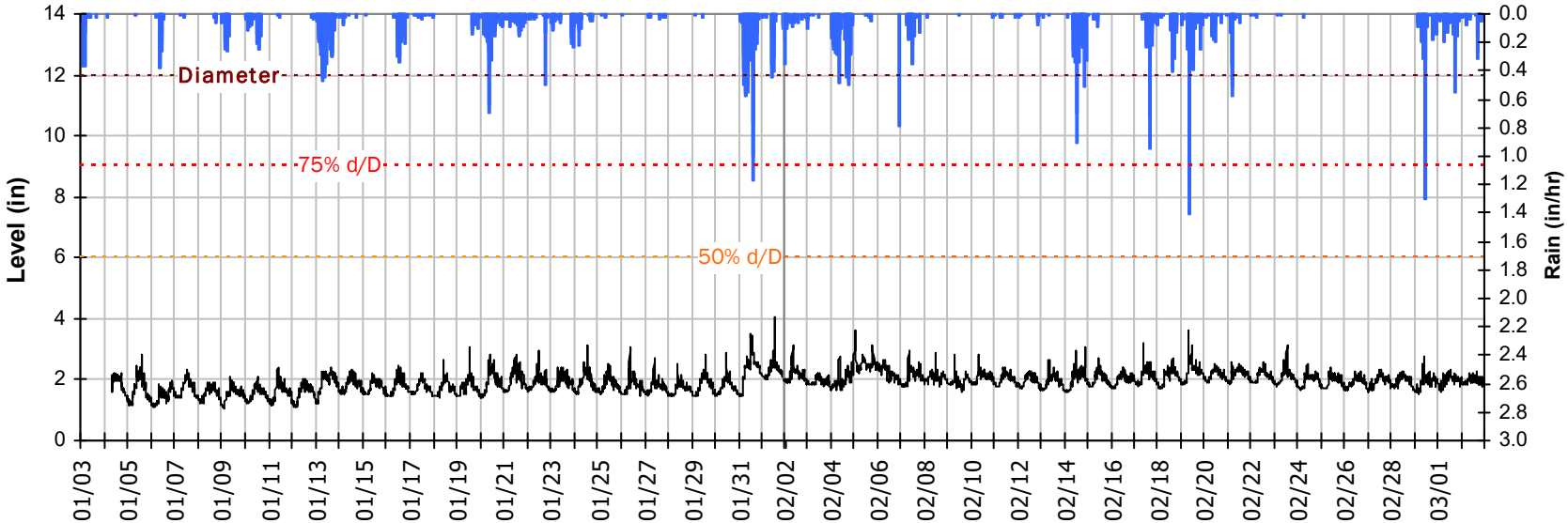
0.038 *mgd*

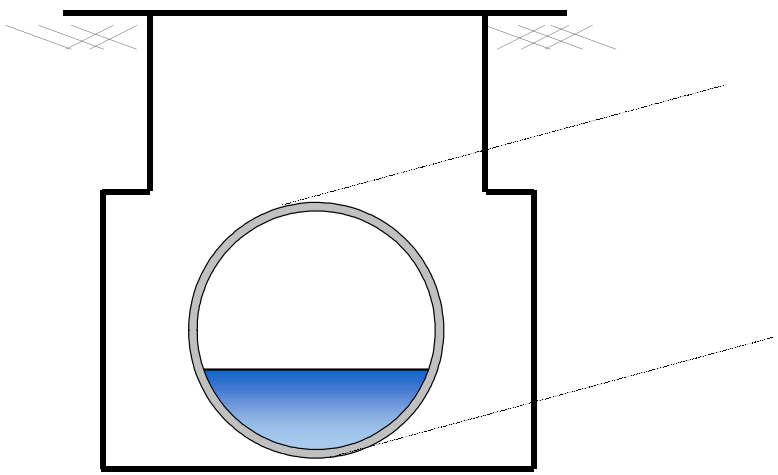


FM-07

Site Capacity and Surcharge Summary

Realtime Flow Levels with Rainfall Data over Peak Level Period

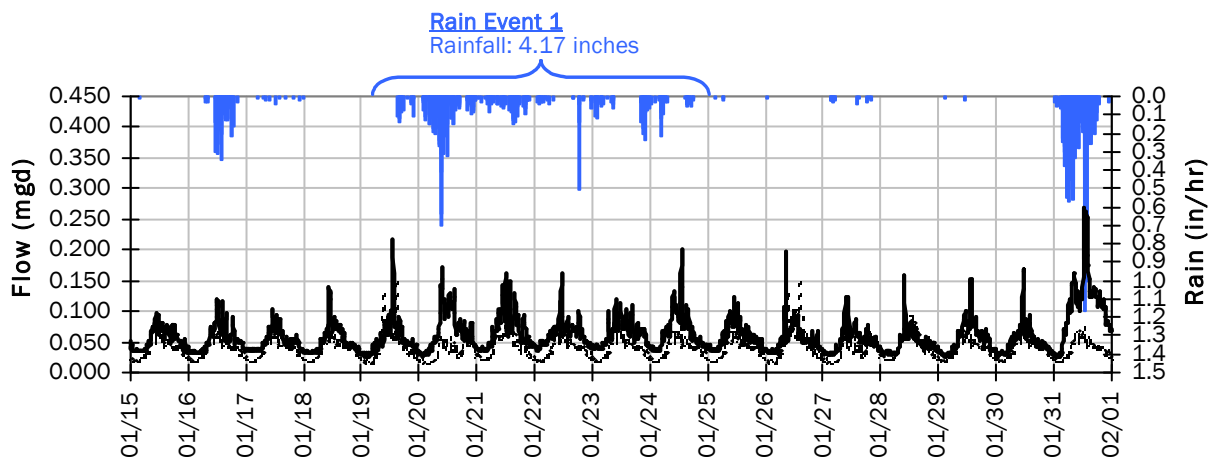




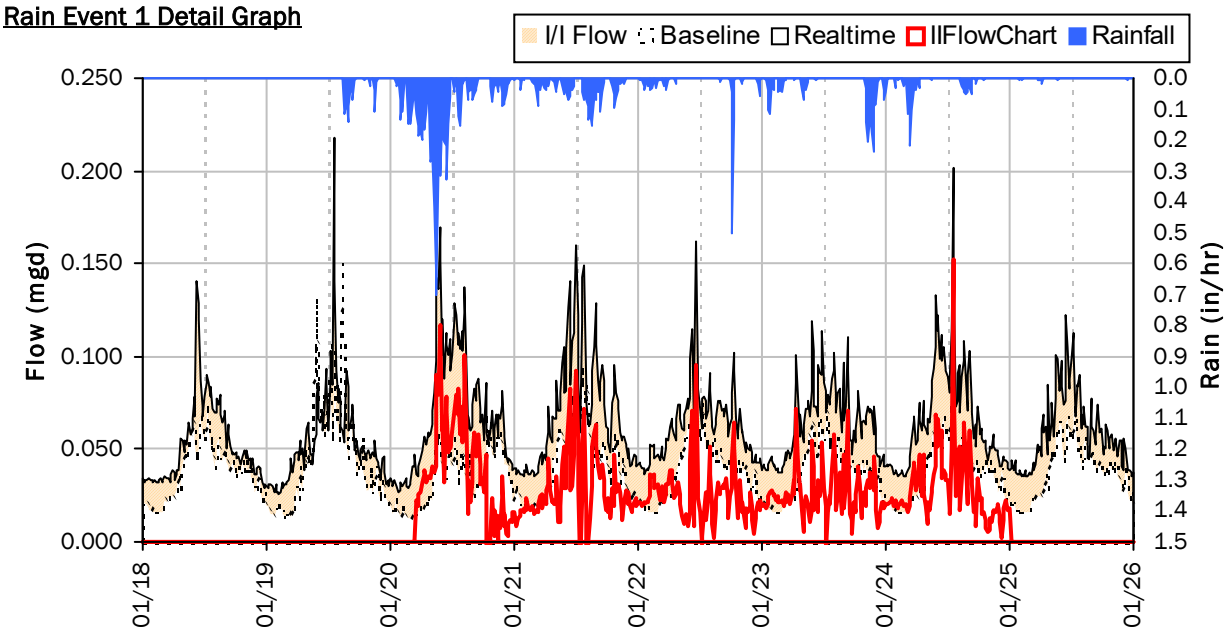
Pipe Diameter:	12	*inches*
Peak Measured Level:	4.05	*inches*
Peak d/D Ratio:	0.34	

FM-07
I/I Summary: Rain Event 1

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 1 Detail Graph

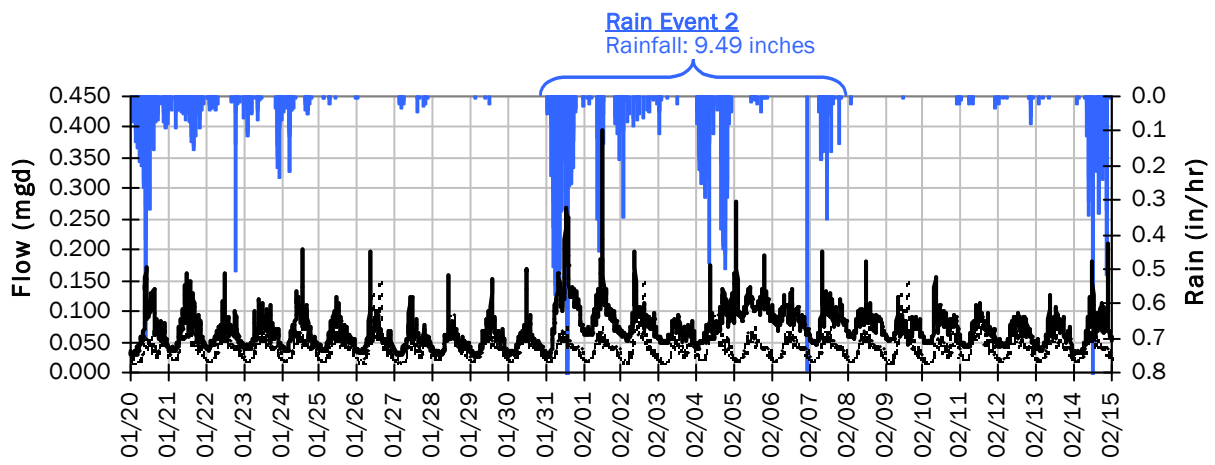


Storm Event I/I Analysis (Rain = 4.17 inches)

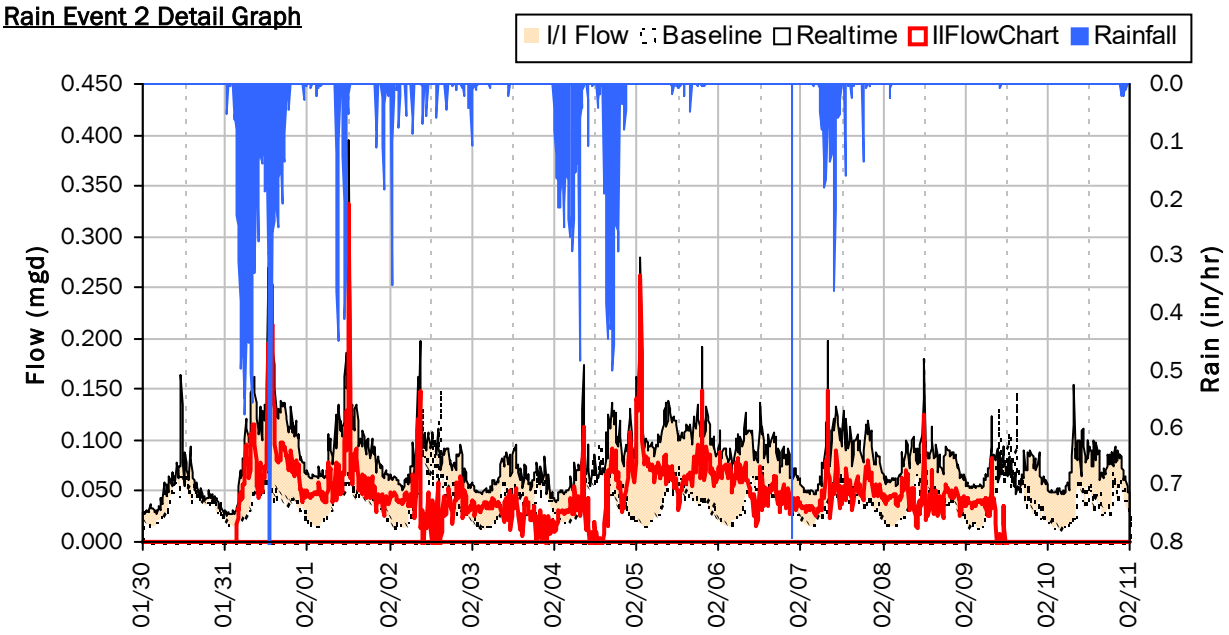
Capacity		Inflow / Infiltration	
Peak Flow:	0.202 *mgd*	**Peak I/I Rate:**	0.153 *mgd*
PF:	5.24	**Total I/I:**	140,000 *gallons*
Peak Level:	3.12 *in*		
d/D Ratio:	0.26		

FM-07
I/I Summary: Rain Event 2

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 2 Detail Graph

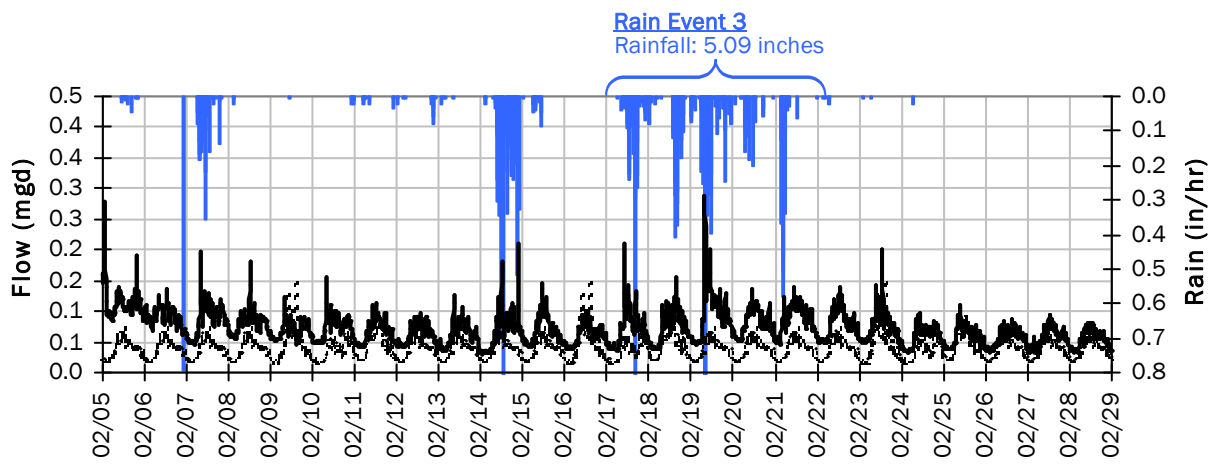


Storm Event I/I Analysis (Rain = 9.49 inches)

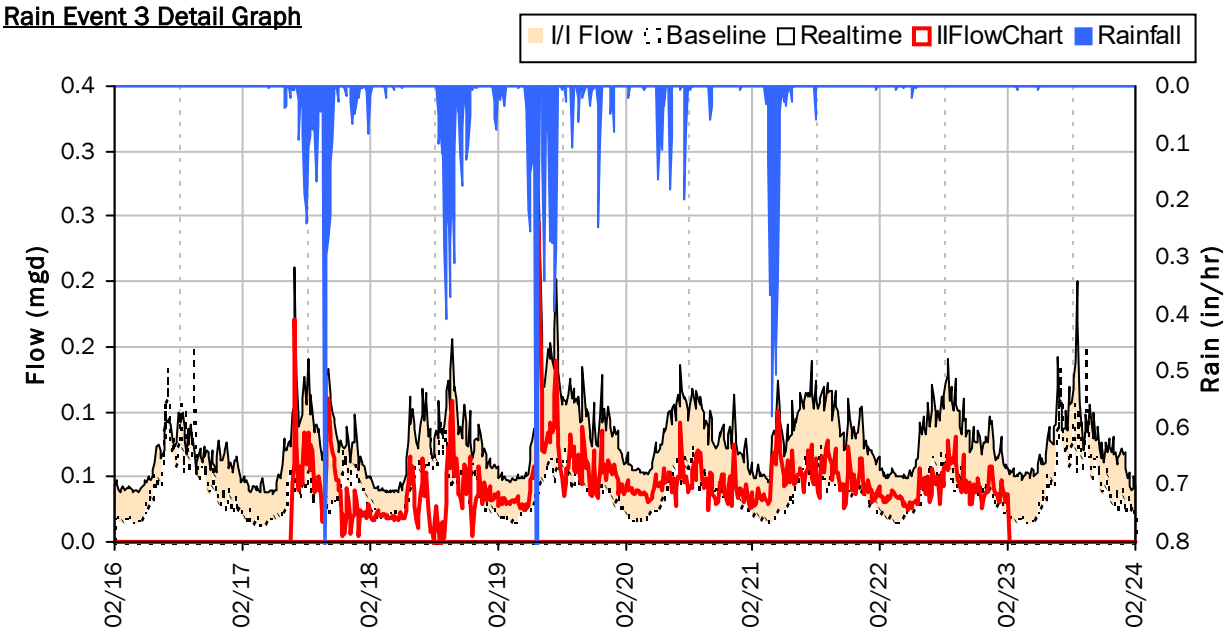
Capacity		Inflow / Infiltration	
Peak Flow:	0.395 *mgd*	**Peak I/I Rate:**	0.332 *mgd*
PF:	10.26	**Total I/I:**	469,000 *gallons*
Peak Level:	4.05 *in*		
d/D Ratio:	0.34		

FM-07
I/I Summary: Rain Event 3

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 3 Detail Graph

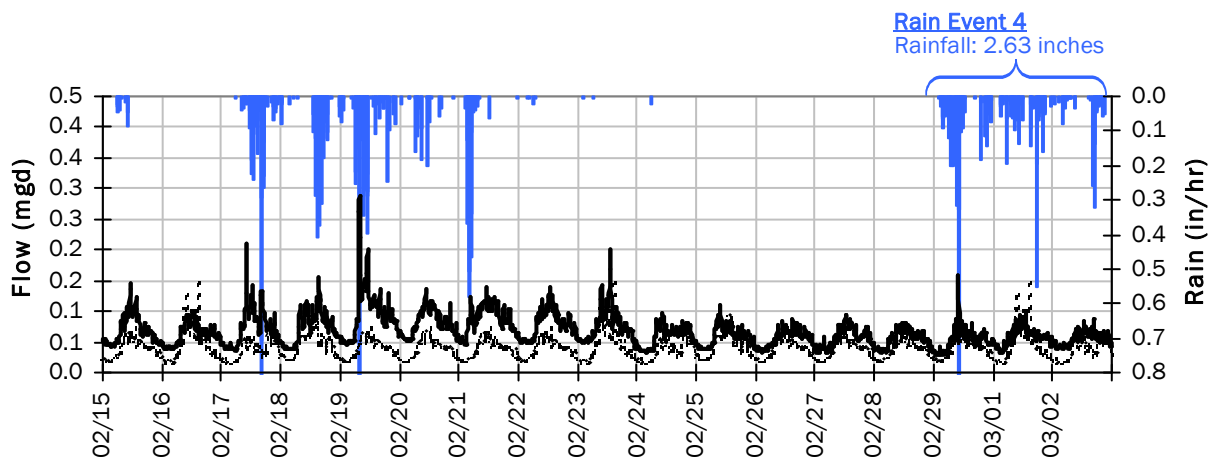


Storm Event I/I Analysis (Rain = 5.09 inches)

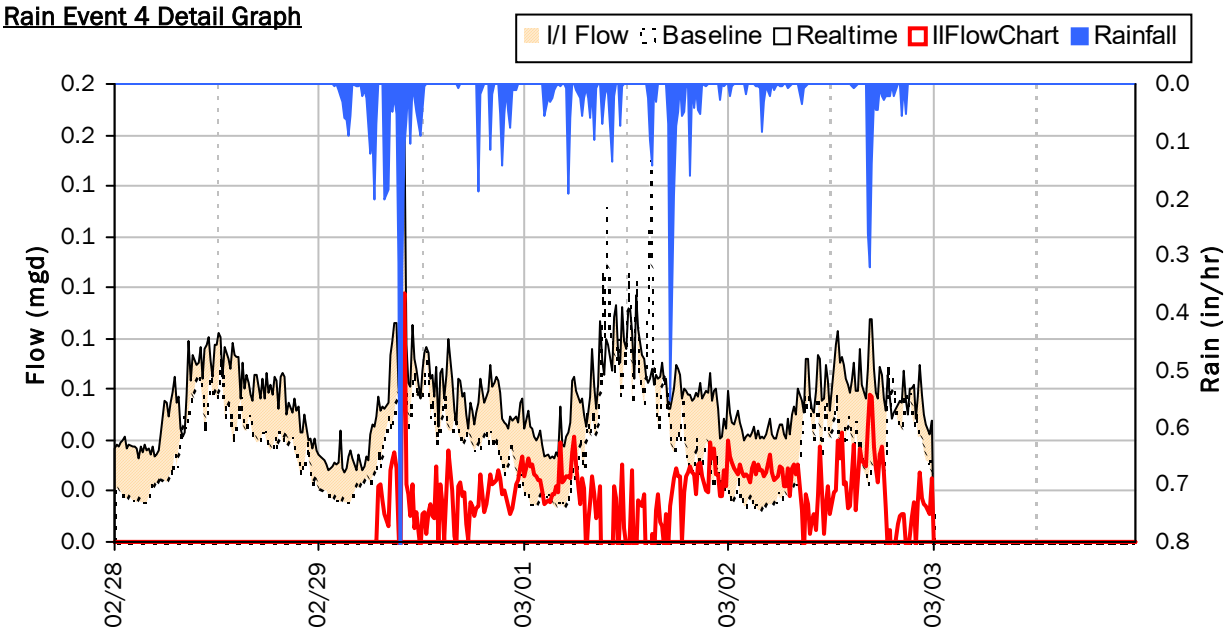
Capacity		Inflow / Infiltration	
Peak Flow:	0.29 *mgd*	**Peak I/I Rate:**	0.25 *mgd*
PF:	7.48	**Total I/I:**	252,000 *gallons*
Peak Level:	3.61 *in*		
d/D Ratio:	0.30		

FM-07
I/I Summary: Rain Event 4

Baseline and Realtime Flows with Rainfall Data over Monitoring Period



Rain Event 4 Detail Graph



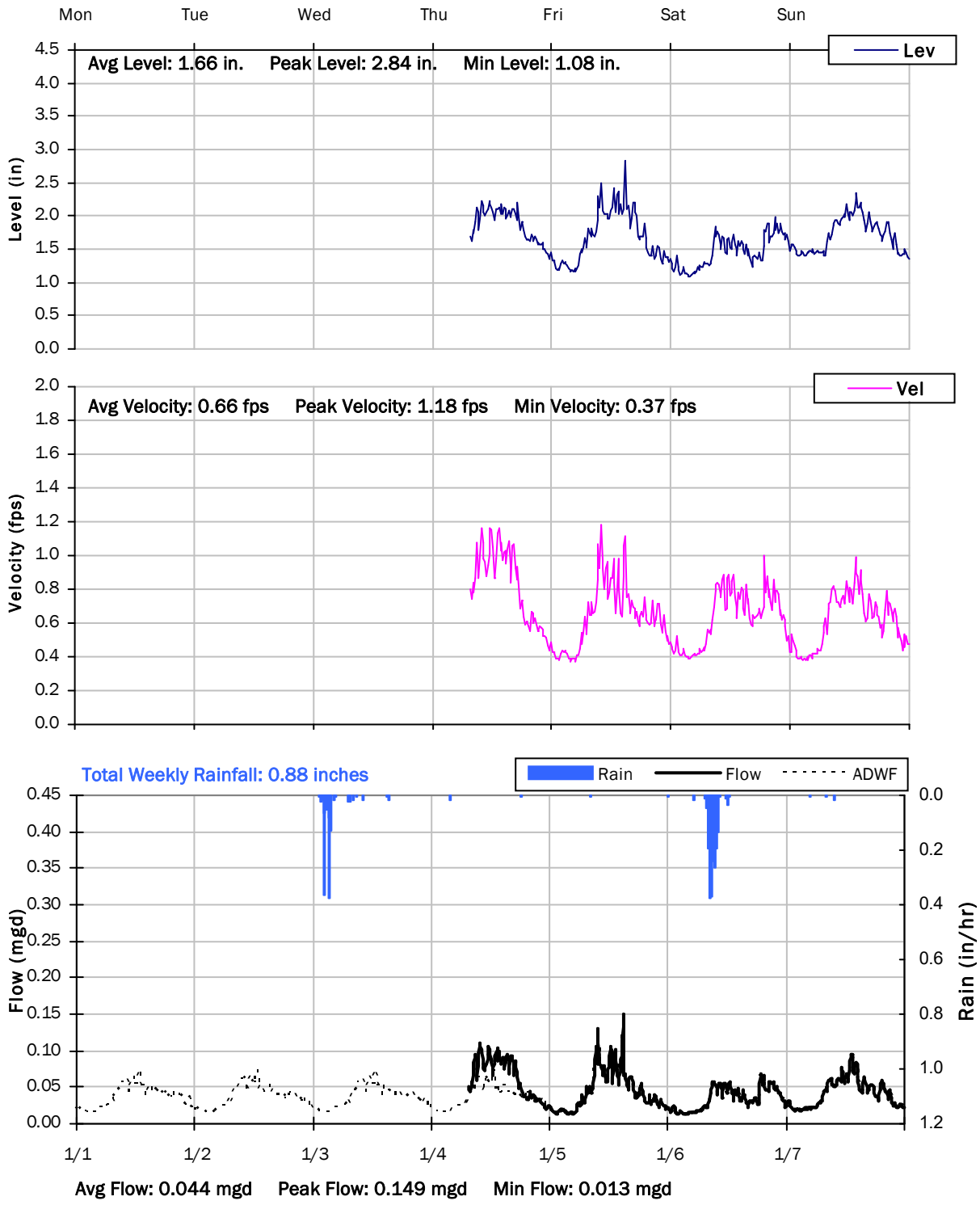
Storm Event I/I Analysis (Rain = 2.63 inches)

Capacity		Inflow / Infiltration	
Peak Flow:	0.16 *mgd*	**Peak I/I Rate:**	0.10 *mgd*
PF:	4.16	**Total I/I:**	50,000 *gallons*
Peak Level:	2.75 *in*		
d/D Ratio:	0.23		

FM-07

Weekly Level, Velocity and Flow Hydrographs

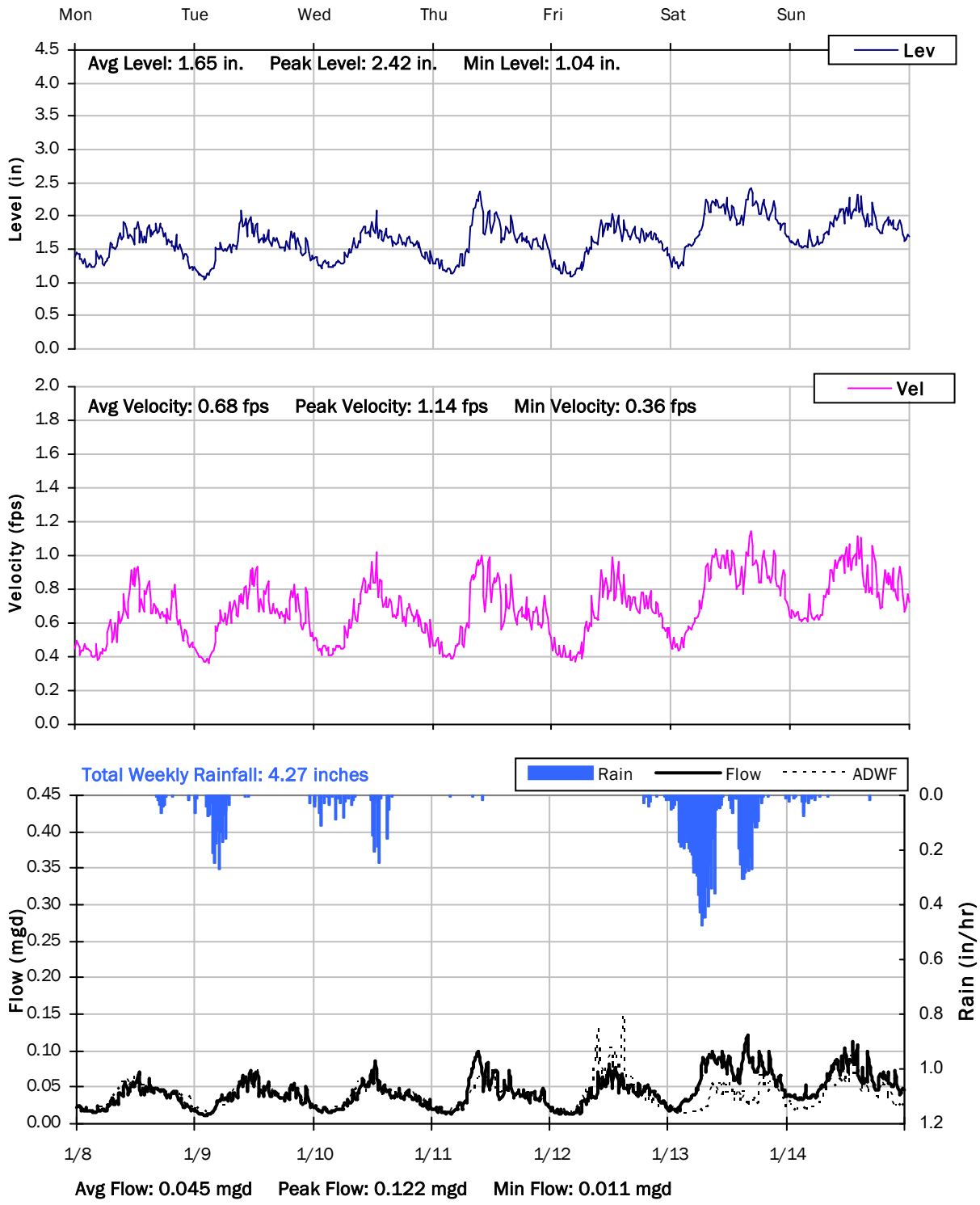
1/1/2024 to 1/8/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

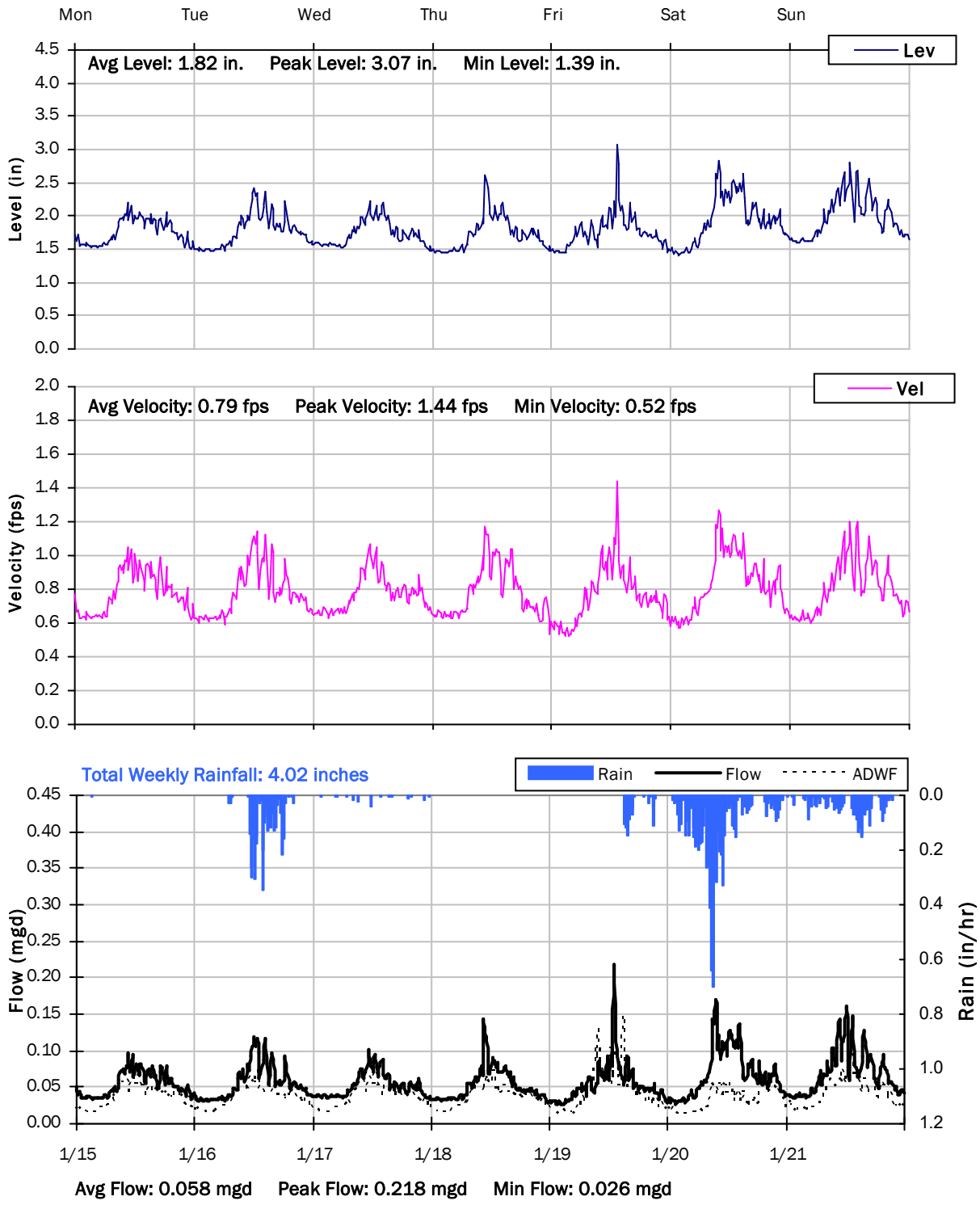
1/8/2024 to 1/15/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

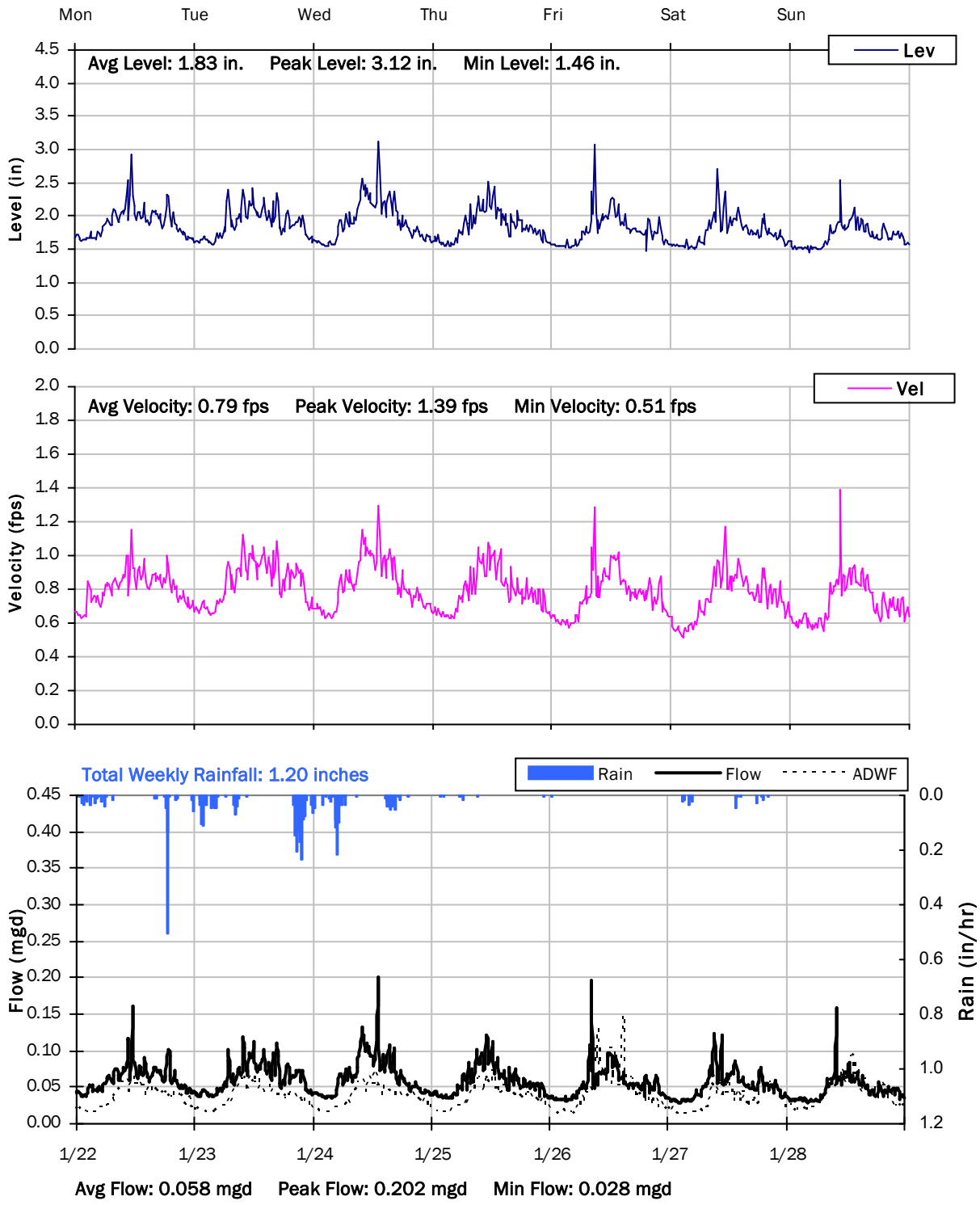
1/15/2024 to 1/22/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

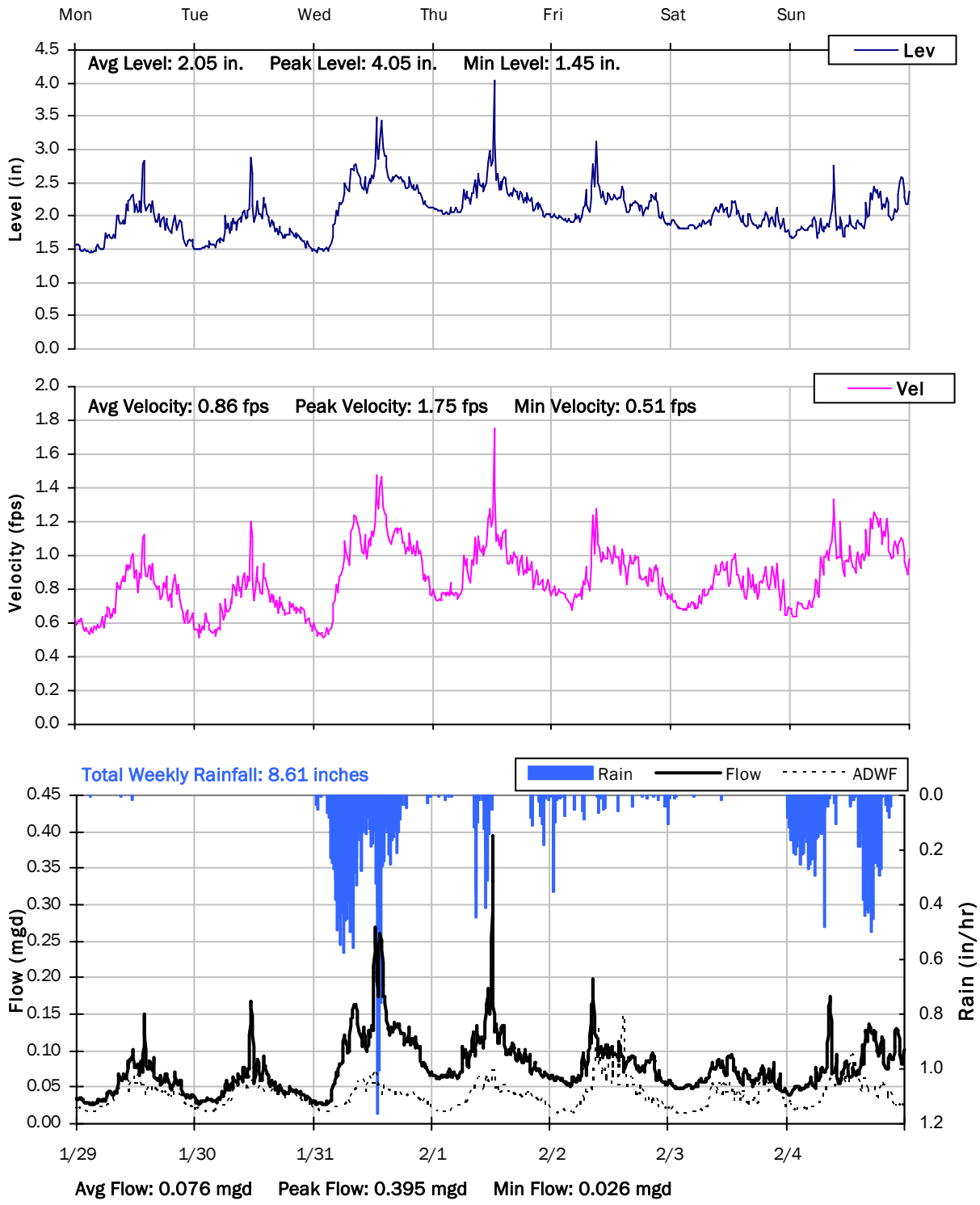
1/22/2024 to 1/29/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

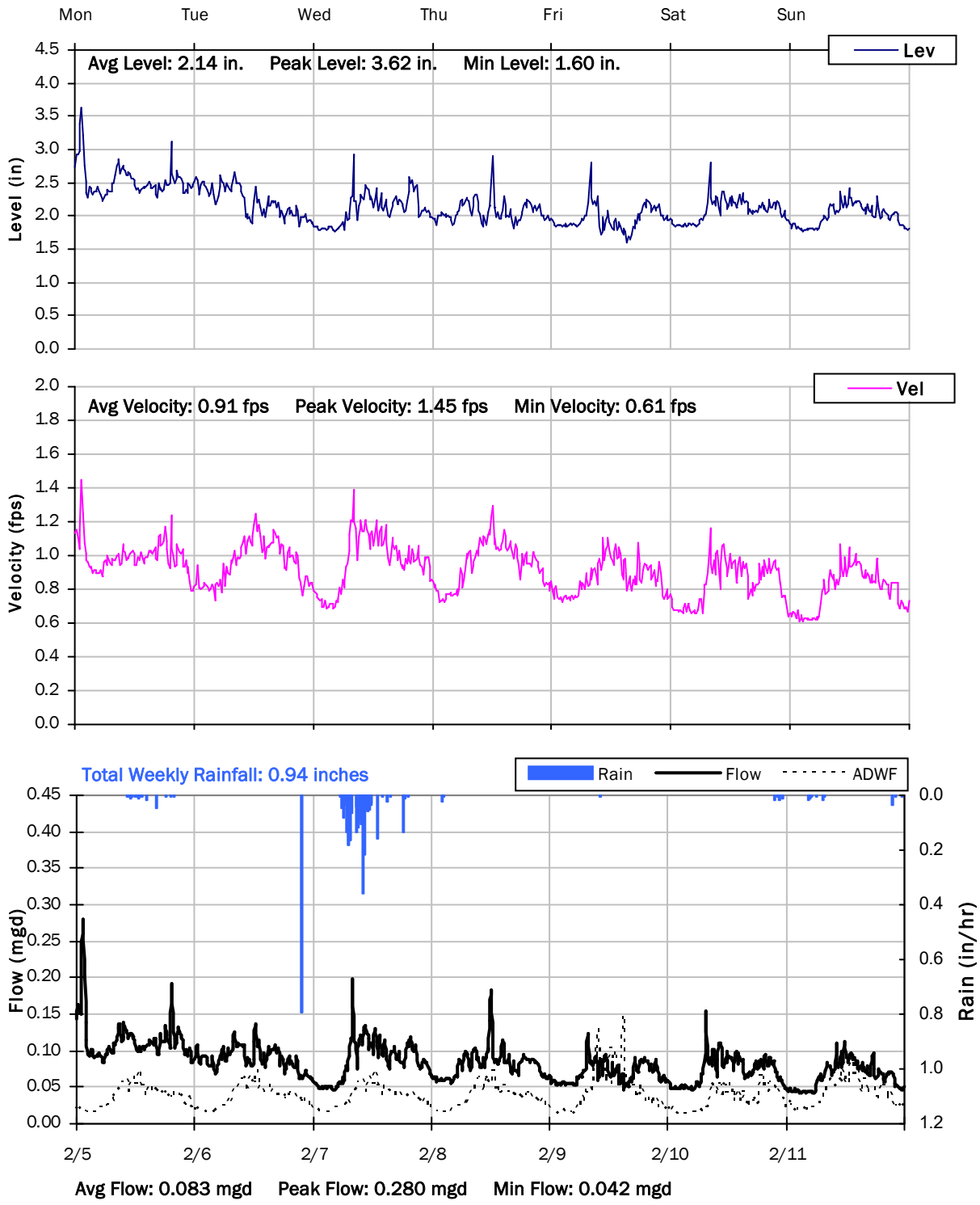
1/29/2024 to 2/5/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

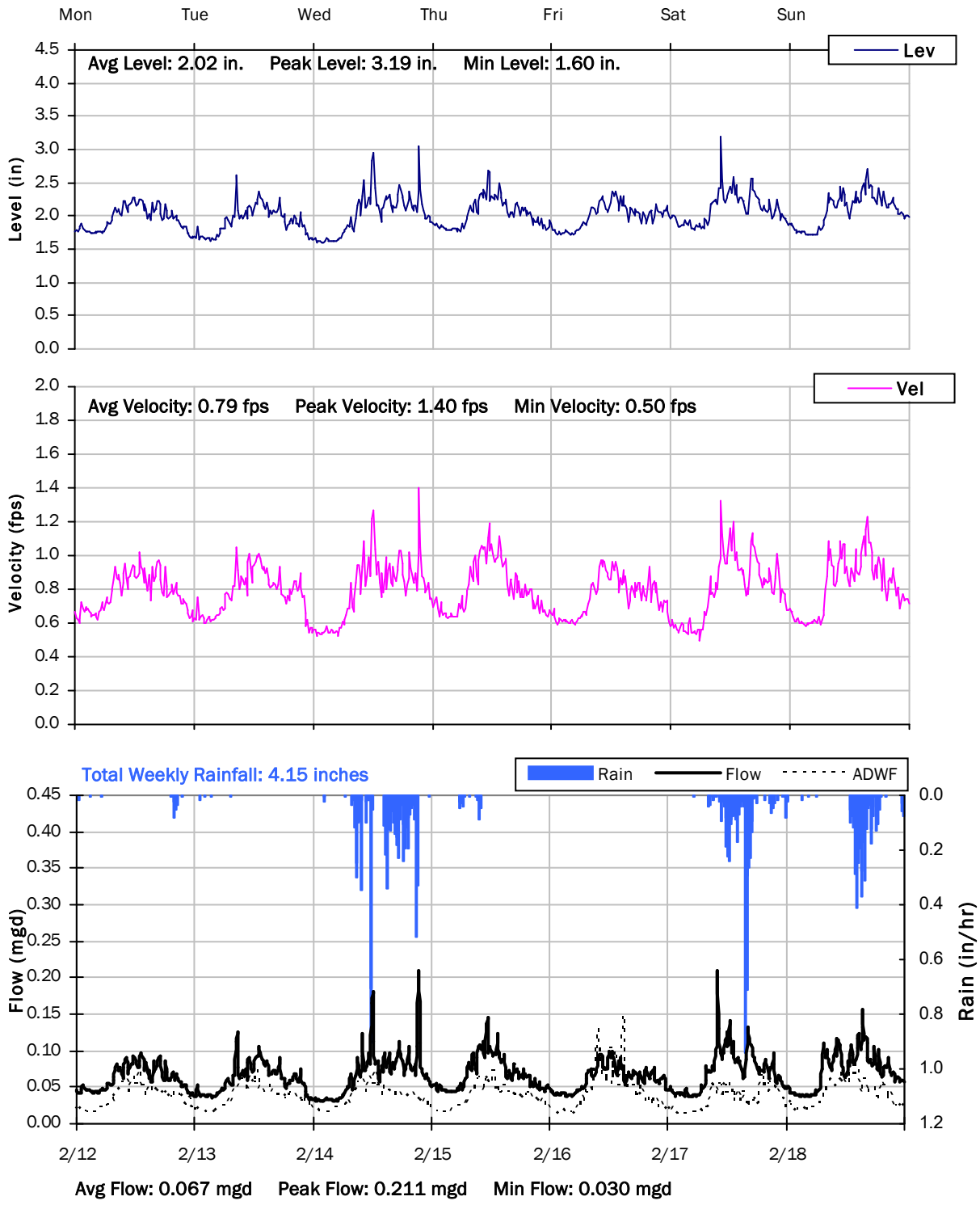
2/5/2024 to 2/12/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

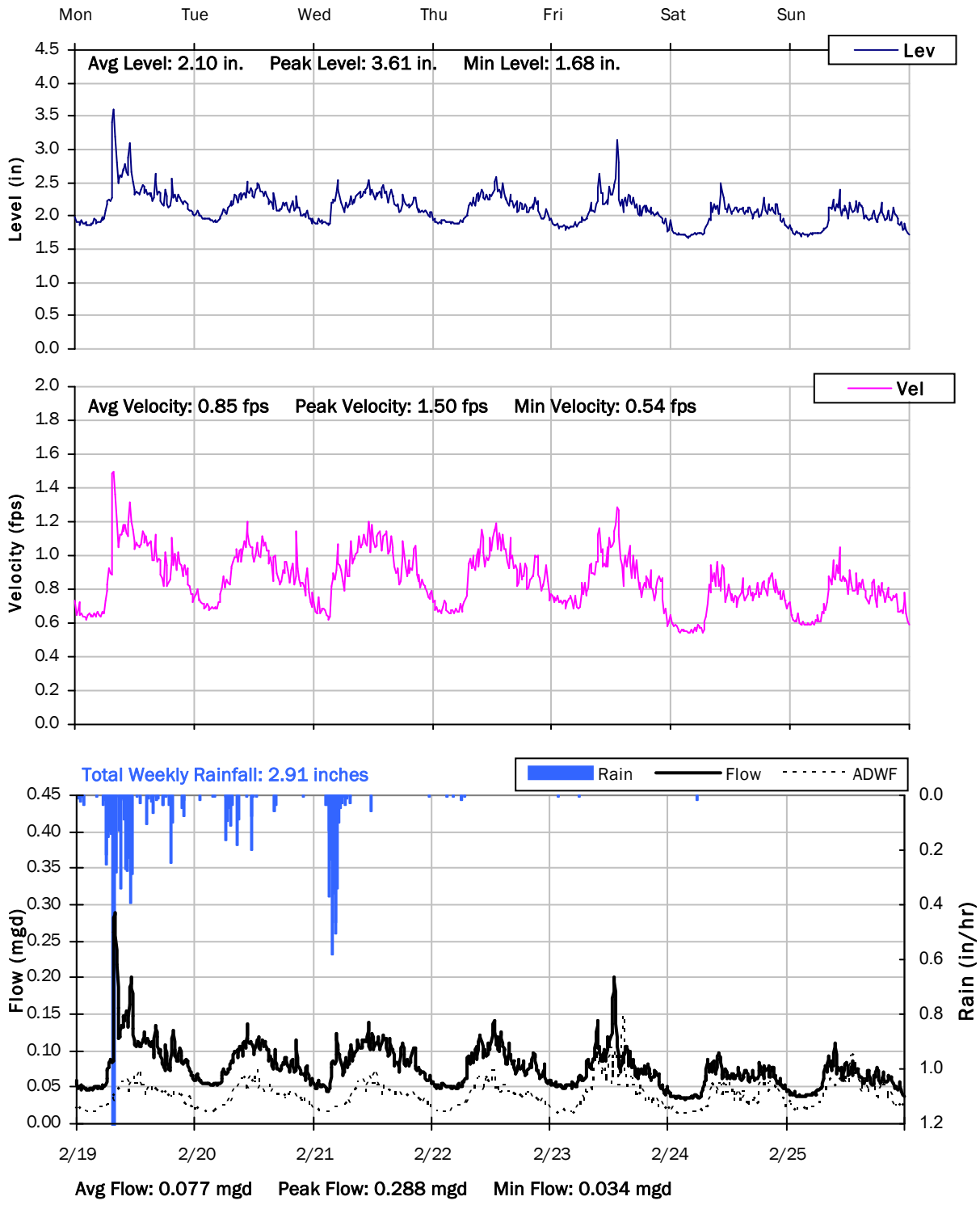
2/12/2024 to 2/19/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

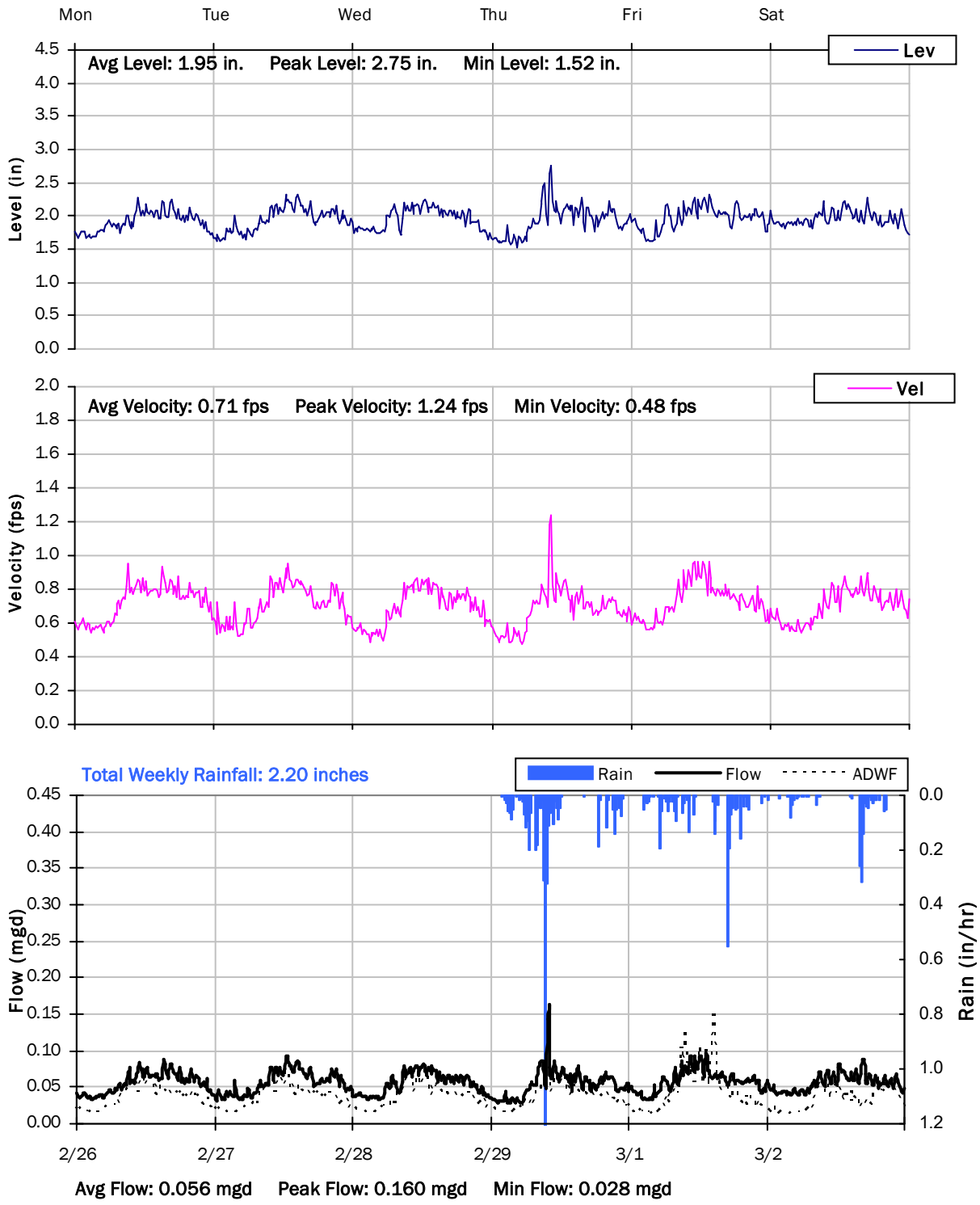
2/19/2024 to 2/26/2024



FM-07

Weekly Level, Velocity and Flow Hydrographs

2/26/2024 to 3/4/2024



V&A Project No. 23-0169

V&A
consulting engineers
1000 Broadway
Suite 320
Oakland, CA 94607
510.903.6600
510.903.6601, Fax

Appendix C. Model Calibration Results

Appendix C: Model Calibration Results

Ft. Bragg Wastewater CSMP

City of Fort Bragg

December 5, 2025

This page is intentionally left blank

Appendix C: Model Calibration Results

1.1 Dry Weather Flow (DWF) Calibration Results

This section includes DWF calibration results for each monitored basin. Model results are shown alongside field measurements from the flow monitoring performed by V&A.

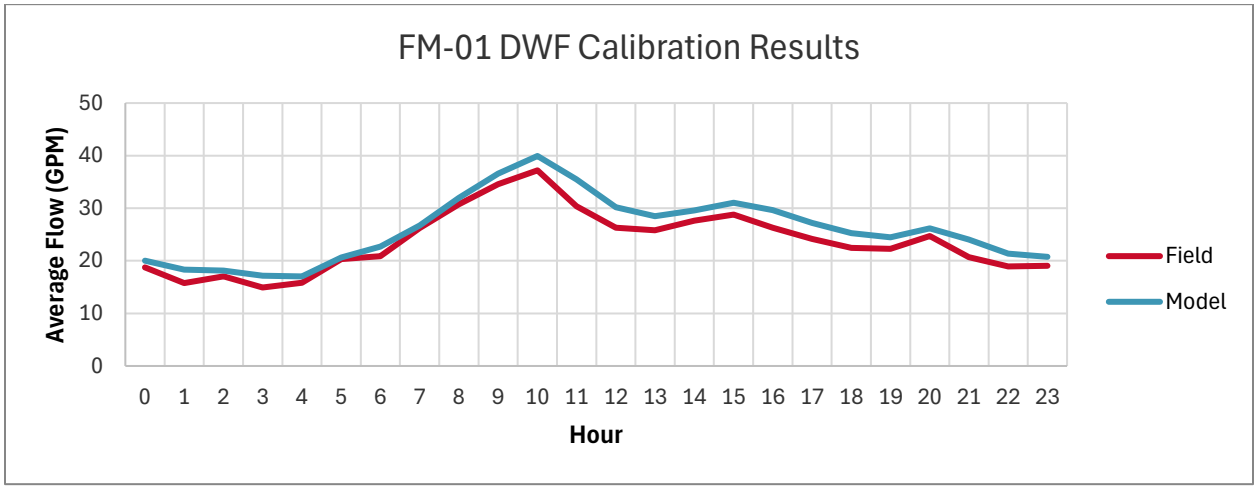


Figure 4. A. 1. FM-01 DWF Calibration Results

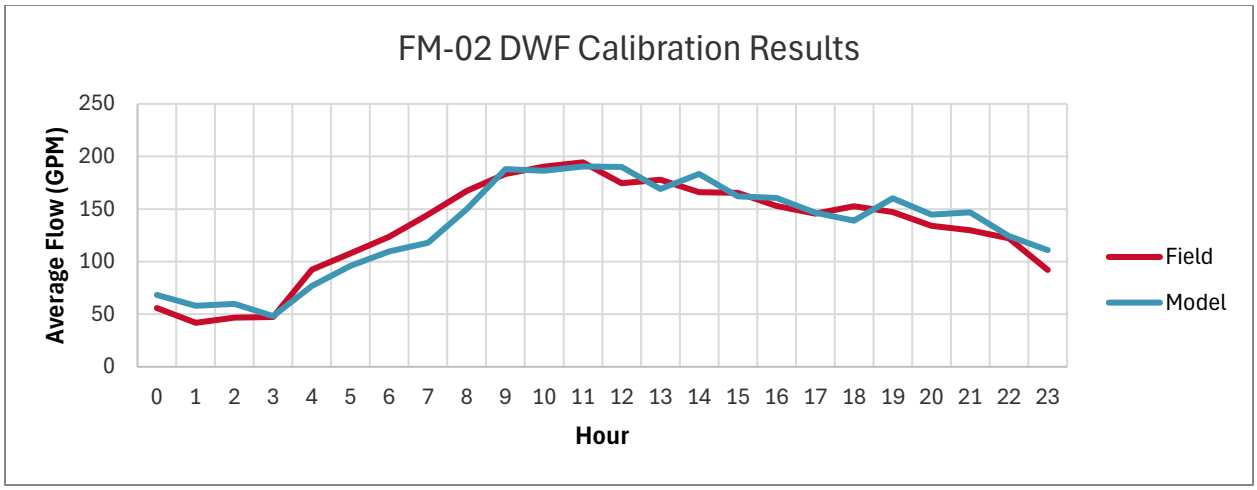


Figure 4. A. 2. FM-02 DWF Calibration Results

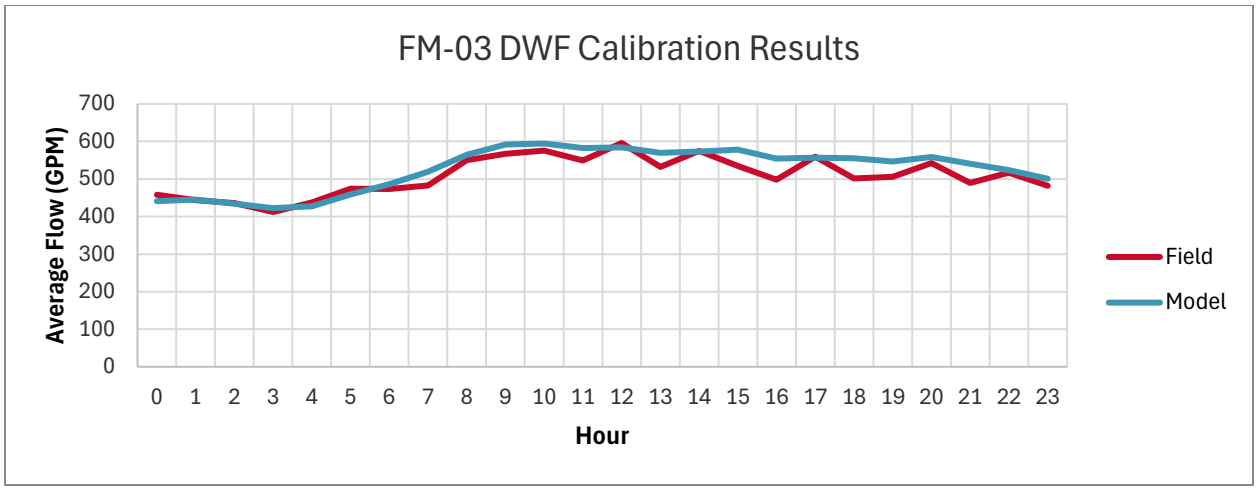


Figure 4. A. 3. FM-03 DWF Calibration Results

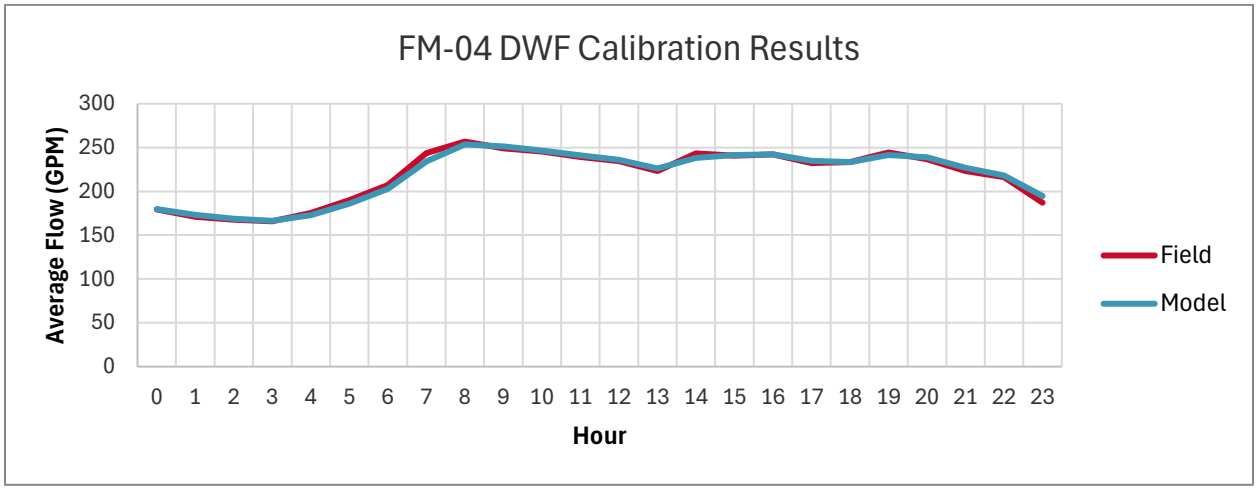


Figure 4. A. 4. FM-04 DWF Calibration Results

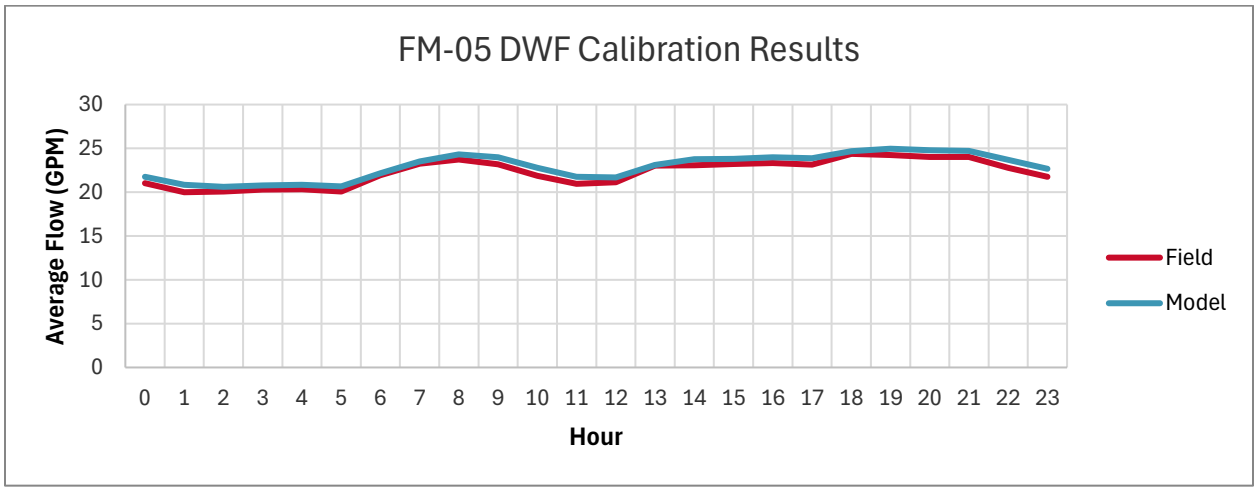


Figure 4. A. 5. FM-05 DWF Calibration Results

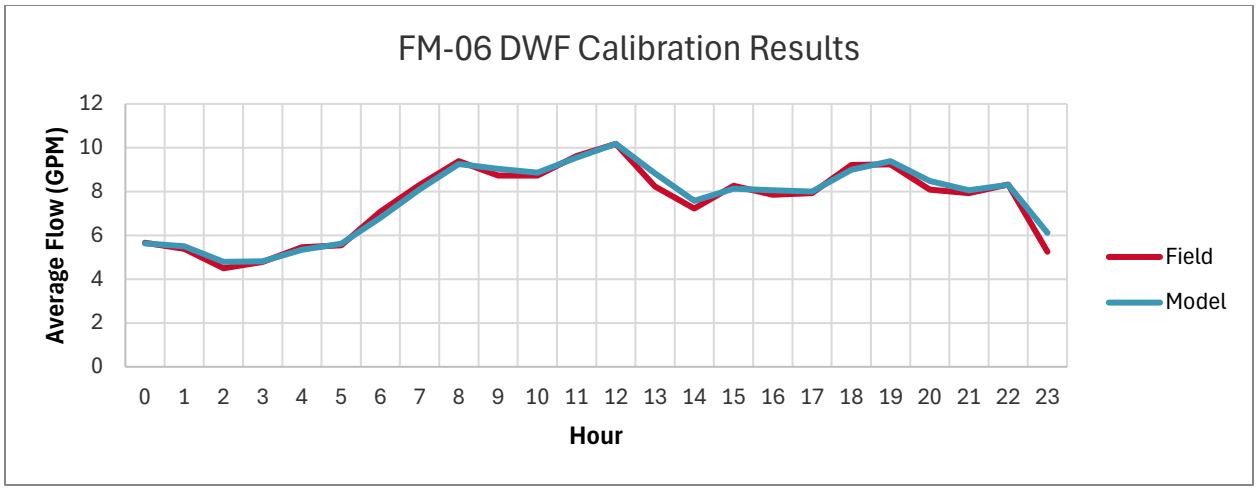


Figure 4. A. 6. FM-06 DWF Calibration Results

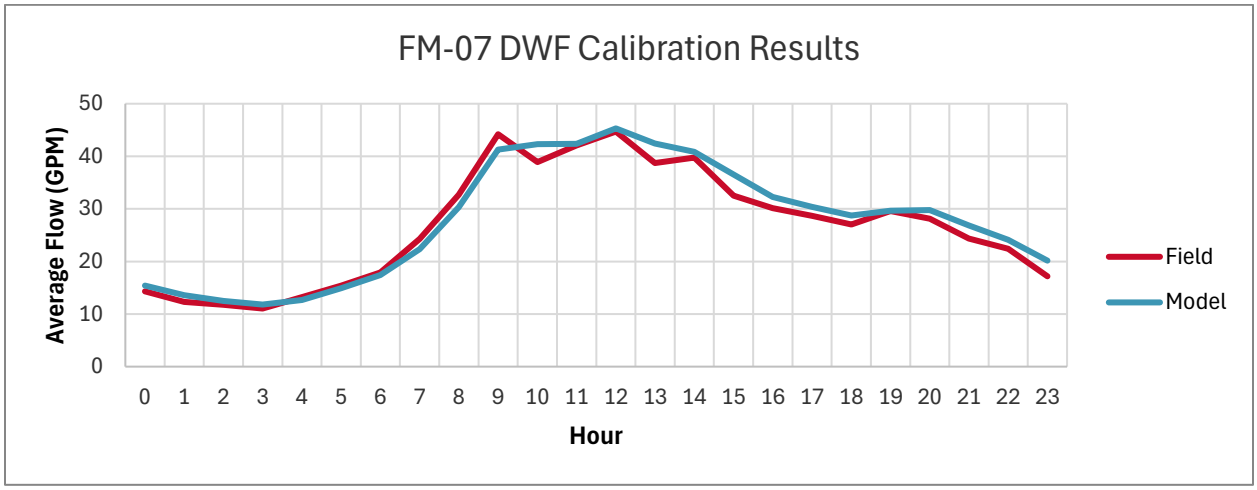


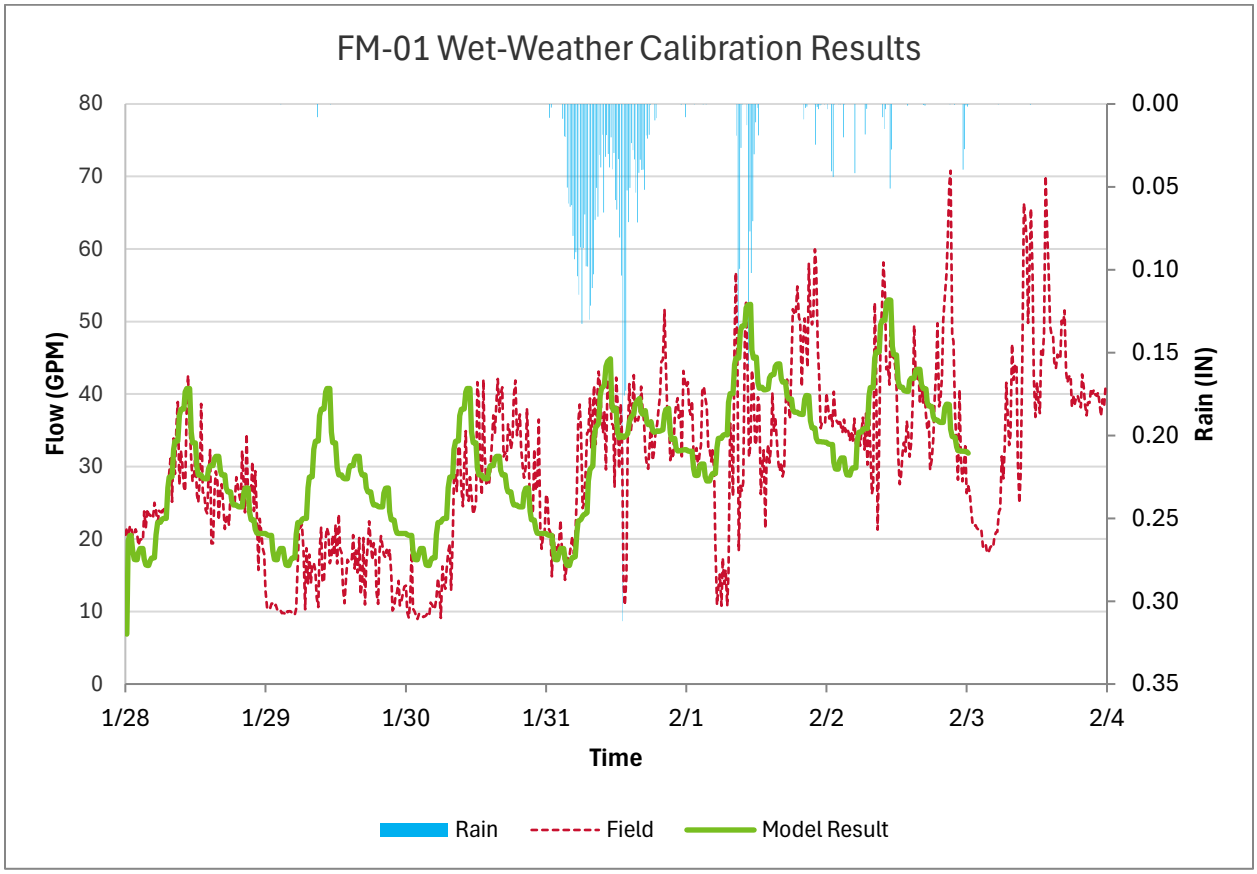
Figure 4. A. 7. FM-07 DWF Calibration Results

1.2 Wet-Weather Calibration Results

This section includes wet-weather RTKs and calibration results for each monitored basin. Model results are shown alongside flow and rainfall measurements from the flow monitoring performed by V&A.

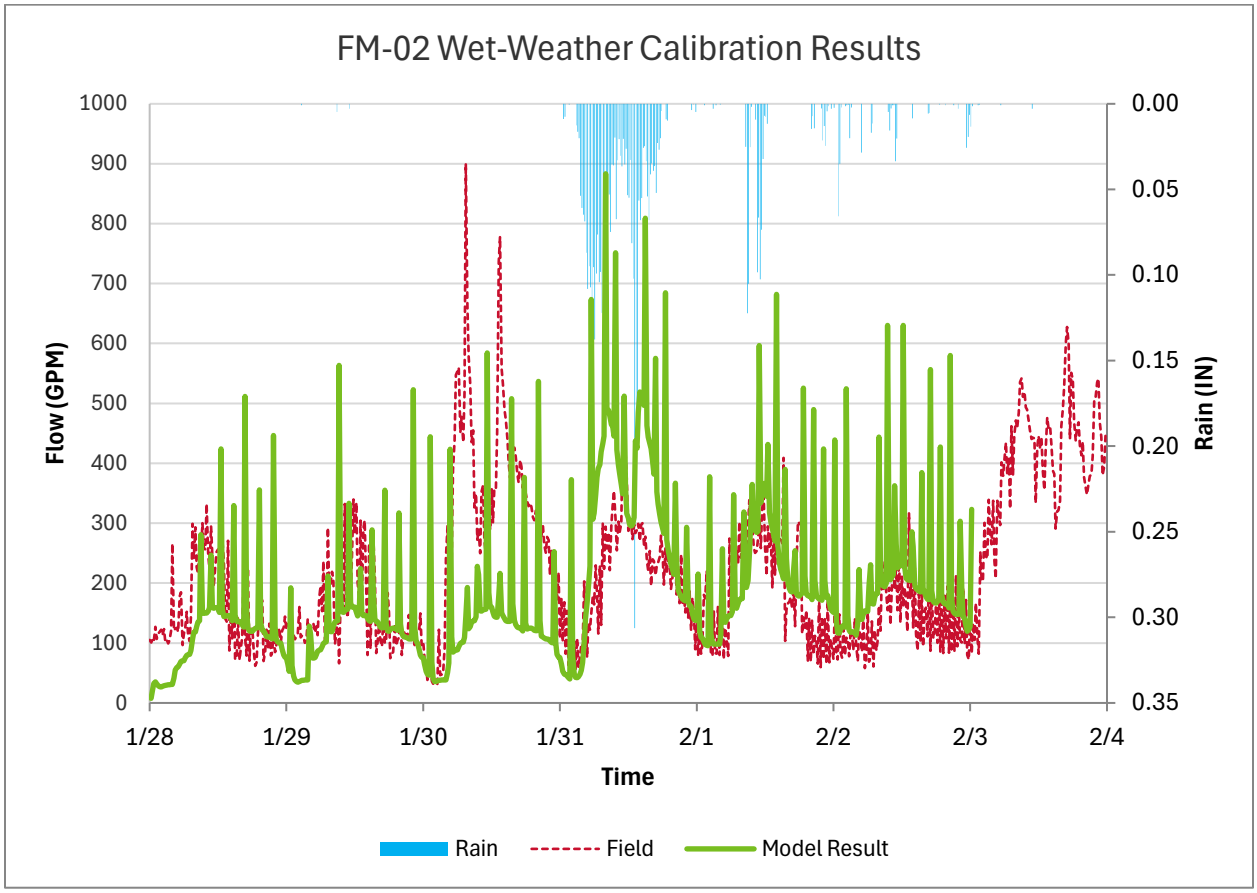
1.2.1 FM-01 RTKs and Calibration Results

Response Type	R	T	K
Short-Term	0.016	10.000	20.000
Medium-Term	0.017	5.000	25.000
Long-Term	0.018	20.000	30.000



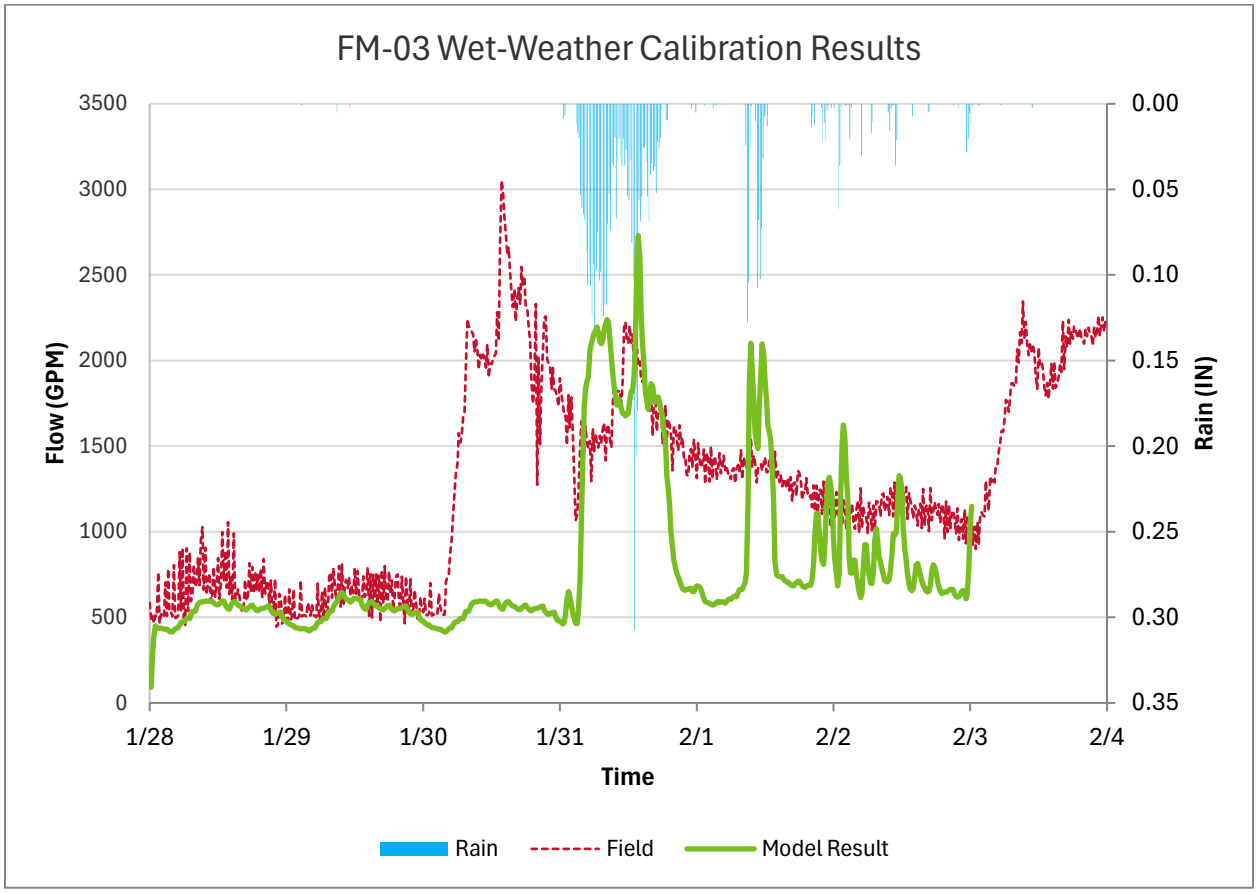
1.2.2 FM-02 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.058	0.100	40.000
Medium-Term	0.058	2.000	45.000
Long-Term	0.060	40.000	50.000



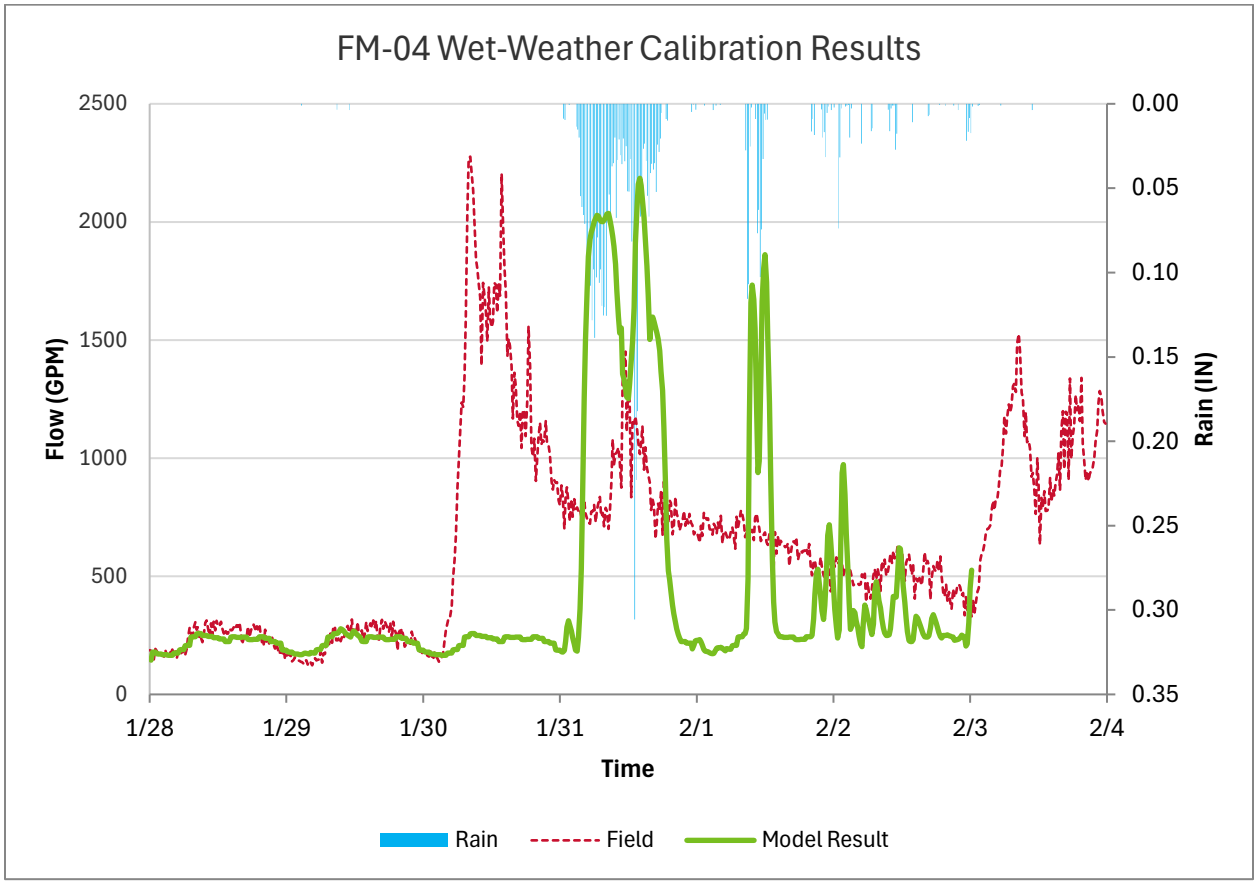
1.2.3 FM-03 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.170	0.100	8.000
Medium-Term	0.040	2.000	30.000
Long-Term	0.414	40.000	50.000



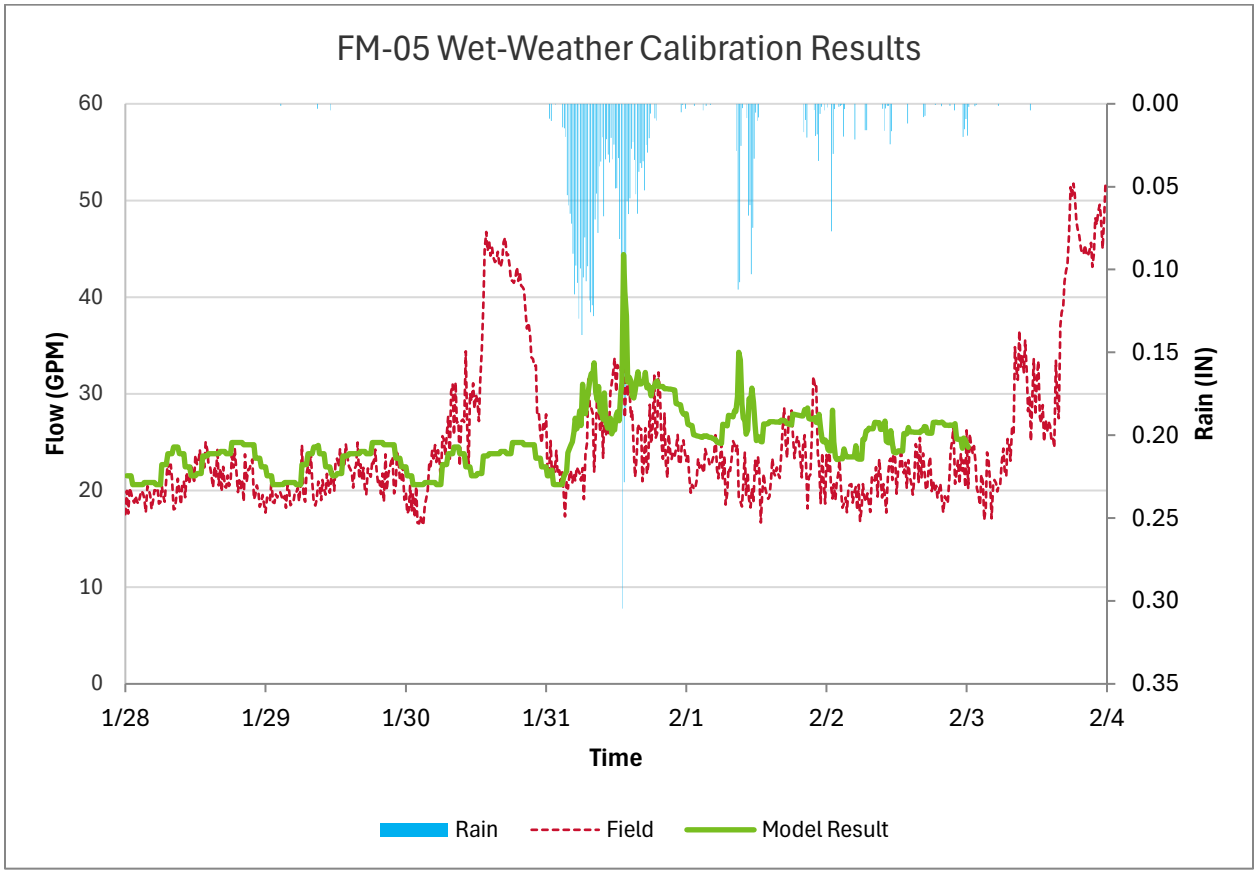
1.2.4 FM-04 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.450	0.500	3.000
Medium-Term	0.450	0.500	3.000
Long-Term	0.100	500.000	4.000



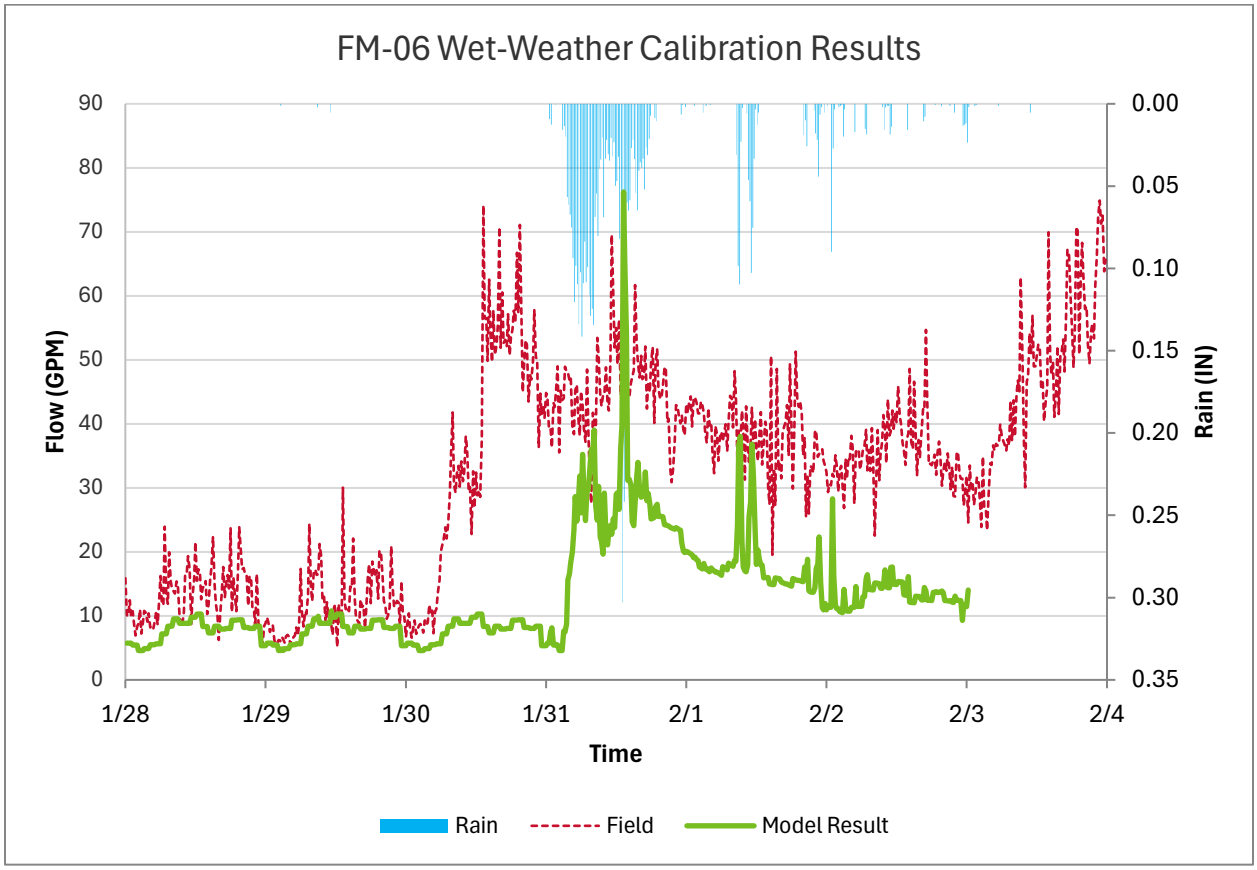
1.2.5 FM-05 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.010	0.100	1.000
Medium-Term	0.016	5.000	5.000
Long-Term	0.021	22.000	5.000



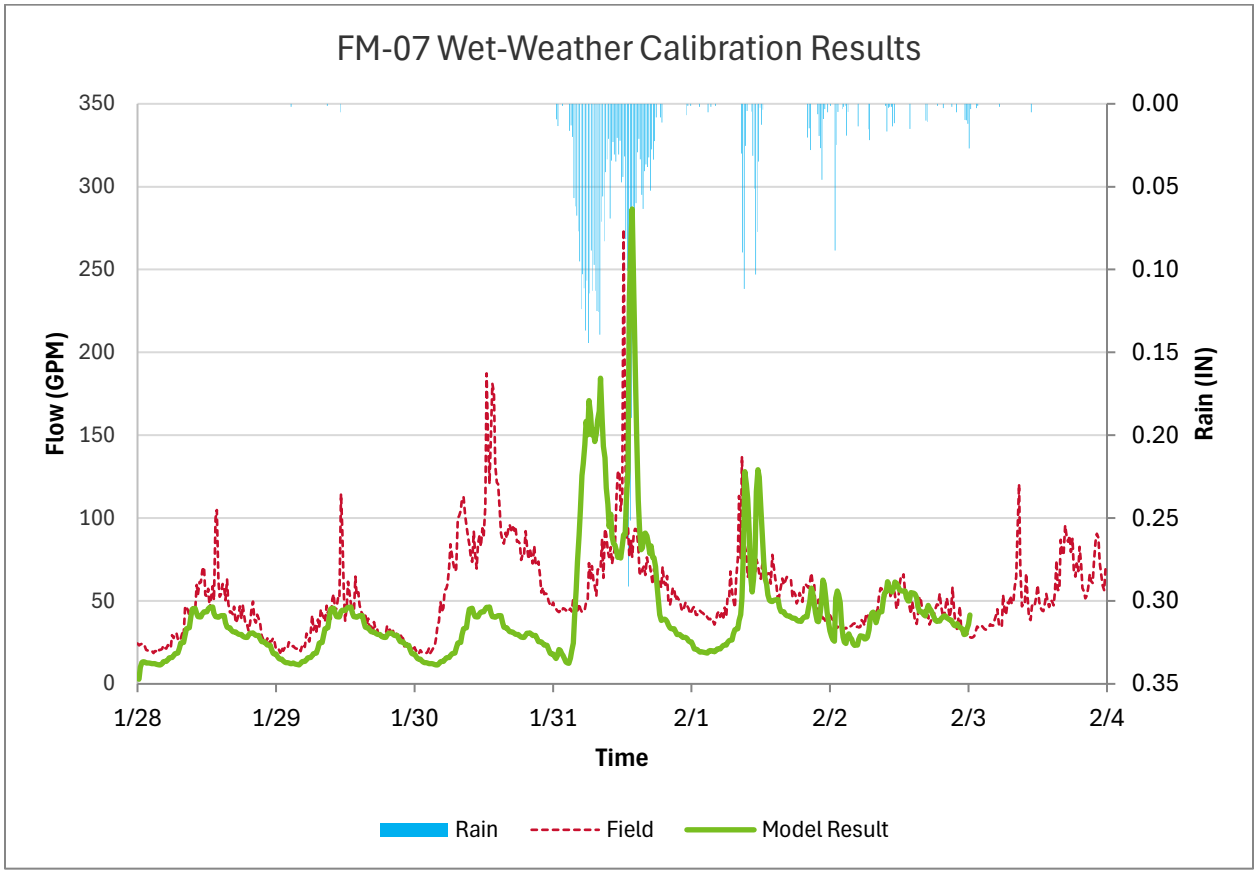
1.2.6 FM-06 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.025	0.100	1.000
Medium-Term	0.035	5.000	5.000
Long-Term	0.030	22.000	5.000



1.2.7 FM-07 RTKs and Calibration REsults

Response Type	R	T	K
Short-Term	0.0060	0.010	1.000
Medium-Term	0.0075	0.500	1.000
Long-Term	0.0080	26.000	5.000



Appendix D. Risk Factors & Weighting

Appendix D – Risk Factor Scoring Tables

Likelihood of Failure

- Weighting: 60%
- Max score: 5
- Minimum score: 0

Remaining Useful Life

- Weighting: 21%
- Max score: 5
- Minimum score: 1

Value	Grade
< -100%	5
10 to -100%	4
40 to 10%	3
90 to 40%	2
90 to 100%	1

Infiltration and Inflow (I&I)

- Weighting: 38%
- Max score: 5
- Minimum score: 1

Value	Grade
>800%	5
400 to 800%	3
300 to 400%	2
<300% or unknown	1

SSO History

- Weighting: 29%
- Max score: 5
- Minimum score: 0

Value	Grade
2 or more	5
1	3
0	0

Groundwater Fluctuations

- Weighting: 12%
- Max score: 5
- Minimum score: 1

Value	Grade
Known Groundwater Fluctuation	5
No Known Groundwater Fluctuation	1

Consequence of Failure

- Weighting: 40%
- Maximum COF score: 5
- Minimum COF score: 0

Diameter

- Weighting: 17%
- Max score: 5
- Minimum score: 1

Value	Grade
> 20 in	5
10 to 20 in	3
6 to 10 in	2
< 6 in	1

Critical Facilities

- Weighting: 33%
- Max score: 5
- Minimum score: 1

Value	Grade
Hospitals & Critical Care Facilities	5
WWTP	5
Schools and Coast Guard Station	4
Parks	2
Other	1

Proximity to Water Bodies

- Weighting: 50%
- Max score: 5
- Minimum score: 1

Value	Grade
< 50 ft	5
50 to 100 ft	4
100 to 150 ft	3
> 150 ft	1

Appendix E. CCTV Inspection Plan

Ft. Bragg WWCS Master Plan

Gravity Main Segments for CCTV

Rank	ID	Description	Reason	City Notes	Length (ft)	AssetID	Material	Diameter	FromMH	ToMH	HDR Notes
1	HDR-01	Pudding Creek, E of Hwy 1, along trailer park	I&I, high winter base flows		241.0	Mn-5810	Unknown	8	4314 (9A)	4310 (9)	
2	HDR-02	Pudding Creek, W. of Hwy 1 to Pump Station	I&I, high winter base flows		495.8	Mn-5103	Unknown	8	4311 (12)	4313 (11)	
					453.4	Mn-5385	Unknown	8	4313 (11)	4594 (10A)	
					441.1	Mn-5109	Unknown	8	4594 (10A)	4050 (10)	
3	FB-14	E of Hwy 1, N of the trailer park	I&I		518.1	Mn-5112	Unknown	8	4308 (7)	4309 (8)	
					199.5	Mn-5099	Unknown	8	4309 (8)	4589	
4	FB-15	Segment under Hwy 1 to Pudding creek pu	I&I		160.1	Mn-5301	Unknown	12	4589	4587	Under Highway
5	FB-16	Under Hwy 1 to Pudding Creek PS	I&I	6" & 12"	97.2	Mn-5102	Unknown	6	4310 (9)	4050 (10)	Under Highway
					71.5	Mn-5268	Unknown	12	4050 (10)	4588	
6	HDR-03	Oak St, between Harrison St and Harold St, 10"	I&I, Potential Stormwater cross-connect		762.5	Mn-4789	Unknown	10	4417 (179)	4125 (188)	
7	HDR-07	E Oak St from Wall St to alley between Harold & Corry, 6"	I&I, Potential Stormwater cross-connect		167.2	Mn-5148	Unknown	6	4151 (278)	4152 (279)	
					173.6	Mn-4696	Unknown	6	4152 (279)	4410 (286)	
					126.3	Mn-4901	Unknown	6	4410 (286)	4623	
					205.1	Mn-4797	Unknown	6	4623	4174 (290)	
					151.7	Mn-4699	Unknown	6	4174 (290)	4176 (292)	
					338.9	Mn-5155	Unknown	6	4176 (292)	4181 (295)	Tee in middle
					538.8	Mn-4976	Unknown	6	4181 (295)	4179 (178)	
8	HDR-06	Livingston St. from WIllow to Oak			622.9	Mn-4755	Unknown	6	4153 (287)	4410 (286)	
9	FB-09	Jewett St, From High school area to E Oak St	I&I	S. Sanderson Way from Chestnut street to Oak Street and include Jewett line (culdesac one block east of Ssanderson). This one is experiencing I&I and overfilling the recently slipplined section.	688.2	Mn-4771	Unknown	6	Fttng-7648	4147 (320)	No upstream MH
10	FB-08	S. Sanderson from Chestnut to Oak Streets	I&I	S. Sanderson Way from Chestnut street to Oak Street and include Jewett line (culdesac one block east of S Sanderson). This one is experiencing I&I and overfilling the recently slipplined section.	521.6	Mn-5179	Unknown	6	Clnt-7222	4201 (298)	C/O at upstream end
					704.7	Mn-5150	Unknown	6	4201 (298)	4413 (274)	
					258.6	Mn-5159	Unknown	6	4413 (274)	4180 (271)	
					401.2	Mn-4765	Unknown	6	4180 (271)	4146 (270)	
11	FB-06	Franklin St from E Chestnut St to Hazel St	I&I	Franklin Street from Maple to Chestnut, experiencing significant I&I in this line and looking for source.	365.3	Mn-5180	Unknown	8	4301 (107)	4248 (101A)	
					268.7	Mn-4644	Unknown	8	4248 (101A)	4244 (101)	
12	FB-07	Franklin Street from Hazel St to Maple St	I&I	Franklin Street from Maple to Chestnut, experiencing significant I&I in this line and looking for source.	328.3		Unknown	6	Clnt-7291	4116 (98)	C/O at upstream end
13	FB-03	Alley in between Brandon and Harold, S. of Bush	Frequent plugs	Frequent plugs at 637 & 627, requiring monthly maintenance. Need the line from manhole (between slipline) running south.	384.6	Mn-4664	Unknown	6	Fttng-7716	4088 (151)	No upstream MH
14	FB-04	Alley bewteen Perkins & Brandon, S. of Bush	Frequent Plugs	Frequent plugs. Need to run camera south from manhole. Manholes at north end are offset and you cannot see from the south to the north.	349.8		Unknown	6	Fttng-7715	4351 (153)	No upstream MH

15	FB-02	Cedar St, from N Lincoln St to N Harold St	Find end of line	Find end of line (near 827 Cedar). There is a 6” running north that connects.	609.1	Mn-5146	Unknown	6	Fttng-7625	4137 (260A)	No upstream MH
					262.2	Mn-4679	Unknown	6	4137 (260A)	4651 (258A)	Tee in line ~20' upstream of 4651
					149.0	Mn-5474	Unknown	6	Fttng-7623	4651 (258A)	No upstream MH
16	FB-01	From Harrison St. east to alley between Harrison & McPherson, S. of Alder	Belly in Line	Belly in pipe at 127 S Harrison, not sure the cleanout on the east side exists. These are not really manholes, so getting the camera in this location may prove difficult. Push camera would be ideal in this location.	40.9	Mn-5736	Unknown	6	Clnt-7241	4126 (192)	Upstream C/O
					162.7	Mn-4784	Unknown	6	4126 (192)	4127 (191)	
17	FB-13	S. McPherson from Maple to Hazel	Potential I&I	Groundwater from residential garage on N end running down street gutter (E side), disappears into hole in gutter around 320 McPhereson	293.7	Mn-5536	Unknown	6	Fttng-7569	4991 (207)	No upstream MH
18	FB-10	S Lincoln St, W. to Park St, N to Maple	Frequent plugs	This is a clay line, issues at manhole #309, frequent plugs on Park Street (worms). Begginning at S Lincoln cross country to Park, North to Maple. The segment on Maple was recently reconstructed (we think!), but issues continue in the line running north o	216.6	Mn-5727	VCP	6	4190 (307)	Fttng-7407	May be ell in line, downstream end is a tee?
					279.1	Mn-5550	VCP	6	Fttng-7407	4430 (309)	May be ell in line, upstream end might be tee?
19	HDR-05	Maple St, between Park St and Harold			179.5	Mn-5044	Unknown	6	Fttng-7406	4183 (197)	Upstream end mioght be a tee (?)
20	HDR-04	South of Intersection of Maple St and S Lincoln St			212.4	Mn-5166	VCP	6	Fttng7539	4190 (307)	No upstream MH
21	FB-11	Cypress St., N. of Hospital	Backups, Root intrusion	Root intrusion in mian line running east on Cypress Street. The hospital is experiencing frequent back-ups in there line as well.	445.9	Mn-5445	Unknown	8	4276 (226)	4494 (227)	
					321.4	Mn-5450	Unknown	8	4494 (227)	4279 (228)	
					157.6	Mn-5068	Unknown	8	4278 (229A)	4279 (228)	
22	FB-12	Corner of Grove St and Walnut St	Backups	Blind corner at Grove and Walnut, potentially undersized line issue. Has experienced back-up.	377.5	Mn-4889	Unknown	6	4452 (215)	4284 (216)	Blind corner
23	FB-05	Alley between McPherson and Harrison, S. of Laurel	Odd angle	Alley between North McPherson and North Harrison heading towards E Laurel Street. From manhole on the north heading south. This one has an odd angle on Laurel.	391.5	Mn-5139	Unknown	6	Fttng-7615	4373 (173)	No upstream MH, may be some cleanout along line

Appendix F. CCTV Results

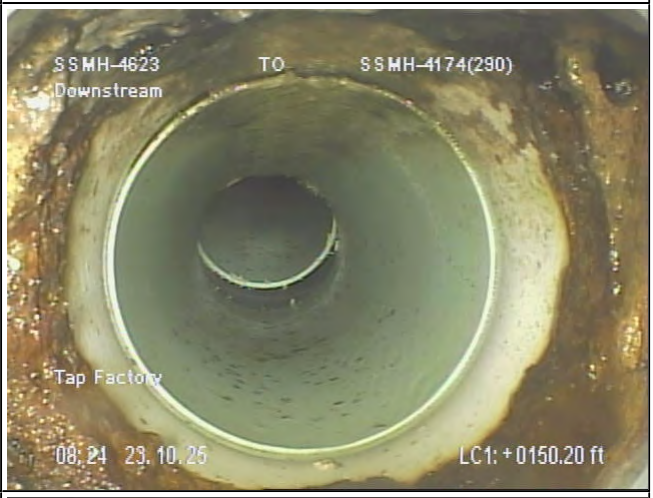
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN--4697	**Date**	10/23/2025 08:58
Street	E OAK ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4623	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4174(290)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	201.5
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/23/2025 08:11
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the **report generator**

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 8:58:00 AM	**Pipe Segment Reference:** MN--4697
Street: E OAK ST	**Upstream MH:** SSMH-4623
Length Surveyed: 201.5	**Downstream MH:** SSMH-4174(290)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4623	00:01:26 00:01:26	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:39 00:01:39	
14.7	Tap Factory Position: 9 Severity: None Size: 4	00:3:10 00:3:10	

Distance	Fault Observation	Time	Picture
70.6	Tap Factory Position: 9 Severity: None Size: 4	00:05:53 00:05:53	
70.6	Infiltration Dripper Lateral Position: 12 To 12 Severity: None Maint Weight: 3	00:06:16 00:06:16	
118.2	Tap Factory Position: 3 Severity: None Size: 4	00:09:28 00:09:28	

Distance	Fault Observation	Time	Picture
150.2	Tap Factory Position: 3 Severity: None Size: 4	00:10:56 00:10:56	
201.5	Access Point Manhole Severity: None Remarks: SSMH-4174(290)	00:13:49 00:13:49	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 8:58:00 AM	**Pipe Segment Reference:** MN--4697
Street: E OAK ST	**Upstream MH:** SSMH-4623
Length Surveyed: 201.5	**Downstream MH:** SSMH-4174(290)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4623

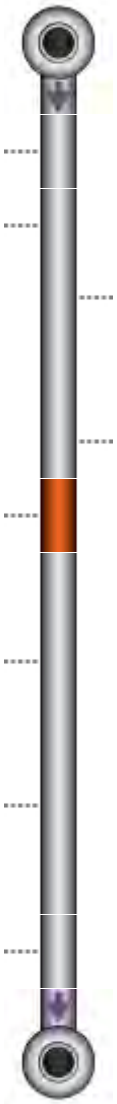
(0.0) AMH - Access Point Manhole Remark: SSMH-4623

(0.0) MWL - Miscellaneous Water Level

(14.7) TF - Tap Factory - Position: 9

(70.6) TF - Tap Factory - Position: 9

(70.6) IDL - Infiltration Dripper Lateral - Position: 12 To 12



(118.2) TF - Tap Factory - Position: 3

(150.2) TF - Tap Factory - Position: 3

(201.5) AMH - Access Point Manhole Remark: SSMH-4174(290)

Total Distance: 201.5

ID Number: SSMH-4174(290)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	3	3
2	0	0	0
1	0	0	0
Overall	0	3	3
Number of Defects	0	1	1
Pipe Rating	0000	3100	3100
Pipe Ratings Index	0	3	3

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:26 86	AMH - Access Point Manhole							
		SSMH-4623							
0	00:01:39 99	MWL - Miscellaneous Water Level				5			
14.7	00:3:10 190	TF - Tap Factory		4				9	
70.6	00:05:53 353	TF - Tap Factory		4				9	
70.6	00:06:16 376	IDL - Infiltration Dripper Lateral						12	12
118.2	00:09:28 568	TF - Tap Factory		4				3	
150.2	00:10:56 656	TF - Tap Factory		4				3	
201.5	00:13:49 829	AMH - Access Point Manhole							
		SSMH-4174(290)							

Created with the POSM report generator

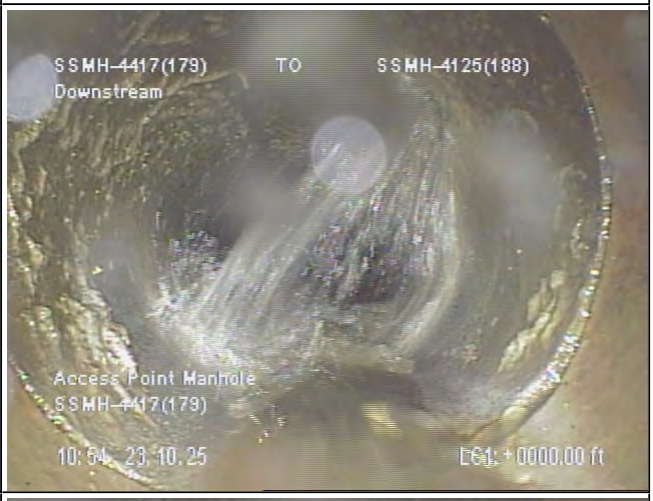
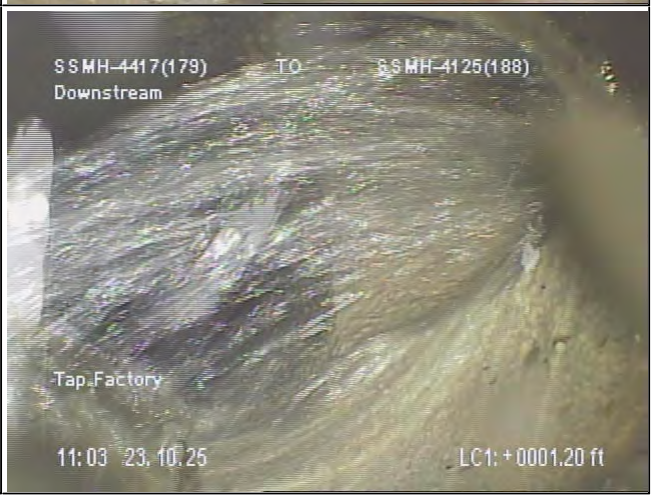
Additional Reports for Session CITY OF FORT BRAGG

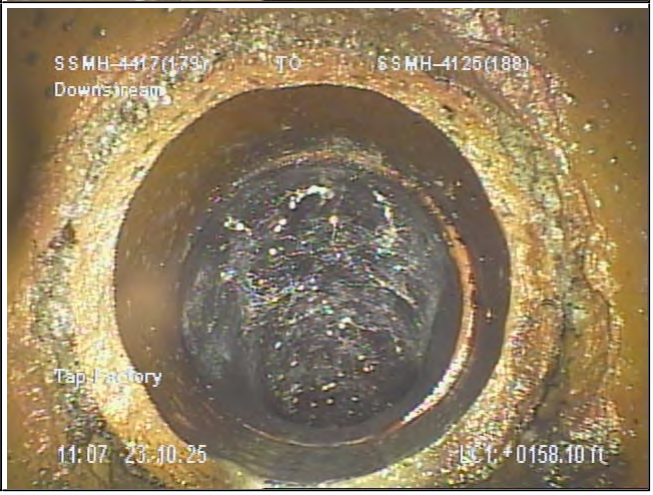
Created with the POSM report generator

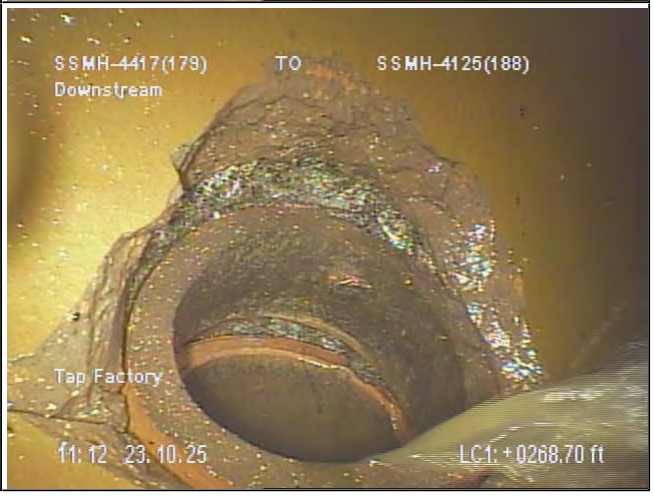
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-4789	**Date**	10/23/2025 11:26
Street	E OAK ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4417(179)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4125(188)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	10	**Width**	
Shape	Circular	**Material**	Vitrified Clay Pipe
Lining Method	None	**Pipe Joint Length**	
Total Length		**Length Surveyed**	759.9
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/23/2025 11:27
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

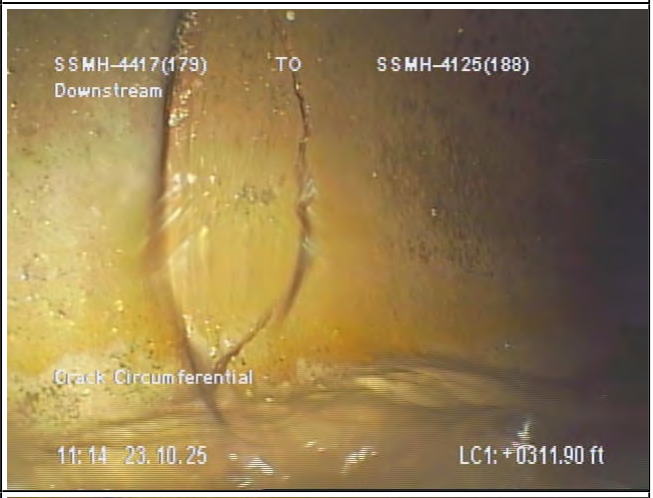
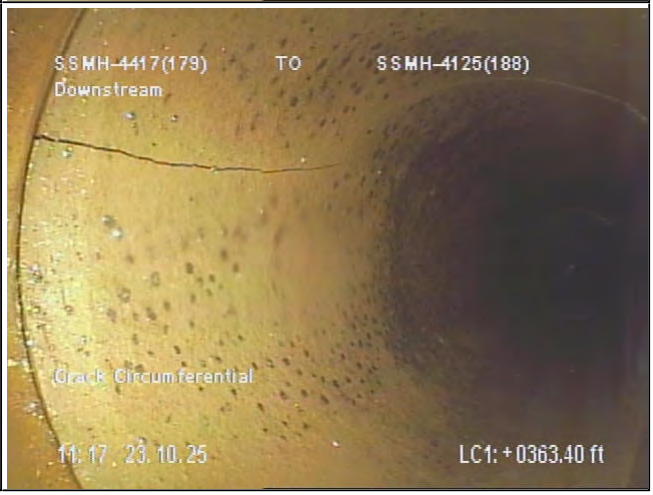
Created with the POSM report generator

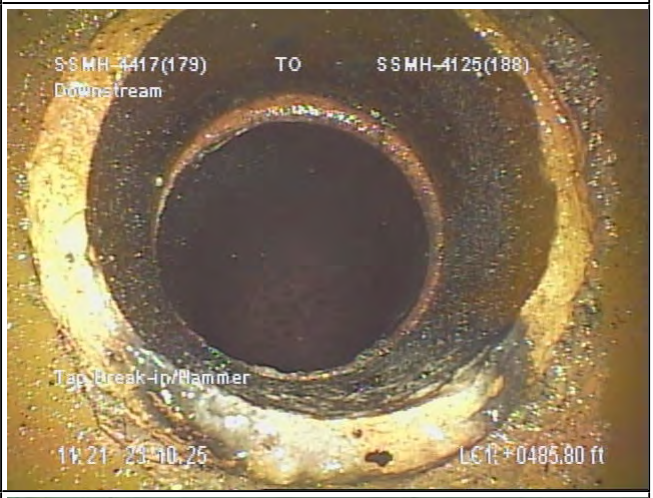
Project: CITY OF FORT BRAGG	
Date: 10/23/2025 11:26:00 AM	**Pipe Segment Reference:** MN-4789
Street: E OAK ST	**Upstream MH:** SSMH-4417(179)
Length Surveyed: 759.9	**Downstream MH:** SSMH-4125(188)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 10	**Material:** Vitrified Clay Pipe

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4417(179)	00:01:30 00:01:30	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:43 00:01:43	
1.2	Tap Factory Position: 3 Severity: None Size: 4	00:05:28 00:05:28	

Distance	Fault Observation	Time	Picture
27.3	Tap Break-in/Hammer Position: 9 Severity: None Size: 4	00:06:27 00:06:27	
63.5	Crack Circumferential Position: 12 To 12 Severity: None Struct Weight: 1	00:07:36 00:07:36	
158.1	Tap Factory Position: 9 Severity: None Size: 4	00:09:25 00:09:25	

Distance	Fault Observation	Time	Picture
172.9	Joint Offset Medium Severity: None Struct Weight: 3	00:10:11 00:10:11	
172.9	Joint Offset Medium Severity: None Struct Weight: 3	00:10:32 00:10:32	
268.7	Tap Factory Position: 9 Severity: None Size: 4	00:14:02 00:14:02	

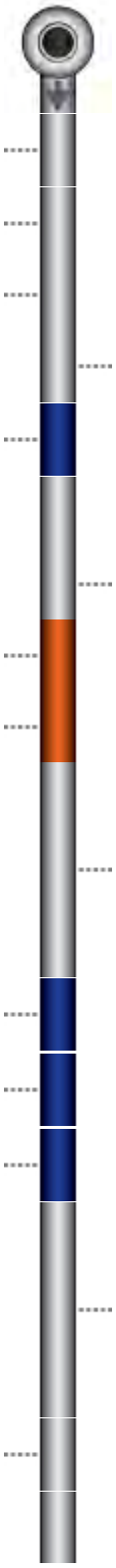
Distance	Fault Observation	Time	Picture
311.9	Crack Circumferential Position: 12 To 12 Severity: None Struct Weight: 1	00:16:26 00:16:26	
359.7	Crack Circumferential Position: 12 To 12 Severity: None Struct Weight: 1	00:18:19 00:18:19	
359.7	Crack Circumferential Position: 12 To 12 Severity: None Struct Weight: 1	00:18:42 00:18:42	

Distance	Fault Observation	Time	Picture
485.8	Tap Break-in/Hammer Position: 9 Severity: None Size: 4	00:23:00 00:23:00	
549.5	Miscellaneous Material Change Severity: None Remarks: PE PIPE	00:24:48 00:24:48	
759.9	Access Point Manhole Severity: None Remarks: SSMH-4125(188)	00:31:41 00:31:41	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 11:26:00 AM	**Pipe Segment Reference:** MN-4789
Street: E OAK ST	**Upstream MH:** SSMH-4417(179)
Length Surveyed: 759.9	**Downstream MH:** SSMH-4125(188)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 10	**Material:** Vitrified Clay Pipe

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5



ID Number: SSMH-4417(179)

(0.0) AMH - Access Point Manhole Remark: SSMH-4417(179)

(0.0) MWL - Miscellaneous Water Level

(1.2) TF - Tap Factory - Position: 3

(27.3) TB - Tap Break-in/Hammer - Position: 9

(63.5) CC - Crack Circumferential - Position: 12 To 12

(158.1) TF - Tap Factory - Position: 9

(172.9) JOM - Joint Offset Medium

(172.9) JOM - Joint Offset Medium

(268.7) TF - Tap Factory - Position: 9

(311.9) CC - Crack Circumferential - Position: 12 To 12

(359.7) CC - Crack Circumferential - Position: 12 To 12

(359.7) CC - Crack Circumferential - Position: 12 To 12

(485.8) TB - Tap Break-in/Hammer - Position: 9

(549.5) MMC - Miscellaneous Material Change Remark: PE PIPE

(759.9) AMH - Access Point Manhole Remark: SSMH-4125(188)

Total Distance: 759.9

ID Number: SSMH-4125(188)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	6	0	6
2	0	0	0
1	4	0	4
Overall	10	0	10
Number of Defects	6	0	6
Pipe Rating	3214	0000	3214
Pipe Ratings Index	1.7	0	1.7

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:30 90	AMH - Access Point Manhole							
		SSMH-4417(179)							
0	00:01:43 103	MWL - Miscellaneous Water Level				5			
1.2	00:05:28 328	TF - Tap Factory		4				3	
27.3	00:06:27 387	TB - Tap Break-in/Hammer		4				9	
63.5	00:07:36 456	CC - Crack Circumferential						12	12
158.1	00:09:25 565	TF - Tap Factory		4				9	
172.9	00:10:11 611	JOM - Joint Offset Medium							
172.9	00:10:32 632	JOM - Joint Offset Medium							
268.7	00:14:02 842	TF - Tap Factory		4				9	
311.9	00:16:26 986	CC - Crack Circumferential						12	12
359.7	00:18:19 1099	CC - Crack Circumferential						12	12
359.7	00:18:42 1122	CC - Crack Circumferential						12	12
485.8	00:23:00 1380	TB - Tap Break-in/Hammer		4				9	
549.5	00:24:48 1488	MMC - Miscellaneous Material Change							
		PE PIPE							
759.9	00:31:41 1901	AMH - Access Point Manhole							

		SSMH-4125(188)

Created with the POSM report generator

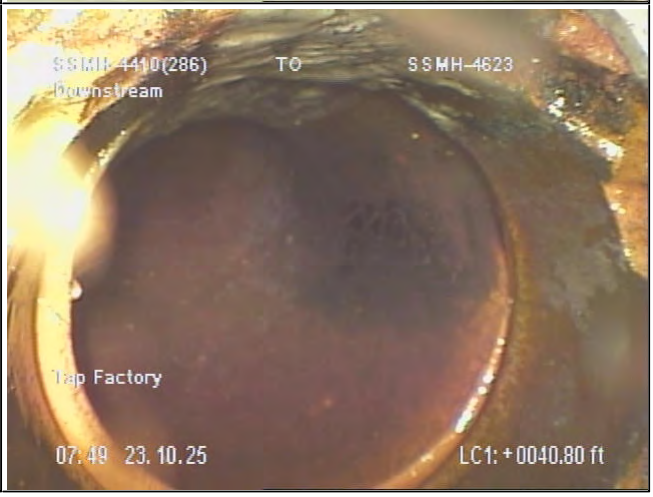
Additional Reports for Session CITY OF FORT BRAGG

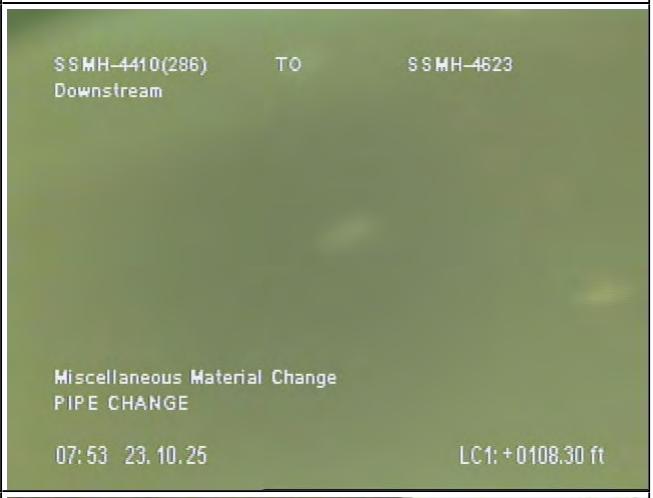
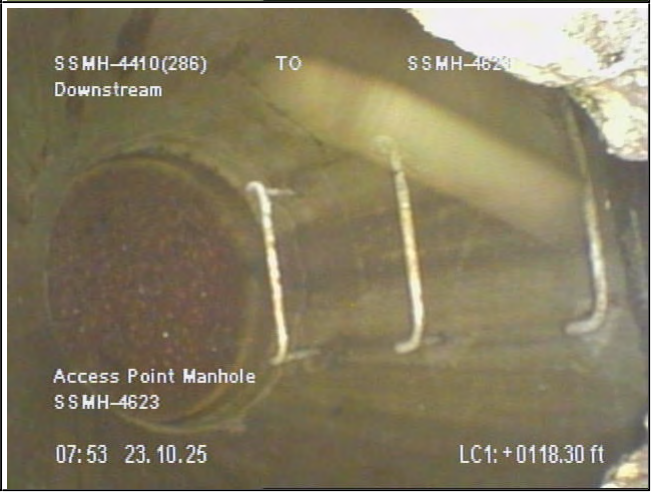
Created with the POSM report generator

Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference		**Date**	10/23/2025 08:38
Street	E OAK ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4410(286)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4623	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	118.3
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/23/2025 08:11
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 8:38:00 AM	**Pipe Segment Reference:**
Street: E OAK ST	**Upstream MH:** SSMH-4410(286)
Length Surveyed: 118.3	**Downstream MH:** SSMH-4623
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4410(286)	00:01:19 00:01:19	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:38 00:01:38	
40.8	Tap Factory Position: 3 Severity: None Size: 4	00:04:16 00:04:16	

Distance	Fault Observation	Time	Picture
40.8	Miscellaneous Material Change Severity: None Remarks: PIPE CHANGE	00:07:37 00:07:37	
118.3	Access Point Manhole Severity: None Remarks: SSMH-4623	00:08:21 00:08:21	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 8:38:00 AM	**Pipe Segment Reference:**
Street: E OAK ST	**Upstream MH:** SSMH-4410(286)
Length Surveyed: 118.3	**Downstream MH:** SSMH-4623
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4410(286)

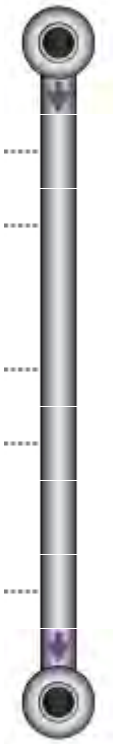
(0.0) AMH - Access Point Manhole Remark: SSMH-4410(286)

(0.0) MWL - Miscellaneous Water Level

(40.8) TF - Tap Factory - Position: 3

(40.8) MMC - Miscellaneous Material Change Remark: PIPE CHANGE

(118.3) AMH - Access Point Manhole Remark: SSMH-4623



Total Distance: 118.3

ID Number: SSMH-4623

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:1979	AMH - Access Point Manhole							
		SSMH-4410(286)							
0	00:01:3898	MWL - Miscellaneous Water Level				5			
40.8	00:04:16256	TF - Tap Factory		4				3	
40.8	00:07:37457	MMC - Miscellaneous Material Change							
		PIPE CHANGE							
118.3	00:08:21501	AMH - Access Point Manhole							
		SSMH-4623							

Created with the POSM report generator

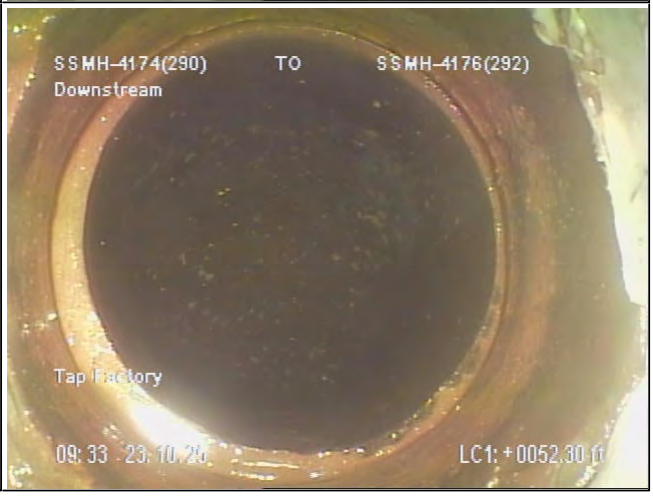
Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-4699	**Date**	10/23/2025 09:33
Street	E OAK ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4174(290)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4176(292)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	146.8
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/23/2025 09:33
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 9:33:00 AM	**Pipe Segment Reference:** MN-4699
Street: E OAK ST	**Upstream MH:** SSMH-4174(290)
Length Surveyed: 146.8	**Downstream MH:** SSMH-4176(292)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4174(290)	00:01:20 00:01:20	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:35 00:01:35	
0.0	Tap Factory Position: 9 Severity: None Size: 4	00:03:43 00:03:43	

Distance	Fault Observation	Time	Picture
146.8	Access Point Manhole Severity: None Remarks: SSMH-4176(292)	00:07:52 00:07:52	

Created with the POSM report generator

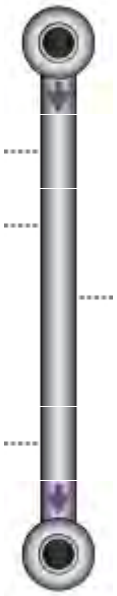
Project: CITY OF FORT BRAGG	
Date: 10/23/2025 9:33:00 AM	**Pipe Segment Reference:** MN-4699
Street: E OAK ST	**Upstream MH:** SSMH-4174(290)
Length Surveyed: 146.8	**Downstream MH:** SSMH-4176(292)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4174(290)

(0.0) AMH - Access Point Manhole Remark: SSMH-4174(290)

(0.0) MWL - Miscellaneous Water Level



(0.0) TF - Tap Factory - Position: 9

(146.8) AMH - Access Point Manhole Remark: SSMH-4176(292)

Total Distance: 146.8

ID Number: SSMH-4176(292)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:2080	AMH - Access Point Manhole							
		SSMH-4174(290)							
0	00:01:3595	MWL - Miscellaneous Water Level				5			
0	00:03:43223	TF - Tap Factory		4				9	
146.8	00:07:52472	AMH - Access Point Manhole							
		SSMH-4176(292)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference		**Date**	10/23/2025 10:49
Street	E OAK ST	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH-4176(292)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4181(295)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	215.2
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/23/2025 09:33
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

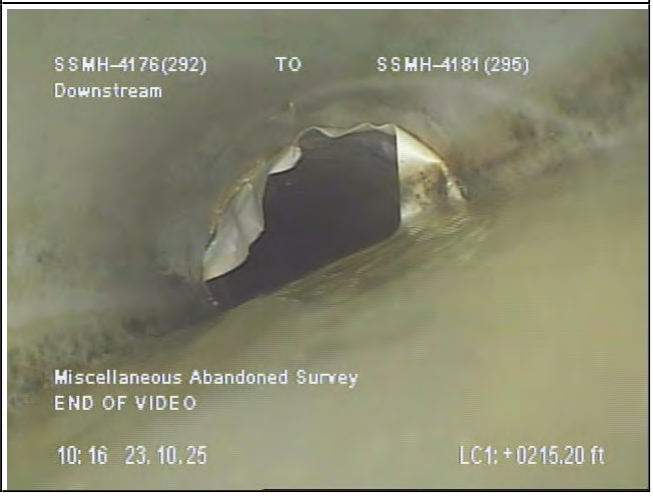
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	No

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 10:49:00 AM	**Pipe Segment Reference:**
Street: E OAK ST	**Upstream MH:** SSMH-4176(292)
Length Surveyed: 215.2	**Downstream MH:** SSMH-4181(295)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4176(292)	00:01:18 00:01:18	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:32 00:01:32	
139.2	Tap Factory Position: 3 Severity: None Size: 4	00:06:51 00:06:51	

Distance	Fault Observation	Time	Picture
163.8	Tap Factory Position: 9 Severity: None Size: 4	00:08:24 00:08:24	
215.2	Lining Feature Detached Position: 12 To 12 Severity: None Struct Weight: 3	00:12:08 00:12:08	
215.2	Miscellaneous General Observation Severity: None Remarks: COULD NOT CONTINUE	00:12:41 00:12:41	

Distance	Fault Observation	Time	Picture
215.2	Miscellaneous Abandoned Survey Severity: None Remarks: END OF VIDEO	00:13:03 00:13:03	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/23/2025 10:49:00 AM	**Pipe Segment Reference:**
Street: E OAK ST	**Upstream MH:** SSMH-4176(292)
Length Surveyed: 215.2	**Downstream MH:** SSMH-4181(295)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

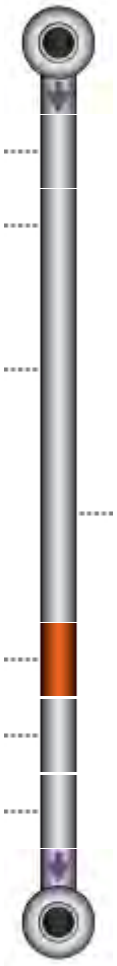
Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4176(292)

(0.0) AMH - Access Point Manhole Remark: SSMH-4176(292)

(0.0) MWL - Miscellaneous Water Level

(139.2) TF - Tap Factory - Position: 3



(163.8) TF - Tap Factory - Position: 9

(215.2) LFD - Lining Feature Detached - Position: 12 To 12

(215.2) MGO - Miscellaneous General Observation Remark: COULD NOT CONTINUE

(215.2) MSA - Miscellaneous Abandoned Survey Remark: END OF VIDEO

Total Distance: 215.2

ID Number: SSMH-4181(295)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	3	0	3
2	0	0	0
1	0	0	0
Overall	3	0	3
Number of Defects	1	0	1
Pipe Rating	3100	0000	3100
Pipe Ratings Index	3	0	3

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:1878	AMH - Access Point Manhole							
		SSMH-4176(292)							
0	00:01:3292	MWL - Miscellaneous Water Level				5			
139.2	00:06:51411	TF - Tap Factory		4				3	
163.8	00:08:24504	TF - Tap Factory		4				9	
215.2	00:12:08728	LFD - Lining Feature Detached						12	12
215.2	00:12:41761	MGO - Miscellaneous General Observation							
		COULD NOT CONTINUE							
215.2	00:13:03783	MSA - Miscellaneous Abandoned Survey							
		END OF VIDEO							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5150	**Date**	10/22/2025 09:52
Street	S SANDERSON WAY	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH-4201(298)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4413(274)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	700.1
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/21/2025 14:12
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

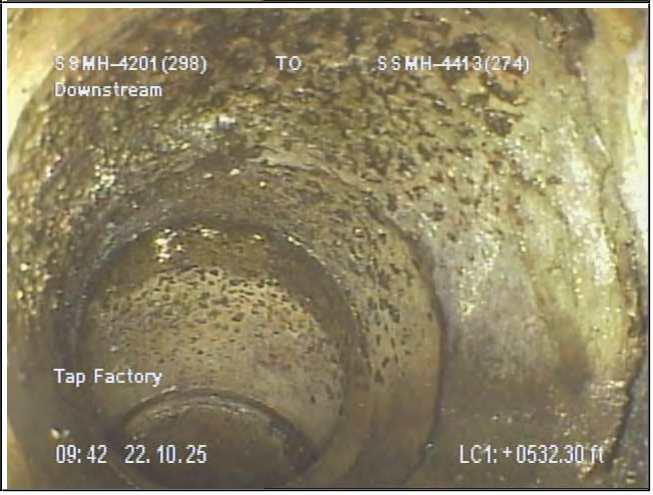
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

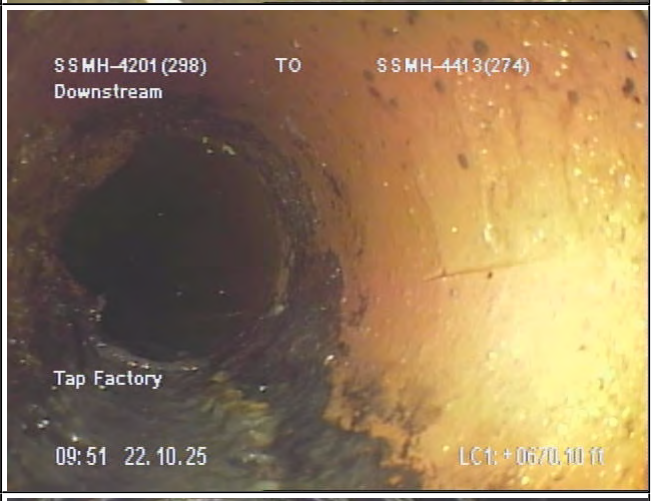
Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 9:52:00 AM	**Pipe Segment Reference:** MN-5150
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4201(298)
Length Surveyed: 700.1	**Downstream MH:** SSMH-4413(274)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4201(298)	00:01:49 00:01:49	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:02:06 00:02:06	
106.9	Tap Factory Position: 9 Severity: None Size: 4	00:11:04 00:11:04	

Distance	Fault Observation	Time	Picture
148.8	Tap Factory Position: 9 Severity: None Size: 4	00:12:54 00:12:54	
254.9	Tap Factory Position: 9 Severity: None Size: 4	00:16:44 00:16:44	
254.9	Tap Factory Position: 9 Severity: None Size: 4	00:31:10 00:31:10	

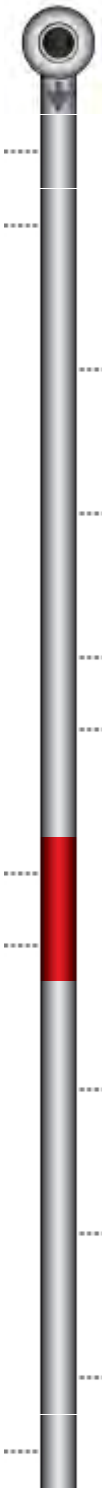
Distance	Fault Observation	Time	Picture
480.9	Joint Offset Large Severity: None Struct Weight: 4	00:34:32 00:34:32	
484.4	Joint Offset Large Severity: None Struct Weight: 4	00:35:16 00:35:16	
532.3	Tap Factory Position: 9 Severity: None Size: 4	00:37:47 00:37:47	

Distance	Fault Observation	Time	Picture
575.2	Tap Factory Position: 9 Severity: None Size: 4	00:40:45 00:40:45	
670.1	Tap Factory Position: 9 Severity: None Size: 4	00:46:50 00:46:50	
700.1	Access Point Manhole Severity: None Remarks: SSMH-4413(274)	00:51:49 00:51:49	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 9:52:00 AM	**Pipe Segment Reference:** MN-5150
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4201(298)
Length Surveyed: 700.1	**Downstream MH:** SSMH-4413(274)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5



ID Number: SSMH-4201(298)

(0.0) AMH - Access Point Manhole Remark: SSMH-4201(298)

(0.0) MWL - Miscellaneous Water Level

(106.9) TF - Tap Factory - Position: 9

(148.8) TF - Tap Factory - Position: 9

(254.9) TF - Tap Factory - Position: 9

(254.9) TF - Tap Factory - Position: 9

(480.9) JOL - Joint Offset Large

(484.4) JOL - Joint Offset Large

(532.3) TF - Tap Factory - Position: 9

(575.2) TF - Tap Factory - Position: 9

(670.1) TF - Tap Factory - Position: 9

(700.1) AMH - Access Point Manhole Remark: SSMH-4413(274)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	8	0	8
3	0	0	0
2	0	0	0
1	0	0	0
Overall	8	0	8
Number of Defects	2	0	2
Pipe Rating	4200	0000	4200
Pipe Ratings Index	4	0	4

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:49 109	AMH - Access Point Manhole							
		SSMH-4201(298)							
0	00:02:06 126	MWL - Miscellaneous Water Level				5			
106.9	00:11:04 664	TF - Tap Factory		4				9	
148.8	00:12:54 774	TF - Tap Factory		4				9	
254.9	00:16:44 1004	TF - Tap Factory		4				9	
254.9	00:31:10 1870	TF - Tap Factory		4				9	
480.9	00:34:32 2072	JOL - Joint Offset Large							
484.4	00:35:16 2116	JOL - Joint Offset Large							
532.3	00:37:47 2267	TF - Tap Factory		4				9	
575.2	00:40:45 2445	TF - Tap Factory		4				9	
670.1	00:46:50 2810	TF - Tap Factory		4				9	
700.1	00:51:49 3109	AMH - Access Point Manhole							
		SSMH-4413(274)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

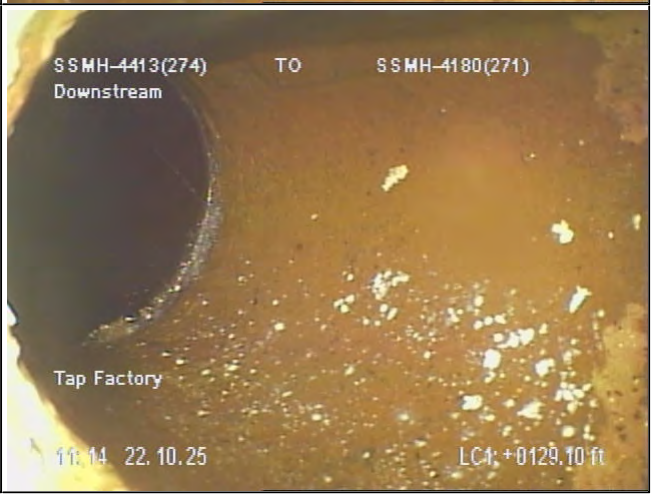
Created with the POSM report generator

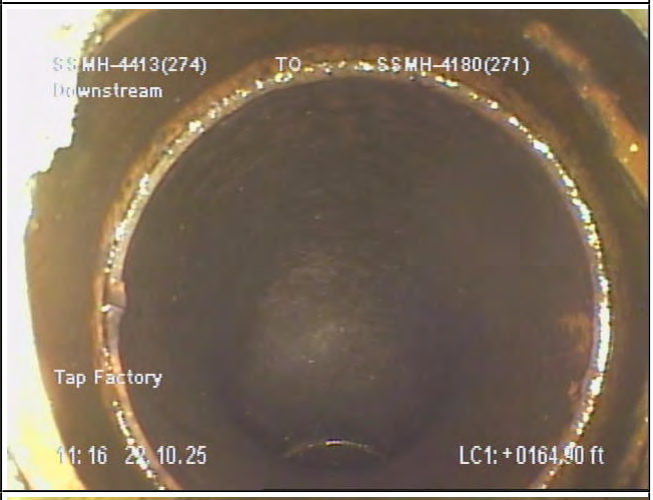
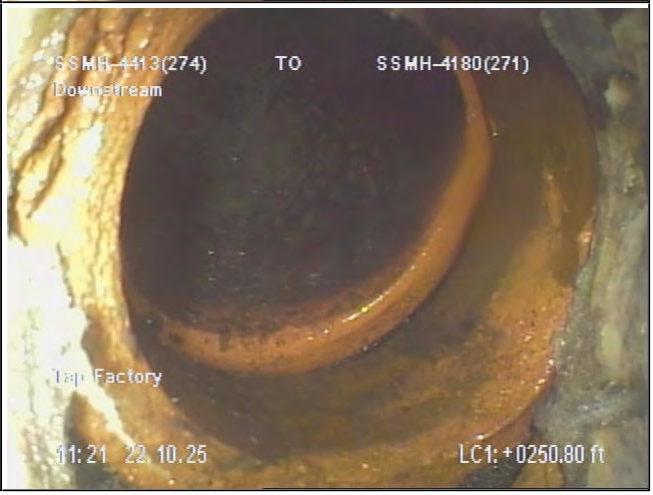
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5159	**Date**	10/22/2025 11:30
Street	S SANDERSON WAY	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4413(274)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4180(271)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	255.1
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/21/2025 14:12
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

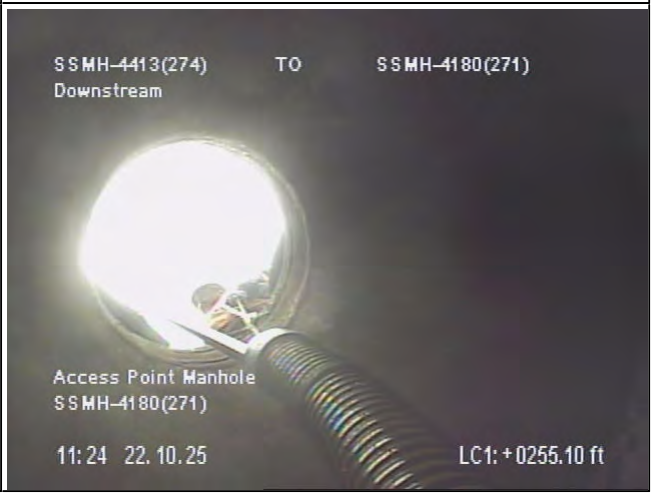
Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 11:30:00 AM	**Pipe Segment Reference:** MN-5159
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4413(274)
Length Surveyed: 255.1	**Downstream MH:** SSMH-4180(271)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4413(274)	00:03:00 00:03:00	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:03:14 00:03:14	
0.1	Joint Offset Medium Severity: None Struct Weight: 3	00:06:29 00:06:29	

Distance	Fault Observation	Time	Picture
65.5	Tap Factory Position: 9 Severity: None Size: 4	00:09:18 00:09:18	
73.0	Tap Factory Position: 3 Severity: None Size: 4	00:09:51 00:09:51	
73.0	Tap Factory Position: 3 Severity: None Size: 4	00:13:18 00:13:18	

Distance	Fault Observation	Time	Picture
164.9	Tap Factory Position: 9 Severity: None Size: 4	00:14:58 00:14:58	
209.2	Tap Factory Position: 3 Severity: None Size: 4	00:17:00 00:17:00	
250.8	Tap Factory Position: 12 Severity: None Size: 4	00:20:08 00:20:08	

Distance	Fault Observation	Time	Picture
255.1	Access Point Manhole Severity: None Remarks: SSMH-4180(271)	00:22:28 00:22:28	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 11:30:00 AM	**Pipe Segment Reference:** MN-5159
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4413(274)
Length Surveyed: 255.1	**Downstream MH:** SSMH-4180(271)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

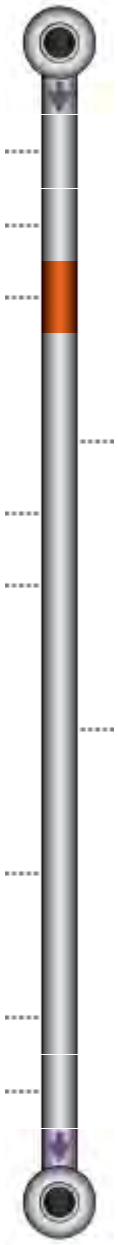
Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4413(274)

(0.0) AMH - Access Point Manhole Remark: SSMH-4413(274)

(0.0) MWL - Miscellaneous Water Level

(0.1) JOM - Joint Offset Medium



(65.5) TF - Tap Factory - Position: 9

(73.0) TF - Tap Factory - Position: 3

(73.0) TF - Tap Factory - Position: 3

(164.9) TF - Tap Factory - Position: 9

(209.2) TF - Tap Factory - Position: 3

(250.8) TF - Tap Factory - Position: 12

(255.1) AMH - Access Point Manhole Remark: SSMH-4180(271)

Total Distance: 255.1

ID Number: SSMH-4180(271)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	3	0	3
2	0	0	0
1	0	0	0
Overall	3	0	3
Number of Defects	1	0	1
Pipe Rating	3100	0000	3100
Pipe Ratings Index	3	0	3

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:03:00 180	AMH - Access Point Manhole							
		SSMH-4413(274)							
0	00:03:14 194	MWL - Miscellaneous Water Level				5			
0.1	00:06:29 389	JOM - Joint Offset Medium							
65.5	00:09:18 558	TF - Tap Factory		4				9	
73	00:09:51 591	TF - Tap Factory		4				3	
73	00:13:18 798	TF - Tap Factory		4				3	
164.9	00:14:58 898	TF - Tap Factory		4				9	
209.2	00:17:00 1020	TF - Tap Factory		4				3	
250.8	00:20:08 1208	TF - Tap Factory		4				12	
255.1	00:22:28 1348	AMH - Access Point Manhole							
		SSMH-4180(271)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5099	**Date**	10/21/2025 13:33
Street	PUDDING CREEK RD HWY 1	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH- 4309(8)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4589	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	175.2
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	No

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 1:33:00 PM	**Pipe Segment Reference:** MN-5099
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4309(8)
Length Surveyed: 175.2	**Downstream MH:** SSMH-4589
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	**Access Point Manhole** **Severity: None** **Remarks: SSMH- 4309(8)**	**00:01:14** **00:01:14**	
0.0	**Miscellaneous Water Level** **Severity: None** **Percent: 5**	**00:01:27** **00:01:27**	
175.2	**Joint Offset Large** **Severity: None** **Struct Weight: 4**	**00:10:03** **00:10:03**	

Distance	Fault Observation	Time	Picture
175.2	Miscellaneous General Observation Severity: None Remarks: ENDING VIDEO	00:10:42 00:10:42	
175.2	Miscellaneous Abandoned Survey Severity: None Remarks: CLEAR TO 175.2	00:11:11 00:11:11	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 1:33:00 PM	**Pipe Segment Reference:** MN-5099
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4309(8)
Length Surveyed: 175.2	**Downstream MH:** SSMH-4589
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH- 4309(8)

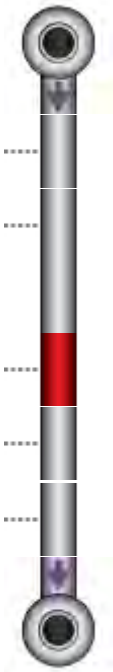
(0.0) AMH - Access Point Manhole Remark: SSMH- 4309(8)

(0.0) MWL - Miscellaneous Water Level

(175.2) JOL - Joint Offset Large

(175.2) MGO - Miscellaneous General Observation Remark: ENDING VIDEO

(175.2) MSA - Miscellaneous Abandoned Survey Remark: CLEAR TO 175.2



Total Distance: 175.2

ID Number: SSMH-4589

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	4	0	4
3	0	0	0
2	0	0	0
1	0	0	0
Overall	4	0	4
Number of Defects	1	0	1
Pipe Rating	4100	0000	4100
Pipe Ratings Index	4	0	4

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:1474	AMH - Access Point Manhole							
		SSMH- 4309(8)							
0	00:01:2787	MWL - Miscellaneous Water Level				5			
175.2	00:10:03603	JOL - Joint Offset Large							
175.2	00:10:42642	MGO - Miscellaneous General Observation							
		ENDING VIDEO							
175.2	00:11:11671	MSA - Miscellaneous Abandoned Survey							
		CLEAR TO 175.2							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5112	**Date**	10/21/2025 12:43
Street	PUDDING CREEK RD HWY 1	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH- 4308(7)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4309 (8)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	519.5
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 12:43:00 PM	**Pipe Segment Reference:** MN-5112
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4308(7)
Length Surveyed: 519.5	**Downstream MH:** SSMH-4309 (8)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH- 4308(7)	00:01:36 00:01:36	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:58 00:01:58	
519.5	Access Point Manhole Severity: None Remarks: SSMH-4309 (8)	00:15:50 00:15:50	

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 12:43:00 PM	**Pipe Segment Reference:** MN-5112
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4308(7)
Length Surveyed: 519.5	**Downstream MH:** SSMH-4309 (8)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

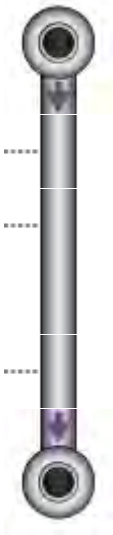
ID Number: SSMH- 4308(7)

(0.0) AMH - Access Point Manhole Remark: SSMH- 4308(7)

(0.0) MWL - Miscellaneous Water Level

(519.5) AMH - Access Point Manhole Remark: SSMH-4309 (8)

Total Distance: 519.5



ID Number: SSMH-4309 (8)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:36 96	AMH - Access Point Manhole							
		SSMH- 4308(7)							
0	00:01:58 118	MWL - Miscellaneous Water Level				5			
519.5	00:15:50 950	AMH - Access Point Manhole							
		SSMH-4309 (8)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

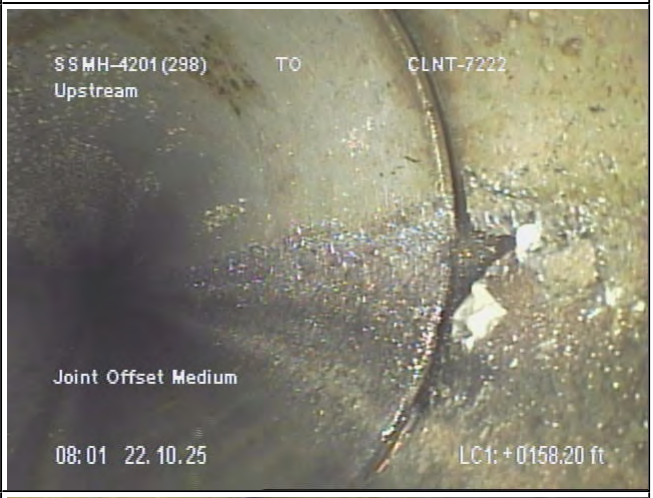
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5179	**Date**	10/22/2025 08:32
Street	S SANDERSON WAY	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	CLNT-7222	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4201(298)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Upstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/21/2025 14:12
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	

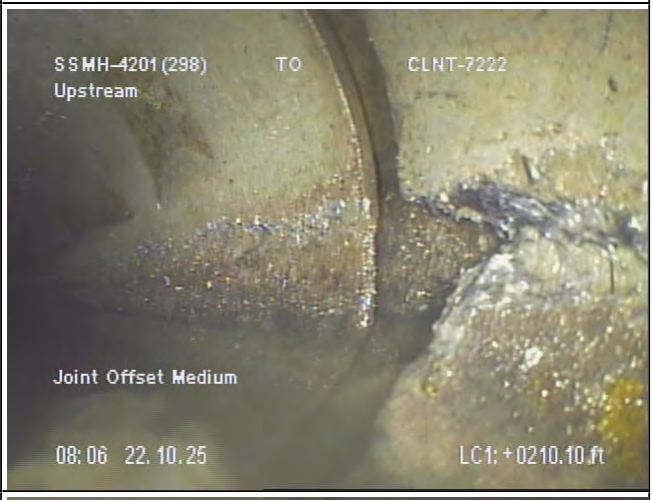
Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 8:32:00 AM	**Pipe Segment Reference:** MN-5179
Street: S SANDERSON WAY	**Upstream MH:** CLNT-7222
Length Surveyed: 0	**Downstream MH:** SSMH-4201(298)
Run Number:	**Direction of Survey:** Upstream
Height (Diameter): 6	**Material:** Polyethylene

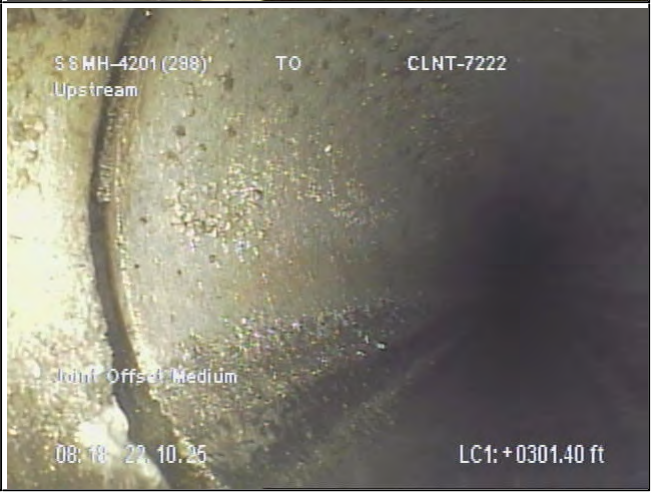
Distance	Fault Observation	Time	Picture
0.0	**Access Point Manhole** **Severity: None** **Remarks: SSMH-4201(298)**	**00:03:24** **00:03:24**	
0.0	**Miscellaneous Water Level** **Severity: None** **Percent: 5**	**00:03:38** **00:03:38**	
41.5	**Joint Offset Medium** **Severity: None** **Struct Weight: 3**	**00:05:55** **00:05:55**	

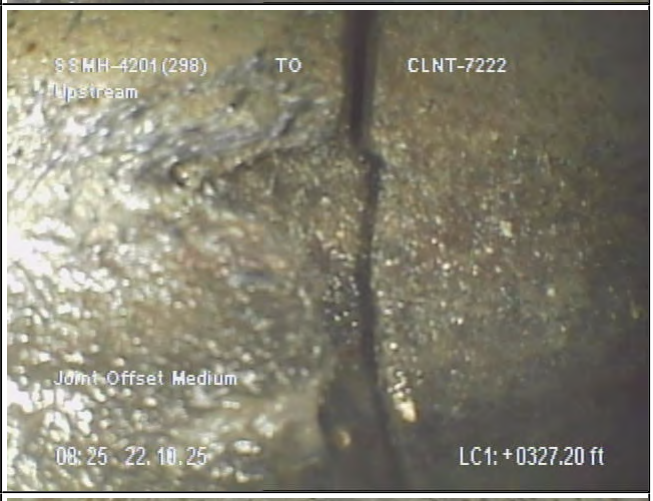
Distance	Fault Observation	Time	Picture
93.3	Joint Offset Medium Severity: None Struct Weight: 3	00:08:08 00:08:08	
93.3	Joint Offset Medium Severity: None Struct Weight: 3	00:09:25 00:09:25	
131.8	Joint Offset Medium Severity: None Struct Weight: 3	00:10:20 00:10:20	

Distance	Fault Observation	Time	Picture
158.2	Joint Offset Medium Severity: None Struct Weight: 3	00:11:54 00:11:54	
171.2	Joint Offset Medium Severity: None Struct Weight: 3	00:13:02 00:13:02	
183.5	Joint Offset Medium Severity: None Struct Weight: 3	00:14:19 00:14:19	

Distance	Fault Observation	Time	Picture
210.1	Joint Offset Medium Severity: None Struct Weight: 3	00:16:38 00:16:38	
210.1	Joint Offset Medium Severity: None Struct Weight: 3	00:17:28 00:17:28	
210.1	Joint Offset Medium Severity: None Struct Weight: 3	00:18:49 00:18:49	

Distance	Fault Observation	Time	Picture
249.6	Joint Offset Medium Severity: None Struct Weight: 3	00:20:39 00:20:39	
263.6	Joint Offset Medium Severity: None Struct Weight: 3	00:21:55 00:21:55	
277.0	Joint Offset Medium Severity: None Struct Weight: 3	00:23:27 00:23:27	

Distance	Fault Observation	Time	Picture
288.3	Joint Offset Medium Severity: None Struct Weight: 3	00:25:21 00:25:21	
300.2	Tap Factory Position: 3 Severity: None Size: 4	00:27:25 00:27:25	
301.4	Joint Offset Medium Severity: None Struct Weight: 3	00:28:13 00:28:13	

Distance	Fault Observation	Time	Picture
313.8	Joint Offset Medium Severity: None Struct Weight: 3	00:30:56 00:30:56	
313.8	Joint Offset Medium Severity: None Struct Weight: 3	00:35:13 00:35:13	
346.7	Miscellaneous General Observation Severity: None Remarks: COULD NOT CONTINUE	00:42:35 00:42:35	

Distance	Fault Observation	Time	Picture
346.7	Miscellaneous General Observation Severity: None Remarks: REVERSAL NEEDED	00:43:12 00:43:12	
346.7	Miscellaneous Abandoned Survey Severity: None Remarks: 346.7 FT	00:43:38 00:43:38	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 8:32:00 AM	**Pipe Segment Reference:** MN-5179
Street: S SANDERSON WAY	**Upstream MH:** CLNT-7222
Length Surveyed: 0	**Downstream MH:** SSMH-4201(298)
Run Number:	**Direction of Survey:** Upstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4201(298)

(0.0) AMH - Access Point Manhole Remark: SSMH-4201(298)

(0.0) MWL - Miscellaneous Water Level

(41.5) JOM - Joint Offset Medium

(93.3) JOM - Joint Offset Medium

(93.3) JOM - Joint Offset Medium

(131.8) JOM - Joint Offset Medium

(158.2) JOM - Joint Offset Medium

(171.2) JOM - Joint Offset Medium

(183.5) JOM - Joint Offset Medium

(210.1) JOM - Joint Offset Medium

(210.1) JOM - Joint Offset Medium

(210.1) JOM - Joint Offset Medium

(249.6) JOM - Joint Offset Medium

(263.6) JOM - Joint Offset Medium

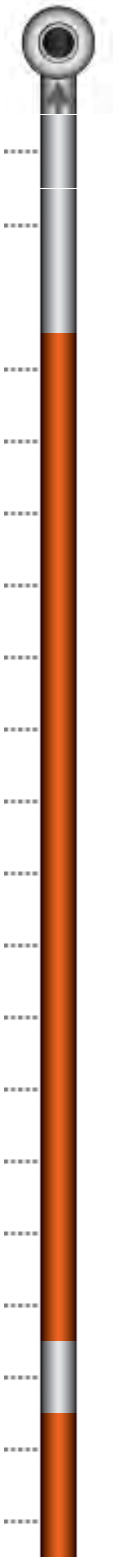
(277.0) JOM - Joint Offset Medium

(288.3) JOM - Joint Offset Medium

(300.2) TF - Tap Factory - Position: 3

(301.4) JOM - Joint Offset Medium

(313.8) JOM - Joint Offset Medium

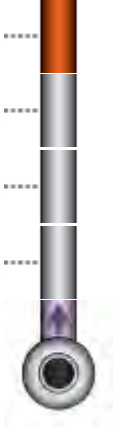


(313.8) JOM - Joint Offset Medium

(346.7) MGO - Miscellaneous General Observation
Remark: COULD NOT CONTINUE

(346.7) MGO - Miscellaneous General Observation
Remark: REVERSAL NEEDED

(346.7) MSA - Miscellaneous Abandoned Survey
Remark: 346.7 FT



Total Distance: 0

ID Number: CLNT-7222

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	51	0	51
2	0	0	0
1	0	0	0
Overall	51	0	51
Number of Defects	17	0	17
Pipe Rating	3B00	0000	3B00
Pipe Ratings Index	3	0	3

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:03:24 204	AMH - Access Point Manhole							
		SSMH-4201(298)							
0	00:03:38 218	MWL - Miscellaneous Water Level				5			
41.5	00:05:55 355	JOM - Joint Offset Medium							
93.3	00:08:08 488	JOM - Joint Offset Medium							
93.3	00:09:25 565	JOM - Joint Offset Medium							
131.8	00:10:20 620	JOM - Joint Offset Medium							
158.2	00:11:54 714	JOM - Joint Offset Medium							
171.2	00:13:02 782	JOM - Joint Offset Medium							
183.5	00:14:19 859	JOM - Joint Offset Medium							
210.1	00:16:38 998	JOM - Joint Offset Medium							
210.1	00:17:28 1048	JOM - Joint Offset Medium							
210.1	00:18:49 1129	JOM - Joint Offset Medium							
249.6	00:20:39 1239	JOM - Joint Offset Medium							
263.6	00:21:55 1315	JOM - Joint Offset Medium							
277	00:23:27 1407	JOM - Joint Offset Medium							

288.3	00:25:21 1521	JOM - Joint Offset Medium			
300.2	00:27:25 1645	TF - Tap Factory	4		3
301.4	00:28:13 1693	JOM - Joint Offset Medium			
313.8	00:30:56 1856	JOM - Joint Offset Medium			
313.8	00:35:13 2113	JOM - Joint Offset Medium			
346.7	00:42:35 2555	MGO - Miscellaneous General Observation			
		COULD NOT CONTINUE			
346.7	00:43:12 2592	MGO - Miscellaneous General Observation			
		REVERSAL NEEDED			
346.7	00:43:38 2618	MSA - Miscellaneous Abandoned Survey			
		346.7 FT			

Created with the POSM report generator

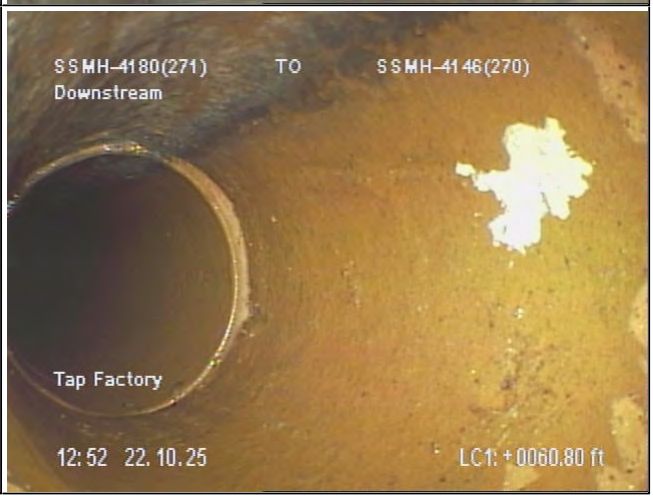
Additional Reports for Session CITY OF FORT BRAGG

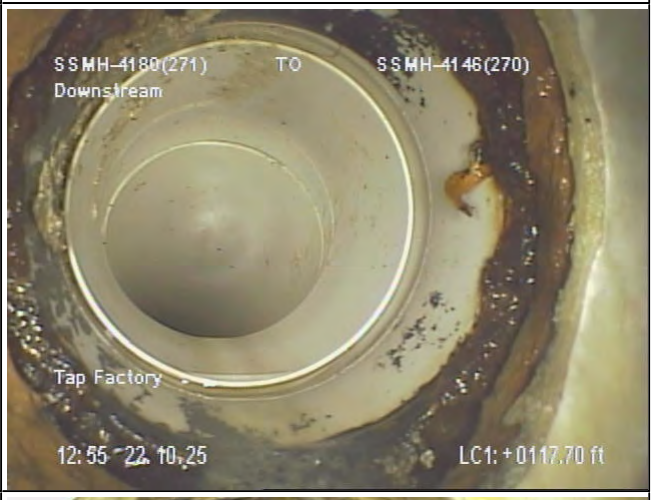
Created with the POSM report generator

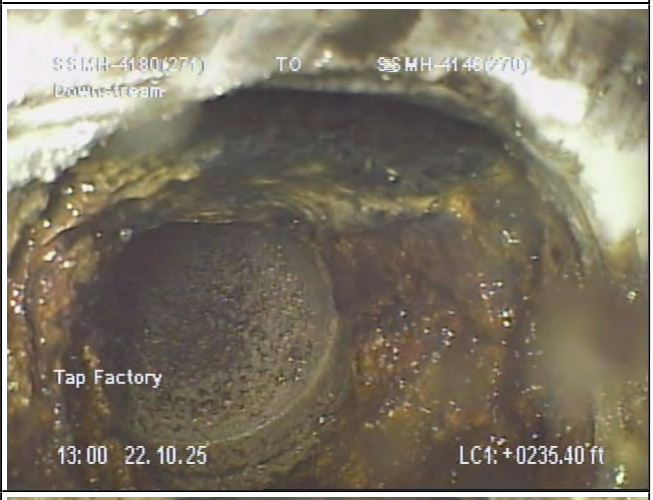
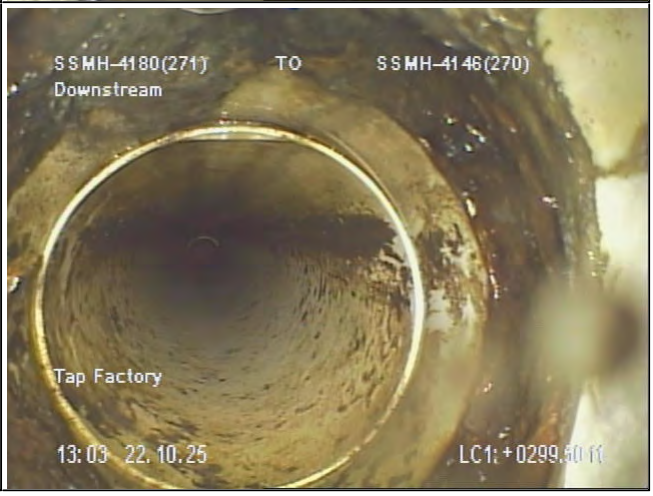
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-4765	**Date**	10/22/2025 12:36
Street	S SANDERSON WAY	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4180(271)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4146(270)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	399
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/22/2025 12:37
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

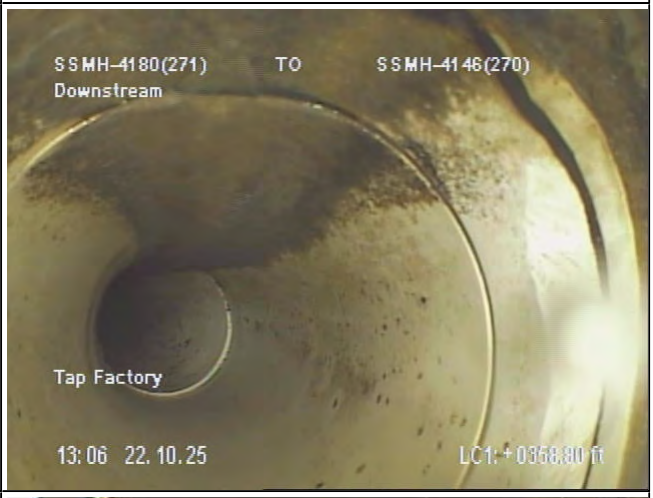
Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 12:36:00 PM	**Pipe Segment Reference:** MN-4765
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4180(271)
Length Surveyed: 399	**Downstream MH:** SSMH-4146(270)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	**Access Point Manhole** **Severity: None** **Remarks: SSMH-4180(271)**	**00:01:28** **00:01:28**	
0.0	**Miscellaneous Water Level** **Severity: None** **Percent: 5**	**00:01:40** **00:01:40**	
60.8	**Tap Factory** **Position: 3** **Severity: None** **Size: 4**	**00:03:57** **00:03:57**	

Distance	Fault Observation	Time	Picture
60.8	Tap Factory Position: 9 Severity: None Size: 4	00:06:14 00:06:14	
133.8	Tap Factory Position: 3 Severity: None Size: 4	00:07:04 00:07:04	
164.6	Tap Factory Position: 9 Severity: None Size: 4	00:08:26 00:08:26	

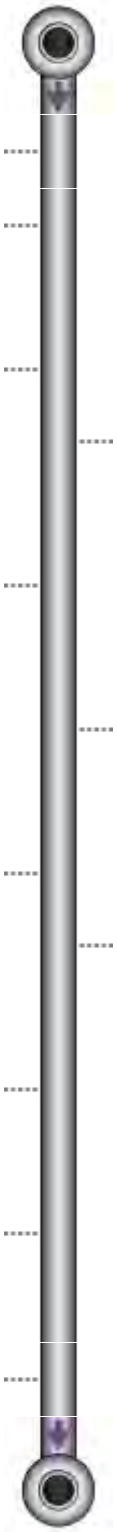
Distance	Fault Observation	Time	Picture
235.4	Tap Factory Position: 3 Severity: None Size: 4	00:11:30 00:11:30	
237.7	Tap Factory Position: 9 Severity: None Size: 4	00:11:58 00:11:58	
299.5	Tap Factory Position: 3 Severity: None Size: 4	00:14:46 00:14:46	

Distance	Fault Observation	Time	Picture
358.8	Tap Factory Position: 3 Severity: None Size: 4	00:17:42 00:17:42	
399.0	Access Point Manhole Severity: None Remarks: SSMH-4146(270)	00:22:26 00:22:26	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 12:36:00 PM	**Pipe Segment Reference:** MN-4765
Street: S SANDERSON WAY	**Upstream MH:** SSMH-4180(271)
Length Surveyed: 399	**Downstream MH:** SSMH-4146(270)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5



ID Number: SSMH-4180(271)

(0.0) AMH - Access Point Manhole Remark: SSMH-4180(271)

(0.0) MWL - Miscellaneous Water Level

(60.8) TF - Tap Factory - Position: 3

(60.8) TF - Tap Factory - Position: 9

(133.8) TF - Tap Factory - Position: 3

(164.6) TF - Tap Factory - Position: 9

(235.4) TF - Tap Factory - Position: 3

(237.7) TF - Tap Factory - Position: 9

(299.5) TF - Tap Factory - Position: 3

(358.8) TF - Tap Factory - Position: 3

(399.0) AMH - Access Point Manhole Remark: SSMH-4146(270)

Total Distance: 399

ID Number: SSMH-4146(270)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:28 88	AMH - Access Point Manhole							
		SSMH-4180(271)							
0	00:01:40 100	MWL - Miscellaneous Water Level				5			
60.8	00:03:57 237	TF - Tap Factory		4				3	
60.8	00:06:14 374	TF - Tap Factory		4				9	
133.8	00:07:04 424	TF - Tap Factory		4				3	
164.6	00:08:26 506	TF - Tap Factory		4				9	
235.4	00:11:30 690	TF - Tap Factory		4				3	
237.7	00:11:58 718	TF - Tap Factory		4				9	
299.5	00:14:46 886	TF - Tap Factory		4				3	
358.8	00:17:42 1062	TF - Tap Factory		4				3	
399	00:22:26 1346	AMH - Access Point Manhole							
		SSMH-4146(270)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5109	**Date**	10/21/2025 10:14
Street	PUDDING CREEK RD HWY 1	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH- 4594(10A)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4050 (10)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	445.8
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/20/2025 15:07
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 10:14:00 AM	**Pipe Segment Reference:** MN-5109
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4594(10A)
Length Surveyed: 445.8	**Downstream MH:** SSMH-4050 (10)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4594(10A)	00:03:52 00:03:52	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:04:05 00:04:05	
445.8	Access Point Manhole Severity: None Remarks: SSMH-4050 (10)	00:16:49 00:16:49	

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 10:14:00 AM	**Pipe Segment Reference:** MN-5109
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- 4594(10A)
Length Surveyed: 445.8	**Downstream MH:** SSMH-4050 (10)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

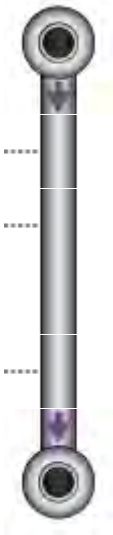
ID Number: SSMH- 4594(10A)

(0.0) AMH - Access Point Manhole Remark: SSMH- 4594(10A)

(0.0) MWL - Miscellaneous Water Level

(445.8) AMH - Access Point Manhole Remark: SSMH-4050 (10)

Total Distance: 445.8



ID Number: SSMH-4050 (10)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:03:52 232	AMH - Access Point Manhole							
		SSMH- 4594(10A)							
0	00:04:05 245	MWL - Miscellaneous Water Level				5			
445.8	00:16:49 1009	AMH - Access Point Manhole							
		SSMH-4050 (10)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-4696	**Date**	10/22/2025 16:06
Street	E OAK ST	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH-4152(279)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4410(286)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	98.4
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/22/2025 15:49
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 4:06:00 PM	**Pipe Segment Reference:** MN-4696
Street: E OAK ST	**Upstream MH:** SSMH-4152(279)
Length Surveyed: 98.4	**Downstream MH:** SSMH-4410(286)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4152(279)	00:01:19 00:01:19	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:33 00:01:33	
41.1	Tap Factory Position: 3 Severity: None Size: 4	00:04:57 00:04:57	

Distance	Fault Observation	Time	Picture
58.7	Tap Factory Position: 9 Severity: None Size: 4	00:07:33 00:07:33	
98.4	Tap Factory Position: 3 Severity: None Size: 4	00:11:39 00:11:39	
98.4	Access Point Manhole Severity: None Remarks: SSMH-4410(4696)	00:18:12 00:18:12	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 4:06:00 PM	**Pipe Segment Reference:** MN-4696
Street: E OAK ST	**Upstream MH:** SSMH-4152(279)
Length Surveyed: 98.4	**Downstream MH:** SSMH-4410(286)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

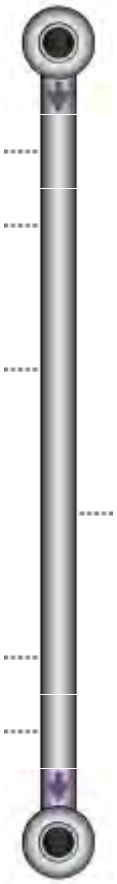
Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH-4152(279)

(0.0) AMH - Access Point Manhole Remark: SSMH-4152(279)

(0.0) MWL - Miscellaneous Water Level

(41.1) TF - Tap Factory - Position: 3



(58.7) TF - Tap Factory - Position: 9

(98.4) TF - Tap Factory - Position: 3

(98.4) AMH - Access Point Manhole Remark: SSMH-4410(4696)

Total Distance: 98.4

ID Number: SSMH-4410(286)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:1979	AMH - Access Point Manhole							
		SSMH-4152(279)							
0	00:01:3393	MWL - Miscellaneous Water Level				5			
41.1	00:04:57297	TF - Tap Factory		4				3	
58.7	00:07:33453	TF - Tap Factory		4				9	
98.4	00:11:39699	TF - Tap Factory		4				3	
98.4	00:18:121092	AMH - Access Point Manhole							
		SSMH-4410(4696)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

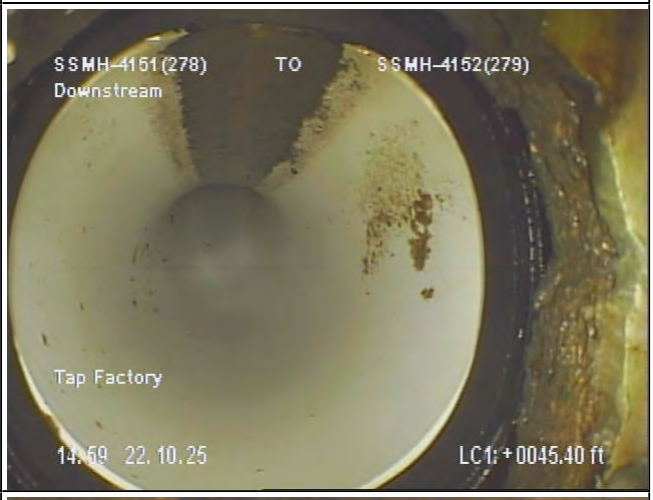
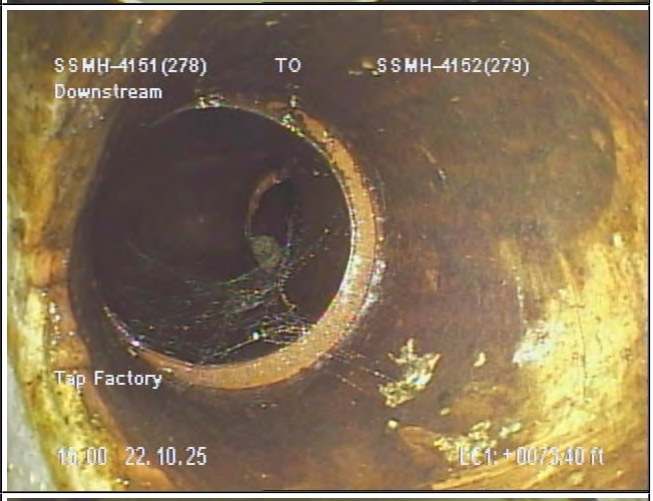
Created with the POSM report generator

Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	MN-5148	**Date**	10/22/2025 15:33
Street	E OAK ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH-4151(278)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH-4152(279)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method	Cured-In-Place Pipe	**Pipe Joint Length**	
Total Length		**Length Surveyed**	162.8
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/22/2025 15:49
Weather	Dry - No Precipitation During Survey	**Location Code**	Other
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 3:33:00 PM	**Pipe Segment Reference:** MN-5148
Street: E OAK ST	**Upstream MH:** SSMH-4151(278)
Length Surveyed: 162.8	**Downstream MH:** SSMH-4152(279)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH-4151(278)	00:01:32 00:01:32	
0.0	Miscellaneous Water Level Severity: None Percent: 5 Remarks: 0	00:02:03 00:02:03	
0.0	Miscellaneous General Observation Severity: None Remarks: E OAK	00:08:00 00:08:00	

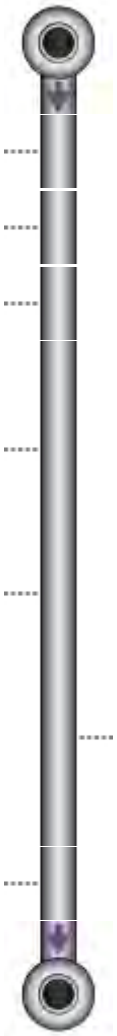
Distance	Fault Observation	Time	Picture
45.4	Tap Factory Position: 3 Severity: None Size: 4	00:11:03 00:11:03	
73.4	Tap Factory Position: 3 Severity: None Size: 4	00:12:17 00:12:17	
83.8	Tap Factory Position: 9 Severity: None Size: 4	00:13:15 00:13:15	

Distance	Fault Observation	Time	Picture
162.8	Access Point Manhole Severity: None Remarks: SSMH-4152(279)	00:17:09 00:17:09	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/22/2025 3:33:00 PM	**Pipe Segment Reference:** MN-5148
Street: E OAK ST	**Upstream MH:** SSMH-4151(278)
Length Surveyed: 162.8	**Downstream MH:** SSMH-4152(279)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 6	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5



ID Number: SSMH-4151(278)

(0.0) AMH - Access Point Manhole Remark: SSMH-4151(278)

(0.0) MWL - Miscellaneous Water Level Remark: 0

(0.0) MGO - Miscellaneous General Observation Remark: E OAK

(45.4) TF - Tap Factory - Position: 3

(73.4) TF - Tap Factory - Position: 3

(83.8) TF - Tap Factory - Position: 9

(162.8) AMH - Access Point Manhole Remark: SSMH-4152(279)

Total Distance: 162.8

ID Number: SSMH-4152(279)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:3292	AMH - Access Point Manhole							
		SSMH-4151(278)							
0	00:02:03123	MWL - Miscellaneous Water Level				5			
		0							
0	00:08:00480	MGO - Miscellaneous General Observation							
		E OAK							
45.4	00:11:03663	TF - Tap Factory		4				3	
73.4	00:12:17737	TF - Tap Factory		4				3	
83.8	00:13:15795	TF - Tap Factory		4				9	
162.8	00:17:091029	AMH - Access Point Manhole							
		SSMH-4152(279)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	TOP SECTION OF HDR #02	**Date**	10/21/2025 08:36
Street	PUDDING CREEK RD HWY 1	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH- (12)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH- 4313(11)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	493.4
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/20/2025 15:07
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 8:36:00 AM	**Pipe Segment Reference:** TOP SECTION OF HDR #02
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- (12)
Length Surveyed: 493.4	**Downstream MH:** SSMH- 4313(11)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	**Access Point Manhole** **Severity: None** **Remarks: SSMH- (10)**	**00:01:35** **00:01:35**	
0.0	**Miscellaneous Water Level** **Severity: None** **Percent: 5**	**00:01:47** **00:01:47**	
24.3	**Joint Offset Medium** **Severity: None** **Struct Weight: 3**	**00:03:50** **00:03:50**	

Distance	Fault Observation	Time	Picture
80.1	Miscellaneous Water Level Sag Severity: None Percent: 15 Struct Weight: 2	00:06:08 00:06:08	
159.2	Miscellaneous Water Level Sag Severity: None Percent: 10 Struct Weight: 2	00:08:44 00:08:44	
281.7	Miscellaneous Water Level Sag Severity: None Percent: 10 Struct Weight: 2	00:12:14 00:12:14	

Distance	Fault Observation	Time	Picture
454.1	Miscellaneous Water Level Sag Severity: None Percent: 10 Struct Weight: 2	00:27:52 00:27:52	
462.2	Miscellaneous General Observation Severity: None Remarks: EDIT TO SSMH-12	00:30:20 00:30:20	
493.4	Miscellaneous General Observation Severity: None Remarks: SSMH-12 TO SSMH-4313(11)	00:39:08 00:39:08	

Distance	Fault Observation	Time	Picture
493.4	Access Point Manhole Severity: None Remarks: SSMH- 4313(11)	00:39:41 00:39:41	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/21/2025 8:36:00 AM	**Pipe Segment Reference:** TOP SECTION OF HDR #02
Street: PUDDING CREEK RD HWY 1	**Upstream MH:** SSMH- (12)
Length Surveyed: 493.4	**Downstream MH:** SSMH- 4313(11)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH- (12)

(0.0) AMH - Access Point Manhole Remark: SSMH-(10)

(0.0) MWL - Miscellaneous Water Level

(24.3) JOM - Joint Offset Medium

(80.1) MWLS - Miscellaneous Water Level Sag

(159.2) MWLS - Miscellaneous Water Level Sag

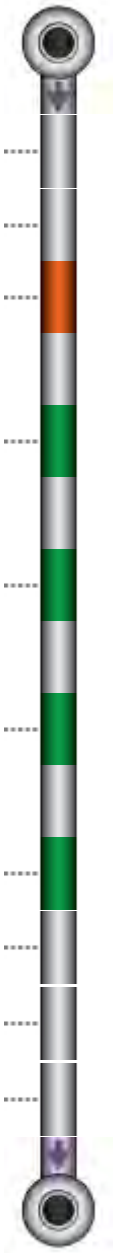
(281.7) MWLS - Miscellaneous Water Level Sag

(454.1) MWLS - Miscellaneous Water Level Sag

(462.2) MGO - Miscellaneous General Observation Remark: EDIT TO SSMH-12

(493.4) MGO - Miscellaneous General Observation Remark: SSMH-12 TO SSMH-4313(11)

(493.4) AMH - Access Point Manhole Remark: SSMH- 4313(11)



Total Distance: 493.4

ID Number: SSMH- 4313(11)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	3	0	3
2	8	0	8
1	0	0	0
Overall	11	0	11
Number of Defects	5	0	5
Pipe Rating	3124	0000	3124
Pipe Ratings Index	2.2	0	2.2

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:35 95	AMH - Access Point Manhole							
		SSMH- (10)							
0	00:01:47 107	MWL - Miscellaneous Water Level				5			
24.3	00:03:50 230	JOM - Joint Offset Medium							
80.1	00:06:08 368	MWLS - Miscellaneous Water Level Sag				15			
159.2	00:08:44 524	MWLS - Miscellaneous Water Level Sag				10			
281.7	00:12:14 734	MWLS - Miscellaneous Water Level Sag				10			
454.1	00:27:52 1672	MWLS - Miscellaneous Water Level Sag				10			
462.2	00:30:20 1820	MGO - Miscellaneous General Observation							
		EDIT TO SSMH-12							
493.4	00:39:08 2348	MGO - Miscellaneous General Observation							
		SSMH-12 TO SSMH-4313(11)							
493.4	00:39:41 2381	AMH - Access Point Manhole							
		SSMH- 4313(11)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

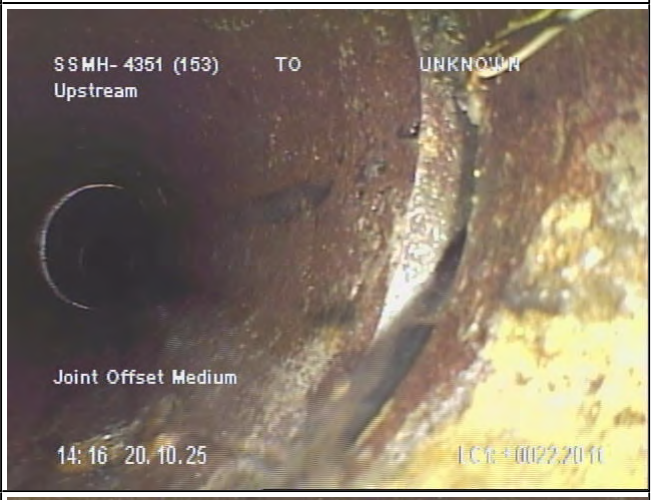
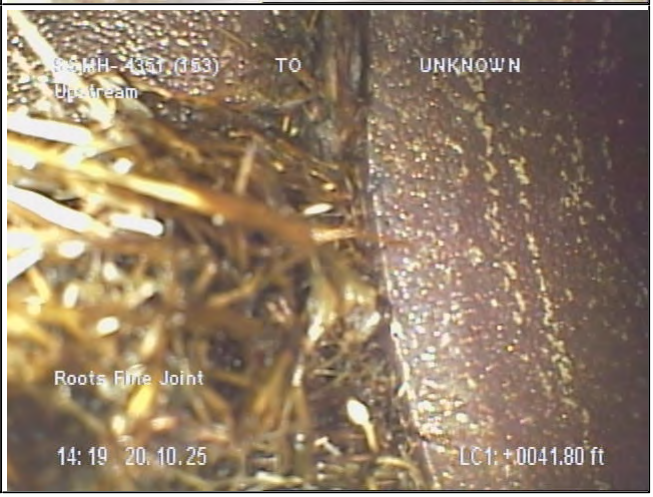
Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	#14 FB-04	**Date**	10/20/2025 15:03
Street	BUSH ST	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	UNKNOWN	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH- 4351 (153)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Upstream
Pipe			
Height (Diameter)	6	**Width**	
Shape	Circular	**Material**	Vitrified Clay Pipe
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	53.9
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/20/2025 15:07
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	No

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 3:03:00 PM	**Pipe Segment Reference:** #14 FB-04
Street: BUSH ST	**Upstream MH:** UNKNOWN
Length Surveyed: 53.9	**Downstream MH:** SSMH- 4351 (153)
Run Number:	**Direction of Survey:** Upstream
Height (Diameter): 6	**Material:** Vitrified Clay Pipe

Distance	Fault Observation	Time	Picture
0.0	Access Point Catch Basin Severity: None Remarks: SSMH- 4351 (153)	00:01:20 00:01:20	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:37 00:01:37	
2.5	Tap Factory Position: 3 Severity: None Size: 4	00:04:46 00:04:46	

Distance	Fault Observation	Time	Picture
4.8	Tap Factory Position: 9 Severity: None Size: 4	00:05:27 00:05:27	
4.8	Roots Ball Lateral Position: 9 Severity: None Percent: 55 Maint Weight: 4	00:05:50 00:05:50	
4.8	Tap Factory Position: 3 Severity: None Size: 4	00:06:24 00:06:24	

Distance	Fault Observation	Time	Picture
22.2	Joint Offset Medium Severity: None Struct Weight: 3	00:07:39 00:07:39	
36.9	Roots Medium Connection Position: 12 To 11 Severity: None Percent: 50 Maint Weight: 3	00:09:29 00:09:29	
41.8	Roots Fine Joint Position: 6 Severity: None Joint Maint Weight: 1	00:10:05 00:10:05	

Distance	Fault Observation	Time	Picture
53.9	Roots Ball Barrel Position: 2 To 11 Severity: None Percent: 55 Maint Weight: 5	00:11:15 00:11:15	
53.9	Miscellaneous General Observation Severity: None Remarks: CAN NOT CONTINUE	00:12:48 00:12:48	
53.9	Miscellaneous Abandoned Survey Severity: None Remarks: ROOTS IN LINE	00:13:19 00:13:19	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 3:03:00 PM	**Pipe Segment Reference:** #14 FB-04
Street: BUSH ST	**Upstream MH:** UNKNOWN
Length Surveyed: 53.9	**Downstream MH:** SSMH- 4351 (153)
Run Number:	**Direction of Survey:** Upstream
Height (Diameter): 6	**Material:** Vitrified Clay Pipe

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH- 4351 (153)

(0.0) ACB - Access Point Catch Basin Remark: SSMH- 4351 (153)

(0.0) MWL - Miscellaneous Water Level

(2.5) TF - Tap Factory - Position: 3

(4.8) TF - Tap Factory - Position: 9

(4.8) RBL - Roots Ball Lateral - Position: 9

(4.8) TF - Tap Factory - Position: 3

(22.2) JOM - Joint Offset Medium

(36.9) RMC - Roots Medium Connection - Position: 12 To 11

(41.8) RFJ - Roots Fine Joint - Position: 6

(53.9) RBB - Roots Ball Barrel - Position: 2 To 11

(53.9) MGO - Miscellaneous General Observation Remark: CAN NOT CONTINUE

(53.9) MSA - Miscellaneous Abandoned Survey Remark: ROOTS IN LINE

Total Distance: 53.9

ID Number: UNKNOWN

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	5	5
4	0	4	4
3	3	3	6
2	0	0	0
1	0	1	1
Overall	3	13	16
Number of Defects	1	4	5
Pipe Rating	3100	5141	5141
Pipe Ratings Index	3	3.3	3.2

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:2080	ACB - Access Point Catch Basin							
		SSMH- 4351 (153)							
0	00:01:3797	MWL - Miscellaneous Water Level				5			
2.5	00:04:46286	TF - Tap Factory		4				3	
4.8	00:05:27327	TF - Tap Factory		4				9	
4.8	00:05:50350	RBL - Roots Ball Lateral				55		9	
4.8	00:06:24384	TF - Tap Factory		4				3	
22.2	00:07:39459	JOM - Joint Offset Medium							
36.9	00:09:29569	RMC - Roots Medium Connection				50		12	11
41.8	00:10:05605	RFJ - Roots Fine Joint					X	6	
53.9	00:11:15675	RBB - Roots Ball Barrel				55		2	11
53.9	00:12:48768	MGO - Miscellaneous General Observation							
		CAN NOT CONTINUE							
53.9	00:13:19799	MSA - Miscellaneous Abandoned Survey							
		ROOTS IN LINE							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

Project Information

Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	HDR#02	**Date**	10/20/2025 11:53
Street	PUDDING CREEK W HWY 1	**City**	FORT BRAGG
Comments			

Manhole

Upstream MH	SSMH- 4311(12)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH- 4050(10)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream

Pipe

Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Polyethylene
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	445.4
Year Laid		**Year Renewed**	

Misc

Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Light Cleaning	**Date Cleaned**	10/20/2025 11:54
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	

Custom

Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	

Pacp 6

Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	Yes

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 11:53:00 AM	**Pipe Segment Reference:** HDR#02
Street: PUDDING CREEK W HWY 1	**Upstream MH:** SSMH- 4311(12)
Length Surveyed: 445.4	**Downstream MH:** SSMH- 4050(10)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH- 4311(12)	00:01:36 00:01:36	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:49 00:01:49	
445.4	Access Point Manhole Severity: None Remarks: SSMH- 4050(10)	00:20:18 00:20:18	

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 11:53:00 AM	**Pipe Segment Reference:** HDR#02
Street: PUDDING CREEK W HWY 1	**Upstream MH:** SSMH- 4311(12)
Length Surveyed: 445.4	**Downstream MH:** SSMH- 4050(10)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Polyethylene

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

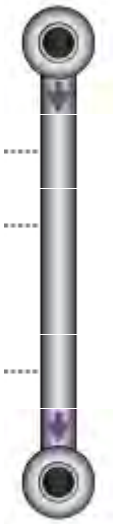
ID Number: SSMH- 4311(12)

(0.0) AMH - Access Point Manhole Remark: SSMH- 4311(12)

(0.0) MWL - Miscellaneous Water Level

(445.4) AMH - Access Point Manhole Remark: SSMH- 4050(10)

Total Distance: 445.4



ID Number: SSMH- 4050(10)

Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Overall	0	0	0
Number of Defects	0	0	0
Pipe Rating	0000	0000	0000
Pipe Ratings Index	0	0	0

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:36 96	AMH - Access Point Manhole							
		SSMH- 4311(12)							
0	00:01:49 109	MWL - Miscellaneous Water Level				5			
445.4	00:20:18 1218	AMH - Access Point Manhole							
		SSMH- 4050(10)							

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

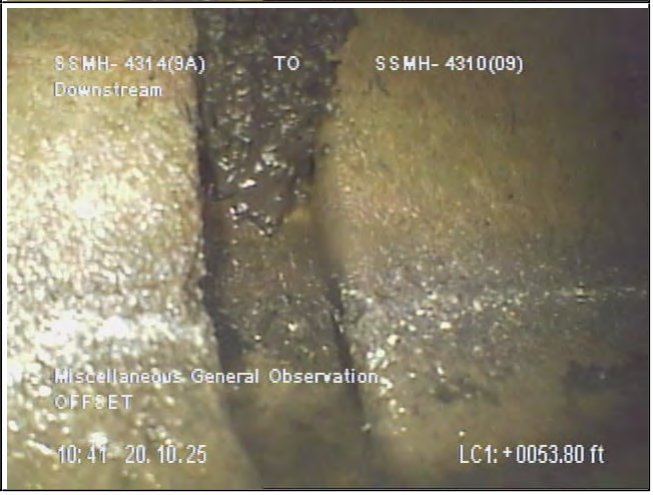
Created with the POSM report generator

Project Information			
Surveyor Name	DAVID COVARRUBIAS	**Certificate Number**	U-111707009737
Owner	CITY OF FORT BRAGG	**Customer**	CITY OF FORT BRAGG
Drainage Area		**PO Number**	BE25380
Pipe Segment Reference	HDR# 01	**Date**	10/20/2025 11:33
Street	PUDDING CREEK E	**City**	FORT BRAGG
Comments			
Manhole			
Upstream MH	SSMH- 4314(9A)	**Rim to Invert (U)**	
Grade to Invert (U)		**Rim to Grade (U)**	
Downstream MH	SSMH- 4310(09)	**Rim to Invert (D)**	
Grade to Invert (D)		**Rim to Grade (D)**	
Sewer Use	Sanitary Sewage Pipe	**Direction of Survey**	Downstream
Pipe			
Height (Diameter)	8	**Width**	
Shape	Circular	**Material**	Asbestos Cement
Lining Method		**Pipe Joint Length**	
Total Length		**Length Surveyed**	181.4
Year Laid		**Year Renewed**	
Misc			
Flow Control	Not Controlled	**Media Label**	DVD
Purpose	Maintenance Related	**Sewer Category**	
Pre-Cleaning	Not Known	**Date Cleaned**	
Weather	Dry - No Precipitation During Survey	**Location Code**	
Additional Info		**Location Details**	
Custom			
Number of Taps		**Number of Roots**	
Num Cracks / Fractures		**Number of Broken / Holes / Collapse**	
Number of Deposits		**Custom6**	
Custom7		**Struct Grade**	
OM Grade		**Overall Grade**	
Pacp 6			
Reverse Setup ID		**Sheet (Group) Number**	
Imperial Units (US)	True	**Pressure Value**	
Work Order		**Project**	CITY OF FORT BRAGG
		Completed	No

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 11:33:00 AM	**Pipe Segment Reference:** HDR# 01
Street: PUDDING CREEK E	**Upstream MH:** SSMH- 4314(9A)
Length Surveyed: 181.4	**Downstream MH:** SSMH- 4310(09)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Asbestos Cement

Distance	Fault Observation	Time	Picture
0.0	Access Point Manhole Severity: None Remarks: SSMH- 4314(9A)	00:01:34 00:01:34	
0.0	Miscellaneous Water Level Severity: None Percent: 5	00:01:47 00:01:47	
13.1	Joint Offset Medium Severity: None Struct Weight: 3	00:03:03 00:03:03	

Distance	Fault Observation	Time	Picture
27.1	Joint Offset Medium Severity: None Struct Weight: 3	00:03:56 00:03:56	
27.1	Joint Offset Large Defective Severity: None Struct Weight: 4	00:04:45 00:04:45	
53.8	Miscellaneous General Observation Severity: None Remarks: OFFSET	00:06:06 00:06:06	

Distance	Fault Observation	Time	Picture
53.8	Joint Offset Medium Severity: None Struct Weight: 3	00:06:27 00:06:27	
65.8	Joint Offset Medium Severity: None Struct Weight: 3	00:07:22 00:07:22	
106.3	Joint Offset Medium Severity: None Struct Weight: 3	00:08:56 00:08:56	

Distance	Fault Observation	Time	Picture
156.9	Joint Offset Medium Severity: None Struct Weight: 3	00:11:05 00:11:05	
156.9	Joint Offset Medium Severity: None Struct Weight: 3	00:11:58 00:11:58	
156.9	Miscellaneous General Observation Severity: None Remarks: DEBRIES IN LINE	00:12:52 00:12:52	

Distance	Fault Observation	Time	Picture
181.4	Miscellaneous General Observation Severity: None Remarks: UNABLE TO CONTINUE	00:13:19 00:13:19	
181.4	Miscellaneous Abandoned Survey Severity: None Remarks: ENDING VIDEO	00:13:46 00:13:46	

Created with the POSM report generator

Project: CITY OF FORT BRAGG	
Date: 10/20/2025 11:33:00 AM	**Pipe Segment Reference:** HDR# 01
Street: PUDDING CREEK E	**Upstream MH:** SSMH- 4314(9A)
Length Surveyed: 181.4	**Downstream MH:** SSMH- 4310(09)
Run Number:	**Direction of Survey:** Downstream
Height (Diameter): 8	**Material:** Asbestos Cement

Severity
Light–1
Moderate–2
Average–3
Heavy–4
Severe–5

ID Number: SSMH- 4314(9A)

(0.0) AMH - Access Point Manhole Remark: SSMH- 4314(9A)

(0.0) MWL - Miscellaneous Water Level

(13.1) JOM - Joint Offset Medium

(27.1) JOM - Joint Offset Medium

(27.1) JOLD - Joint Offset Large Defective

(53.8) MGO - Miscellaneous General Observation Remark: OFFSET

(53.8) JOM - Joint Offset Medium

(65.8) JOM - Joint Offset Medium

(106.3) JOM - Joint Offset Medium

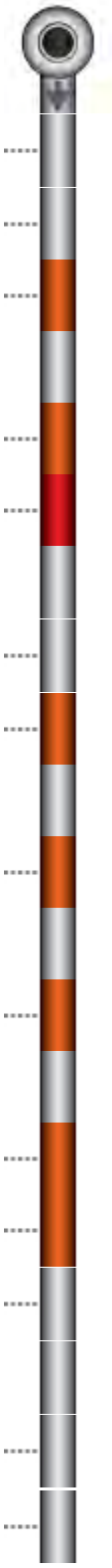
(156.9) JOM - Joint Offset Medium

(156.9) JOM - Joint Offset Medium

(156.9) MGO - Miscellaneous General Observation Remark: DEBRIES IN LINE

(181.4) MGO - Miscellaneous General Observation Remark: UNABLE TO CONTINUE

(181.4) MSA - Miscellaneous Abandoned Survey Remark: ENDING VIDEO



Created with the POSM report generator

Nassco C.C.T.V. Defect Code Information

Grade	Structural	O&M	Overall
5	0	0	0
4	4	0	4
3	21	0	21
2	0	0	0
1	0	0	0
Overall	25	0	25
Number of Defects	8	0	8
Pipe Rating	4137	0000	4137
Pipe Ratings Index	3.1	0	3.1

Nassco C.C.T.V. Defect Code Information

Distance	Video Ref	Code	Cont Defect	Value			Joint	Circumferential Location	
				Dimension		%		At / From	To
				1st	2nd				
0	00:01:34 94	AMH - Access Point Manhole							
		SSMH- 4314(9A)							
0	00:01:47 107	MWL - Miscellaneous Water Level				5			
13.1	00:03:03 183	JOM - Joint Offset Medium							
27.1	00:03:56 236	JOM - Joint Offset Medium							
27.1	00:04:45 285	JOLD - Joint Offset Large Defective							
53.8	00:06:06 366	MGO - Miscellaneous General Observation							
		OFFSET							
53.8	00:06:27 387	JOM - Joint Offset Medium							
65.8	00:07:22 442	JOM - Joint Offset Medium							
106.3	00:08:56 536	JOM - Joint Offset Medium							
156.9	00:11:05 665	JOM - Joint Offset Medium							
156.9	00:11:58 718	JOM - Joint Offset Medium							
156.9	00:12:52 772	MGO - Miscellaneous General Observation							
		DEBRIES IN LINE							
181.4	00:13:19 799	MGO - Miscellaneous General Observation							
		UNABLE TO CONTINUE							

181.4	00:13:46 826	MSA - Miscellaneous Abandoned Survey			
		ENDING VIDEO			

Created with the POSM report generator

Additional Reports for Session CITY OF FORT BRAGG

Created with the POSM report generator

PROJECT BE25380
CITY OF FORT BRAGG
10-22-2025

S SANDERSON WAY

1. SSMH-4201(298) TO SSMH-CLNT-7222
UPSTREAM
PIPE SEGMENT REF:5179
6 INCH
SEVERAL OFFSETS AND JOINT SEPERATIONS IN THIS SEGMENT. MSA THIS LINE AND COULD NOT CONTIUE TO CLNT
FOOTAGE: 346.7 FT

2. SSMH-4201(298) TO SSMH-4413(274)
DOWNSTREAM
PIPE SEGMENT REF:5150
6 INCH
LARGE OFFSET IN LINE.
FOOTAGE:700.10 FT

3.SSMH-4413(274) TO SSMH-4180(271)
DOWNSTREAM
PIPE SEGMENT REF: 5159
6 INCH
BEND IN LINE.
FOOTAGE:255.0 FT

4.SSMH-4180(271) TO SSMH-4146(270)
DOWNSTREAM
PIPE SEGMENT REF:4765
6 IMCH
FOOTAGE:399.0 FT

E OAK ST

5.SSMH-4151(278) TO 4152(279)
DOWNSTREAM
PIPESEGMENT REF: 5148
6 INCH
FOOTAGE:162.8 FT

6.SSMH-4152(279) TO SSMH-4410(286)
PIPE SEGMENT REF:4696
DOWNSTREAM
PIPE SEGMENT REF:4696
FOOTAGE:168.0 FT

TOTAL FOOTAGE: 2,031.6 FT

PROJECT BE25380
CITY OF FORT BRAGG
10-23-2025

E OAK ST

1. SSMH-4410(286) TO SSMH-4623
DOWNSTREAM
PIPE SEGMENT REF:4901
6 INCH
THIS LINE HAD ALOT OF WATER. HIGH FLOW AREA. THERE WAS ALSO A REPAIR SPOT IN THIS LINE.
FOOTAGE: FT 118.3 FT

2. SSMH-4623 TO SSMH-4174(290)
DOWNSTREAM
6 INCH
PIPE SEGMENT REF:4697
TOTAL:201.5 FT

3.SSMH-4174(290) TO SSMH-4176(292)
DOWNSTREAM
PIPE SEGMENT REF:4699
FOOTAGE:146.8

4. SSMH-4176(292) TO SSMH-4181(295)
DOWNSTREAM
6 INCH
PIPE SEGMENT REF:N/A
LINNER FALUIRE WHERE I ENDED MY VIDEO. TOO HIGH FLOW FOR A REVERSAL
FOOTAGE: 215.20 FT

5. SSMH-4417(179) TO SSMH-4125(188)
DOWNSTREAM
10 INCH
PIPE SEGMENT REF: N/A
FOOTAGE:759.9

ADDITIONAL NOTES: OAK ST HAD VERY HIGH FLOW. THIS LINE WAS VERY DIFFICULT TO TV DUE HIGH WATER LEVEL. I HAD TO PULL BACK TO ATTEPMET TO GET A BETTER VISUAL.

TOTAL FOOTAGE: 1,441.7 FT

PROJECT BE25380
CITY OF FORT BRAGG
10-21-2025

HWY 1

1. SSMH-4311(12) TO SSMH-4313(11)
HWY 1
DOWNSTREAM
PIPE SEGMENT REF:5103
8 INCH PE LINE
FOOTAGE:493.4 FT

2. SSMH-4594(10A) TO SSMH-4050(10)
HWY 1
DOWNSTREAM
PIPE SEGMENT REF:5109
8 INCH PE PIPE
FOOTAGE:445.8 FT

3. SSMH-4308(7) TO SSMH-4309(8)
HWY 1
DOWNSTREAM
PIPE SEGMENT REF: MN-5112
8 INCH PE PIPE
FOOTAGE: 519.50 FT

4. SSMH-4309(8) TO SSMH-4589
HWY 1
DOWNSTREAM
PIPE SEGMENT REF: MN-5099
COULD NOT GET TO DOWN STREAM MANHOLE DUE TO AN OFFSET LINE. COMBO TRUCK COULD NOT JET LINE DUE TO LOCATION OF MANHOLE.
TOTAL FOOTAGE:175. 2 FT

TOTAL FOOTAGE: 1,633.9 FT

PROJECT BE25380
CITY OF FORT BRAGG
10-20-2025

1. HDR-01
4314 (9A) TO 4310(09)
DOWNSTREAM
I WAS NOT ABLE TO SUCCESSFULLY GET TO THE DOWNSTREAM MANHOLE. THIS LINE HAD SEVERAL OFFSETS IN THE LINE. I WAS ONLY ABLE TO GO 181.FT IN LINE. I WAS NOT ABLE TO CONTINUE DUE TO DEBRIES IN LINE. DOWNSTREAM MANHOLE WAS NOT VISIBLE. REVERSAL NEEDED.

2. HDR-02
4311(12) TO 4050(10)
DOWNSTREAM
NO ISSUES.
445.10 FT CLEAR
DOWNSTREAM MANHOLE HAS MISSING PE PIPE.

3. #14 FB-04
THIS LINE WAS CLEANEED TWICE. LINE HAD NO UPSTREAM MANHOLE. I WAS ONLY ABLE TO TRAVEL 53.9 FT AND HAD TO ABANDON THE SURVEY DUE TO ROOTS.

ADDITIONAL INFO:

SPOKE WITH ALEX FROM HDR AND ADVISED HIM TO ADJUST THE CURRENT MAPS PLEASE. NEW MAPS ARE GOING TO BE CREATED WITH MORE INFO. WE ALSO TALKED ABOUT MAKE SURE THAT EACH MH TO MH INSPECTION HAD ITS OWN. TODAY WE WALKED SITE AND OPENED MANHOLES TO VERIFY THE SECTIONS WE WERE WORKING ON.

TOTAL FOOTAGE: 680 FT

Appendix G. Lift Station Visual Assessment Report

Condition Assessment Report

City of Fort Bragg

Sewer Pump Stations Condition Assessment

March 26, 2025

This page left intentionally blank.

Contents

CHAPTER 1 Introduction 2

CHAPTER 2 Existing Facilities 4

CHAPTER 3 Assessment Approach 4
3.1 Task 1 – Review of Past Documents 4
3.2 Task 2 – City Staff Interviews 4
3.3 Task 3 – Condition Assessment 4
3.4 Estimated Original Useful Life (OUL) and Evaluated Remaining Useful Life (EvRUL). 5
3.5 Condition Rating 5
3.6 Condition Rating Methodology 6

CHAPTER 4 Condition Assessment Findings 8
4.1 South Noyo Pump Station 8
4.1.1 Overview of Facility 8
4.1.2 North Noyo Pump Station 12
4.1.3 Sanderson (Noyo Heights) Pump Station 16
4.1.4 Pudding Pump Station 18
4.1.5 Elm Pump Station 22
4.2 Noyo Point Pump Station 27

Figures

Figure 1 - City Pump Station Overview 3
Figure 2 – South Noyo Pump Station 9
Figure 3 – North Noyo Pump Station 13
Figure 4 – Sanderson (Noyo Heights) Pump Station 16
Figure 5 – Pudding Creek Pump Station 19
Figure 6 – Elm Pump Station 23
Figure 7 – Noyo Point Pump Station 27

Tables

Table 1: Condition Rating Methodology 5
Table 2: South Noyo Condition Ratings 10
Table 3: South Noyo Recommended Improvements 12
Table 4: North Noyo Condition Ratings 14
Table 5: North Noyo Recommended Improvements 15
Table 6: Sanderson Pump Station Condition Ratings 17
Table 7: Sanderson Recommended Improvements 18
Table 8: Pudding Pump Station Condition Ratings 20
Table 9: Pudding Pump Station Recommended Improvements 21
Table 10: Elm Pump Station Condition Ratings 23
Table 11: Elm Pump Station Recommended Improvements 26

Table 12: Noyo Point Pump Station Condition Ratings.....28
Table 13: Noyo Pump Station Recommended Improvements 29

Appendices

Appendix A – List of Facilities

Appendix B – Completed Inspection Forms

Acknowledgements

It should be noted that the City of Fort Bragg (City) staff listed below provided the information, access, and utility history that was vital to developing this report. They were forthcoming answering all our questions, were available for the site inspections, and assisted with our research as needed:

- Chantell O' Neal, Assistant Director; Engineering Division Public Works
- Alden Ramos, Collection System Operations

CHAPTER 1 Introduction

The Fort Bragg Municipal Improvement District No. 1 was formed in 1969 and encompasses the City of Fort Bragg and areas to the north and south, which are not within the City limits. The wastewater collection system is wholly owned and operated by the City through the Municipal Improvement District. The Fort Bragg wastewater facilities consist of a sewer system, six pump stations, a wastewater treatment plant, and an outfall pipeline, which extends 690 feet into the Pacific Ocean. The six pump stations are South Noyo, North Noyo, Sanderson, Pudding, Elm Street, and Noyo Point.

HDR performed a visual assessment of the six lift stations, which are part of the collection system. The visual assessment was performed over a one-day site tour with City staff. The gathered information is used to provide a desktop-based assessment of the lift stations to memorialize the condition of the lift stations. To prioritize capital improvement recommendations generated from the visual assessment, the desktop risk assessment assigns a risk score to each station which will be considered for prioritization of recommended improvements.

The City pump stations are shown in Figure 1.

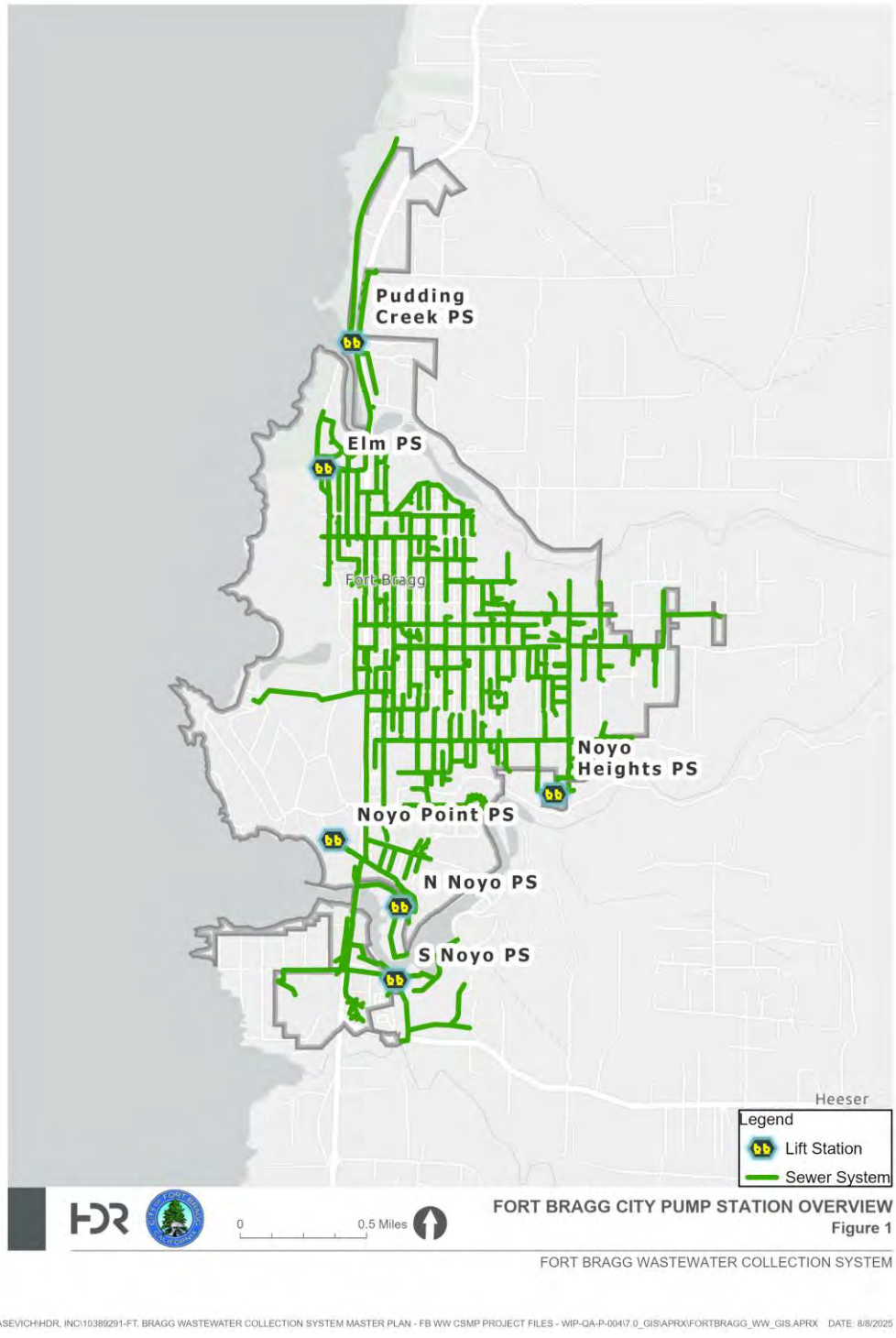


Figure 1 – City Pump Station Overview

CHAPTER 2 Existing Facilities

The scope of this task required visual condition inspections of each pump station utilizing professional personnel familiar with the design and operation of sewer lift stations. The intent of work is to provide an assessment of the condition of these facilities by conducting field inspections, performing a desktop estimate of remaining life, develop a cost opinion range for equipment renewal, modifications and capital projects for each facility, and provide both short-term (<5 Year), mid-term (Year 5 to 10) and long-term (Year 11-20) capital improvement plan (CIP) necessary to meet service demands.

CHAPTER 3 Assessment Approach

The condition assessment performed by HDR and City staff was a collaborative effort leveraging staff's knowledge of facility assets during the physical inspections of the facilities, review of data and documents requested from the City, and a desktop evaluation of the available data to assess the condition and remaining life of the system assets through the following tasks.

- Task 1 – Review of Past Documents
- Task 2 – City Staff Interviews
- Task 3 – Visual Condition Assessment

This report presents the results of the condition assessment results of Tasks 1 through 3. These results are being used to develop asset improvement cost estimates and the short-term, mid-term, and long-term capital improvement plan.

3.1 Task 1 – Review of Past Documents

The purpose of this task was to collect the asset data necessary to complete the condition assessment effort and to provide an understanding of the current state of the City's infrastructure and facilities, the City's recent planning studies and capital improvements, and the current asset inventory and maintenance data. The available information provided by the City was reviewed and compiled with our inspection reports to complete the condition assessments that are included in this report.

3.2 Task 2 – City Staff Interviews

HDR met with City staff prior to visiting the pump station sites to discuss the overall details of the assessment process and provide the foundation for the City's objectives for the assessment. The meeting served as a forum to discuss logistics for performing the field assessments, identify relevant City policies and standards to be complied with, and to discuss facility issues, concerns, background, and history. Based on the discussions on facility issues, the assets to be assessed as part of the field inspections were refined and prioritized.

3.3 Task 3 – Condition Assessment

The purpose of this task was to perform a condition assessment of the pump station facilities to identify assets that are near the end of the original useful life and define recommendations for

replacement and renewal. This condition assessment is considered a Level 2 assessment by industry standards.

- A Level 2 condition assessment is defined as an assessment based on inspections to determine the degree of physical deterioration of an asset through an onsite visual inspection by a subject matter expert. A Level 2 condition assessment typically includes interviews with City staff and a desktop review of relevant materials, such as record drawings, operating data/records, spare parts inventory, and maintenance history.

3.4 Estimated Original Useful Life (OUL) and Evaluated Remaining Useful Life (EvRUL)

Original useful life of equipment varies from utility to utility and is dependent on several factors such as environment, hours of operation, material, installation, maintenance frequency, and many other factors.

Based on the original useful life, a “default” evaluated remaining useful life can be estimated for planning purposes. For example: if a submersible pump is installed in 2000 and is estimated to provide service for 20 years, then by default a replacement should be planned for in 2020 at 0 years remaining useful life. However, if the pump is still providing service and is judged to be in good condition, the replacement can be delayed. Other than the above-grade pumps at Elm Street Pump Station, all the other pumps were submerged at the time of the inspection and could not be visually evaluated.

3.5 Condition Rating

Condition Rating (CR) is a subjective measure of the state of deterioration. A basic rating was established based on “Best Professional Judgment” which includes several factors including remaining percent of original useful life (OUL) or conversely the evaluated remaining useful life (EvRUL), overall deterioration, and the level of maintenance effort necessary to return the asset type to good working order. Performance and reliability are based on staff interviews. Review of operating logs and operating data is considered when available.

Ratings are on a scale of 1 to 5 according to the following table:

Table 1: Condition Rating Methodology

Condition Rating	Description	% of OUL EvRUL	Maintenance Effort
1	**Excellent** or New Condition	100%	Normal Preventive Maintenance
2	**Good** - Minor Defects Only	75%	Normal Preventive Maintenance, Minor Corrective Maintenance
3	**Fair** – Moderate Deterioration	50%	Normal Preventive Maintenance, Major Corrective Maintenance
4	**Poor** – Significant Deterioration	25%	Rehabilitation, if possible

Condition Rating	Description	% of OUL EvRUL	Maintenance Effort
5	**Failure Imminent** -Virtually Unserviceable	> 5%	Replace
0	Unknown		Not inspected

3.6 Condition Rating Methodology

The following is the logic for assigning a condition rating for the system assets.

1. Review industry references of asset class/type original useful life estimates and determine applicability to the City.
2. Determine the facility or assets required performance or capacity requirements. If the facility or asset cannot meet capacity requirements, then consider the asset in a state of imminent failure.
3. If equipment has surpassed its estimated original useful life, then consider its condition. Will it need to be replaced within the planning horizon?
4. If the age of the asset exceeds its useful life, then this logic will be followed:
   a. By default, it is rated a CR4 - Poor
   b. If it shows severe deterioration, then maintain the CR4 - Poor rating
   c. Consider upgrading to a CR3 (Fair) if it appears to be in good condition, performs its function, and does not have an immediate need to repair or replace to meet industry standards.
   d. Consider upgrading to a CR2 (Good) only if there is a report or an assessment that the asset is performing well and repair or replacement may be delayed beyond the 75% of its OUL.
5. If the age of the asset is within its original useful life, then logic will be followed:
   a. If equipment is a recent install or has 90% or more estimated remaining useful life, then by default it is a CR1 (New)
   b. If equipment has 50% or more remaining of its original useful life and there is no indications of frequent repairs or physical deterioration the rating should be a CR2 (Good)
   c. If equipment has less than 50% remaining of its original useful life and there are reports of frequent repairs or physical deterioration, then rating should be CR3 (Fair)
   d. If equipment has less than 50% remaining of its original useful life and findings of significant deterioration and reports indicate a need for rehabilitation, then the rating should be CR4 (Poor)
6. If an asset has failed or is in an imminent failure state, the rating should be CR5 and issue a “red-flag” report to the City.
7. Other considerations:
   a. If the asset is obsolete with no repair parts or technical support available, then a CR4 should be assigned

b. Any asset deemed to not meet reliability or performance requirements should be rated a CR4 or CR5 depending on the severity of the deficiency.

CHAPTER 4 Condition Assessment Findings

4.1 South Noyo Pump Station

4.1.1 Overview of Facility

The South Noyo Pump Station was installed during the 1970 Regional Sewage Disposal Project. It has two pumps rated at 460 gpm each. The pump station drains the Ft. Bragg wastewater collection system south of Noyo River. It discharges north over the Highway 1 bridge on the Noyo River to SSM 115 (Utility Network manhole Mnhl-Chnnl-4665) near the intersection of Highway 1 and N. Harbor Drive.

The station is composed of a below-grade wet well that contains the inlet piping, valve, and standpipe, two duty/standby submersible 35 hp pumps and discharge piping, a separate valve vault, and bypass connection mounted above grade adjacent to the valve vault. The building (comprised of concrete walls and concrete roof) above the abandoned drywell houses the electrical panels. Backup power to the lift station is provided with a portable generator connected to an outlet. The sites have perimeter chain link fences and asphalt driveways.

Figure 2 – South Noyo Pump Station

4.1.1.1 Overall Condition Ratings

The South Noyo pump station was reviewed for condition and the results are summarized in Table 2. The following processes/systems/assets were assessed:

- Below Grade Inlet and Wet well
- Discharge Valve Vault
- Electrical systems
- Structures
- Site Features

Table 2: South Noyo Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
Wet well Structure	Structure		NA	3	NA	11-20
Inlet Valve and Standpipe	Mechanical		2	NA	NA	11-20
Submersible Pumps and Rail System	Mechanical	2019	2	NA	NA	11-20
Discharge Piping	Mechanical	2019	2	NA	NA	11-20
Valve Vault Structure and Access Hatch	Structural		NA	2	NA	11-20
Valve Vault Piping	Mechanical	2019	2	NA	NA	11-20
Backflow Preventer	Mechanical		2	NA	NA	11-20
Door	Architectural		NA	4	NA	<5
Site	Civil		4	NA	NA	<5
Electrical Panels	Electrical	2019	NA	NA	2	11-20
Exterior hose bibb and piping	Electrical		2	NA	NA	11-20
Bypass Piping Connection	Mechanical		2	NA	NA	11-20
Handrails	Architectural		NA	2	NA	11-20
Abandoned drywell coating	Architectural		NA	2	NA	>5
Radio and Control Panel	Electrical	2015	NA	NA	2	11-20
Electrical conduits	Electrical		NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- There is a safety net below the wet well access hatch
- Pumps, piping, and MCC replaced in 2019 and are in good condition
- Lot of grease at the time of the inspection. Per City this is manually cleaned periodically.
- Floor of wet well was resurfaced so assumed to be in good condition
- Inlet butterfly valve appears to be in good condition, although it was difficult to see
- FRP grating over the inlet opening in good condition
- Exposed aggregate at top of the inlet opening can lead to increased surface removal and potential exposure of rebar and premature failure
- Minor surface corrosion on the discharge piping grooved couplings and be grinded
- Stainless steel supports appear to be in good condition
- Exterior hose bibb paint peeling, but copper material in good shape
- Valve vault appears to be in good condition

- No safety net on valve vault. Should be added for safety
- Bypass piping connection shows minimal corrosion
- Backflow preventer in good condition. The supports show some corrosion so minor grinding required
- The abandoned drywell equipment and piping is still in place. Could be removed as budget allows
- The building is in good condition, although there is some minor damage below roof
- Corrosion on lower area of door and should be replaced
- Minor damage of paint on handrail into the abandoned drywell
- Some peeling of coating on the upper wall of the drywell (as viewed from the room above). Extents of coating not visually inspected so damage not fully known
- Radio and control panel replaced in 2015 and in good condition
- Site around the wet well and building is mostly ungraded dirt. Addition of asphalt pavement would allow improved access
- Per the City, the power required to operate both pumps at the South Noyo lift station is slightly greater than what the portable generator can output. Can only be solved with a larger portable generator

4.1.1.2 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 3 indicates recommended improvements and timing – whether the project is recommended as a short-term project (<5-year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

Table 3: South Noyo Recommended Improvements

Improvement	Funding	Timeframe	Cost Estimate
Surface prepare and coat the top of the wet well structure where exposed aggregate visible		<5	$5,000
Recoat handrails		<5	$2000
Replace building door		<5	$1000
Install asphalt paving and base to dirt area adjacent to wet well		<5	$15,000
Recoat/spot repair damaged coating inside the abandoned drywell		<5	$2000
Add net or grate under to valve vault hatch		<5	$3,000
		Total Cost	**$28,000**

4.1.2 North Noyo Pump Station

4.1.2.1 Overview of Facility

The North Noyo Pump Station was installed during the 1970 Regional Sewage Disposal Project. It has two pumps rated at 353 gpm each. The pump station drains the Ft. Bragg wastewater collection system north of Noyo River and south of N. Harbor Drive. It discharges northwest along N. Harbor Drive to SSM 116 (Utility Network manhole Mnhl-Chnnl-4236) near the intersection of Highway 1 and N. Harbor Drive.

The station is composed of a below-grade wet well that contains the inlet piping, valve, and standpipe, two duty/standby submersible 25 hp pumps and discharge piping, a separate valve vault, bypass connection mounted above grade adjacent to the valve vault. The building (comprised of concrete walls and concrete roof) above the abandoned drywell houses the electrical panels. Backup power to the lift station is provided with a portable generator connected to an outlet. The sites have perimeter chain link fences and asphalt driveways.

Figure 3 – North Noyo Pump Station

4.1.2.2 Overall Condition Ratings

The North Noyo pump station was reviewed for condition and the results are summarized in Table 4. The following processes/systems/assets for the pump station were assessed:

- Below Grade Inlet and Wet well
- Discharge Valve Vault
- Electrical systems
- Structures
- Site Features

Table 4: North Noyo Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
Wet well Structure	Structure		NA	3	NA	5-10
Inlet Valve and Standpipe	Mechanical		2	NA	NA	11-20
Submersible Pumps and Rail System	Mechanical	2019	2	NA	NA	11-20
Discharge Piping	Mechanical	2019	2	NA	NA	11-20
Valve Vault Structure and Access Hatch	Structural		NA	2	NA	11-20
Valve Vault Piping	Mechanical	2019	2	NA	NA	11-20
Backflow Preventer	Mechanical		2	NA	NA	11-20
Door	Structure		NA	4	NA	<5
Site paving	Civil		4	NA	NA	<5
Electrical Panels	Electrical	2019	NA	NA	2	11-20
Exterior hose bibb and piping	Mechanical		2	NA	NA	11-20
Bypass Piping Connection	Mechanical		2	NA	NA	11-20
Handrails	Architectural		NA	2	NA	11-20
Abandoned drywell coating	Architectural		NA	2	NA	>5
Radio and Control Panel	Electrical	2015	NA	NA	2	11-20
Electrical conduits	Electrical		NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- There is a safety net below the wet well access hatch
- Pumps, piping, and MCC replaced in 2019 and are in good condition
- Lot of grease at the time of the inspection. Per City this is manually cleaned periodically.
- Floor of wet well was resurfaced so assumed to be in good condition
- Inlet butterfly valve appears to be in good condition, although it was difficult to see
- FRP grating over the inlet opening in good condition
- Exposed aggregate at top of the inlet opening can lead to increased surface removal and potential exposure of rebar and premature failure
- Minor surface corrosion on the discharge piping grooved couplings and be grinded
- Stainless steel supports appear to be in good condition
- Exterior hose bibb paint peeling, but copper material in good shape

- Valve vault appears to be in good condition
- No safety net on valve vault. Should be added for safety
- Bypass piping connection shows minimal corrosion
- Backflow preventer in good condition. The supports show some corrosion so minor grinding required
- The abandoned drywell equipment and piping is still in place. Could be removed as budget allows
- The building is in good condition, although there is some minor damage below roof
- Corrosion on lower area of door and should be replaced
- Minor damage of paint on handrail into the abandoned drywell
- Some peeling of coating on the upper wall of the drywell (as viewed from the room above). Extents of coating not visually inspected so damage not fully known
- Radio and control panel replaced in 2015 and in good condition
- Some metal conduit coating damage
- Per the City, there have been some odor complaints at the North Noyo lift station due to it close proximity to the neighborhood and nearby businesses.

4.1.2.3 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 5 indicates recommended improvements and timing – whether the project is recommended as a short-term project (<5-year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

Table 5: North Noyo Recommended Improvements

Improvement	Funding	Timing	Cost Estimate
Surface prepare and coat the top of the wet well structure where exposed aggregate visible		<5	$5,000
Recoat handrails		<5	$2000
Replace building door		<5	$1000
Replace site paving and base		<5	$5,000
Recoat/spot repair damaged coating inside the abandoned drywell		<5	$2000
Recoat areas of peeling coating of conduits		6-10	$1,000
		Total Cost	**$16,000**

4.1.3 Noyo Heights (Sanderson) Pump Station

The Noyo Heights Pump Station was installed in 1990. It has two pumps rated at 190 gpm each. The pump station drains the Ft. Bragg wastewater collection system north of Noyo River along Noyo Heights, Lonne Way, and S. Sanderson Way. It also drains two homes at the south end of Riverview Dr. It discharges north and east on Noyo Heights, then north along S. Sanderson Way to SSM 312 (Utility Network manhole Mnhl-Chnnl-4195) on the 500 block of S. Sanderson Way.

The station is composed of a precast round wet well with two submersible duty/standby 5 hp pumps, a valve vault, and electrical service panels located under a small wooden structure supported on a concrete foundation and composite shingles on the top roof section. The flow coming into the wet well does not have an inlet valve. The lift station is located adjacent to houses. There is a gravel driveway into the site, although the area around the lift station is grass and mulch.

Figure 4 – Sanderson (Noyo Heights) Pump Station

4.1.3.1 Overall Condition Ratings

The Sanderson pump station was reviewed for condition and the results are summarized in Table 6. The following processes/systems/assets for the pump station were assessed:

- Below Grade Inlet and Wet well
- Discharge Valve Vault
- Electrical systems
- Structures

- Site Features

Table 6: Sanderson Pump Station Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
MCC FRP panel	Electrical	1989	NA	NA	3	<5
MCC wood structure	Structure	1989	NA	4	NA	<5
Electrical stand concrete foundation	Structure	1989	NA	2	NA	11-20
Wet well structure	Structure	1989	NA	3	NA	5-10
Wet well Piping	Mechanical	1989	3	NA	NA	<5
Pump controls	Mechanical	1989	NA	NA	2	5-10
Wet well hatch	Structure	1989	NA	2	NA	11-20
Valve vault	Structure	1989	NA	3	NA	5-10
Valve vault piping	Mechanical	1989	4	NA	NA	<5
Site entrance	Civil	1989	2	NA	NA	5-10
Electrical conduits	Electrical	1989	NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- MCC FRP panel showing signs of degradation
- MCC wood structure top frame and composite shingles are damaged
- Wood structure and concrete foundation below roof appears to be in good condition
- Wood structure does not extend too far beyond the panel so does not fully protect panel from UV
- Recommend new ventilated housing over entire electrical service panels
- The wet well showing signs of pittinkg and top of the wet well shows exposed aggregate
- Only floats for pump control and monitoring and no backup
- No grate or safety net under hatch
- Precast round wet well appears to be in good condition
- Station normally has low flow, but there are times when the I/I flows are high

- Station was built in the late 1980's
- Piping, valves, and supports inside the valve vault are corroded, particularly the tops of the isolation (plug) valves
- Exposed aggregate at top of the vault walls. Some concrete peeling from the walls
- Floor appears to be in good condition
- There is quite a large amount of dirt that comes into this station

4.1.3.2 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 7 indicates recommended improvements and timing – whether the project is recommended as a short-term project (<5-year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

Table 7: Sanderson Recommended Improvements

Improvement	Funding	Timing	Cost Estimate
Replace MCC FRP panel		<5	$5,000
Replace MCC wood structure roof and framing. Extend the roof farther past the panel to provide additional UV protection of panels; or		<5	$5,000
Alternatively replace existing wood structure with a new ventilated prefabricated housing		6-10	$10,000
Coat the interior of the wet well structure		6-10	$15,000
Provide backup system to pump controls		<5	$4,000
Provide a safety net or grate under wet well hatch		<5	$1,000
Coat the upper wall of the valve vault		6-10	$1,000
Replace the valve vault piping		<5	$12,000
Regrade the site entrance		6-10	$3,000
		Total Cost	**$51,000(1)**

(1) Cost assuming new housing over the electrical service.

4.1.4 Pudding Creek Pump Station

4.1.4.1 Overview of Facility

The Pudding Creek Pump Station was installed during the 1973 Pudding Creek Interceptor Project. It has two pumps rated at 465 gpm each. The pump station drains the Ft. Bragg wastewater collection system north of Pudding Creek. It discharges south over the Highway 1

Pudding Creek Bridge, along Main Street (Highway 1), and west on W. Elm St. to SSM 37 (Utility Network manhole Mnhl-Chnnl-4321) on the 100 block of W. Elm St.

The pump station is composed of a below-grade wet well with two submersible duty/standby 15 hp pumps, a concrete building with concrete walls and roof over the wet well, a below-grade valve vault, a concrete building with concrete walls and roof over the abandoned drywell. The standby generator is located in the building as well as the electrical panels and automatic transfer switch. There is an asphalt roadway that comes from the main highway and into the site. Most of the surrounding site is sand and vegetation.

Figure 5 – Pudding Creek Pump Station

4.1.4.2 Overall Condition Ratings

The Pudding Pump Station was reviewed for condition and the results are summarized in Table 8. The following processes/systems/assets were assessed:

Error! Reference source not found.

Table 88: Pudding Pump Station Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
Generator Building	Structure		NA		NA	<5
Generator	Electrical		NA	NA	3	<5
UPS (battery)	Electrical		NA	NA	2	5-10
MCC	Electrical		NA	NA	2	5-10
Transfer Switch	Electrical		NA	NA	2	5-10
Handrail	Structure		NA	2	NA	11-20
Engine Silencer Piping	Mechanical			NA	NA	11-20
Exterior CMU Wing Wall	Structure		NA	3	NA	5-10
Generator Exhaust Louver	Mechanical		NA	2	NA	5-10
Monorail	Architectural		NA	2	NA	5-10
Pump Building Electrical	Electrical		NA	NA	5	<5
Pump Discharge Piping	Mechanical		3	NA	NA	5-10
Wet well Roof Opening	Structure		NA	2	NA	<5
Pump Building Walls	Structure		NA	2	NA	
Wet well Access Hatch	Structure		NA	2	NA	<5
Generator Building Door	Architectural		NA	4	NA	<5
Valve Vault	Structure		NA	2	NA	11-20
Valve Vault Piping	Mechanical		2	NA	NA	6-10
Electrical conduits	Electrical		NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- Substantial leaks from roof and from roof vents into the building
- Underside of roof under eaves severely damaged and peeling
- Generator has a lot of corrosion and can lead to premature failure of equipment
- The UPS has been broken so there is no current electronic backup
- The abandoned drywell equipment and piping is still in place. Could be removed as budget allows
- MCC replaced in 2020 so in good condition
- Hairline cracks in underside of roof and signs of leakage

- Transfer switch panel shows some minor surface corrosion
- Handrail into drywell peeling
- Surface corrosion on piping to engine silencer
- Exterior CMU wing wall is damaged, but does not hinder access to the station
- Minor surface corrosion on generator exhaust louver
- Surface corrosion on monorail
- Building over pump station. Light switches and lamp severely corroded and not functioning. No light inside building. They should be replaced as soon as possible.
- Wet well piping was replaced in 2020 but showing a lot of surface corrosion
- Concrete damage at the top of the grated opening over the wet well piping
- Damaged coating on walls of pump building
- Access hatch over the wet well pumps is stuck. There is some surface corrosion on handles and most likely some corrosion under the hatch. Minor cleaning may loosen hatch
- Door and frame corroded
- Valve vault in good condition
- Bypass vault in good condition

4.1.4.3 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 9 indicates recommended improvements and timing – whether the project is recommended as a short-term project (<5-year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

Table 9: Pudding Pump Station Recommended Improvements

Improvement	Funding	Timing	Cost Estimate
Remove and recoat the coatings on the underside of the roof inside and outside building, repair roof and wall cracks, repair leaks through the roof vents inside generator building		<5	$20,000
Replace or prepare and recoat generator parts showing corrosion		<5	$10,000
Replace failed UPS (battery)		<5	$5,000
Prepare and recoat transfer switch panel		6-10	$1,000
Prepare and recoat portion handrail		6-10	$1,000

Improvement	Funding	Timing	Cost Estimate
Remove surface corrosion on engine silencer piping		<5	$1,000
Repair top portion of exterior CMU wing wall		6-10	$1,000
Remove surface corrosion on generator exhaust louver		6-10	$1,000
Prepare and recoat monorail		6-10	$1,000
Replace all existing electrical inside the pump building		<5	$5,000
Prepare and recoat pump discharge piping		<5	$1,000
Prepare and coat the top wall of the wet well		<5	$1,000
Prepare and recoat portions of the pump building walls		6-10	$1,500
Provide maintenance and remove surface corrosion of the wet well access hatch		<5	$1,000
Replace generator building door		<5	$2,000
		Total Cost	**$52,500**

4.1.5 Elm Pump Station

4.1.5.1 Overview of Facility

The Elm Pump Station was installed during the 1970 Regional Sewage Disposal Project. It has two pumps rated at 800 gpm each. The pump station drains the northwest portion of the Ft. Bragg wastewater collection system south of Pudding Creek, and also receives the discharge from the Pudding Creek Pump Station. It discharges south along Stewart St. to W. Fir St., then east along W. Fir Street to SSM 54 (Utility Network manhole Mnhl-Chnnl-7076) at the intersection of W. Fir St. and Main St. (Highway 1).

The station is composed of a building (comprised of concrete walls and concrete roof) that houses two 15 hp self-priming, pad-mounted duty/standby pumps, discharge piping and valves, a standby generator, electrical panels and automatic transfer switch, a below-grade valve vault, above-grade bypass connection. The below-grade wet well extends beyond the building and houses the abandoned drywell and pumps. The PVC suction piping to the self-priming pumps is located inside the wet well. The site has a perimeter chain link fence and a combination concrete and asphalt driveway into the site.

Figure 6 – Elm Pump Station

4.1.5.2 Overall Condition Ratings

The Elm Pump Station was reviewed for condition and the results are summarized in

- Self-priming Pumps
- Discharge Valve Vault
- Electrical systems
- Standby Generator
- Structures
- Site Features

Table 10. The following processes/systems/assets for the well facilities were assessed:

- Self-priming Pumps
- Discharge Valve Vault
- Electrical systems
- Standby Generator
- Structures
- Site Features

Table 10: Elm Pump Station Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
Asphalt Driveway	Civil		4	NA	NA	<5
Manhole Cover	Mechanical		4	NA	NA	<5
Inlet Slide Gate	Mechanical		4	NA	NA	<5
Bypass Piping Connection	Mechanical		2	NA	NA	11-20
Handrail into Abandoned Drywell	Architectural		NA	5	NA	<5
Perimeter Fencing	Architectural		NA	4	NA	<5
Exterior Concrete Slab over Abandoned Drywell	Structural		NA	3	NA	6-10
Exterior Electric Service Panel	Electrical		NA	NA	2	6-10
Exterior Radio Antenna	Electrical		NA	NA	2	6-10
Exterior FRP Conduit	Electrical		NA	NA	3	<5
Building	Structural		NA	2	NA	>20
Louvers and Windows	Architectural		NA	2	NA	11-20
Building Double Door	Architectural		NA	4	NA	<5
Self-Priming Pumps	Mechanical		2	NA	NA	11-20
Spare Self-Priming Pump	Mechanical		2	NA	NA	11-20
Pump Frames	Mechanical		3	NA	NA	6-10
Pump Discharge Piping	Mechanical		1	NA	NA	>20
MCC	Electrical		NA	NA	2	11-20
Building Roof Coating	Architectural		NA	3	NA	<5
Building Wall/Floor Interface	Architectural		NA	4	NA	<5
Generator Louver	Mechanical		2	NA	NA	11-20
Engine Silencer Piping	Mechanical		2	NA	NA	11-20
Entry Sidewalk	Structural		NA	4	NA	<5
Exterior Water Piping	Mechanical		2	NA	NA	11-20
Electrical conduits	Electrical		NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- The asphalt entry is in very poor condition. Could be a potential safety concern
- Crack in manhole cover, but not in danger of immediate failure

- The inlet slide gate does not operate so it is left in an open position. Access to the gate will be difficult if the station needs to remain in service. Would potentially require bypass pumping form upstream of the station
- Minor corrosion on bypass piping
- Railing at abandoned drywell has failed and should be replaced as soon as possible for safety
- The abandoned drywell equipment and piping is still in place. Could be removed as budget allows
- Perimeter fencing and posts show corrosion
- Concrete slab over the abandoned drywell is peeling, but does not appear to impact the structural integrity of the slab
- Service panel outside building has some surface corrosion as well as the antenna pole
- Exterior FRP conduit showing signs of UV damage
- Top part of the roof is damaged, but no signs or reports of leakage
- Louvers and windows in good condition
- Doors severely corroded and one leaf does not move. It should be replaced as soon as possible.
- Signs of mold below the door. Would take some power washing
- Pumps are self-priming type manufactured by Gorman Rupp
- One pump is from 1975 but has a new motor. The second pump is from 2010 and is operated from the original re-built motor. There is one spare pump sitting on the floor
- The spare pump has not been exercised
- Pumps and frames have damaged coatings
- Discharge piping was replaced a couple of years ago and is in good condition
- MCC replaced in 2020 and is in good condition
- Peeling of coating on underside of roof, but does not appear to be leaking
- The air bubbler agitation pump still mounted but is abandoned and can be removed
- The abandoned air gap tank mounted on the wall can be removed
- The interface of the lower wall and floor is wet. It is not clear if water is seeping under the wall. This should be further inspected for the source of leakage
- Generator louver should be cleaned
- Surface corrosion on piping to engine silencer
- Minor hairline cracks in floor although no visible leakage through the cracks
- Sidewalk leading to pump room door is severely damaged and should be replaced for safety
- Exterior water piping coating slightly damaged, but piping is in good condition
- Bypass piping showing some minor surface corrosion

4.1.5.3 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 11 indicates recommended improvements and timing – whether the project is recommended as a short-term project (<5-year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the

recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

Table 11: Elm Pump Station Recommended Improvements

Improvement	Funding	Timing	Cost Estimate
Replace asphalt driveway		<5	$10,000
Replace manhole cover			$1,000
Replace inlet slide gate		<5	$10,000
Recoat bypass piping connection			$500
Replace handrail into abandoned drywell		<5	$5,000
Replace perimeter fencing		<5	$15,000
Repair exterior concrete slab over abandoned drywell		<5	$2,000
Remove surface corrosion from exterior electric service panel		6-10	$500
Remove surface corrosion from exterior radio antenna		6-10	$500
Replace exterior FRP conduit		<5	$500
Repair small section of building roof		<5	$1,500
Replace building double door		<5	$2,000
Exercise spare self-priming pump		<5	$500
Prepare and recoat pump frames		6-10	$1,000
Repair underside of building roof coating		<5	$1,000
Check and seal the interface between the building perimeter wall and floor		<5	$4,000
Remove surface corrosion from generator louver		6-10	$500
Remove surface corrosion from engine silencer piping		6-10	$500
Replace concrete entry sidewalk		<5	$3,000
Prepare and recoat exterior water piping		6-10	$1,000
		Total Cost	**$60,000**

4.2 Noyo Point Pump Station

4.2.1.1 Overview of Facility

The Noyo Point Pump Station was installed in 1986 and has two pumps rated at 45 gpm each. The pump station drains the homes along Noyo Point Road. It discharges east along Noyo Point Rd, across Highway 1 onto N. Harbor Dr., to SSM 116 (Utility Network manhole Mnhl-Chnnl-4236) near the intersection of Highway 1 and N. Harbor Drive.

The station is composed of a precast round wet well with two submersible duty/standby 2.5 hp pumps, a valve vault, and electrical service panels mounted on a free-standing support structure. The flow coming into the wet well does not have an inlet valve. The site is next to a house and is mostly surrounded by gravel and grass.

Figure 7 – Noyo Point Pump Station

4.2.1.2 Overall Condition Ratings

The Noya Point Pump Station was reviewed for condition and the results are summarized in Table 12. The following processes/systems/assets for the well facilities were assessed:

- Below Grade Inlet and Wet well
- Discharge Valve Vault
- Electrical systems
- Structures
- Site Features

Table 12: Noyo Point Pump Station Condition Ratings

Asset Information			Condition Rating			
Asset Name	**System**	**Install Date**	**Mechanical/Civil**	**Structural/Architectural**	**Electrical**	**EvRUL**
MCC Panel Support	Structural	2022	NA	2	NA	6-10
Wet well Floats and Rails	Electrical System	1990	NA	2	NA	6-10
Wet well Structure	Structural	1990	NA	2	NA	11-20
Pump discharge piping	Mechanical	1990	4	NA	NA	<5
Valve Vault	Structural	1990	NA	2	NA	6-10
Valve Vault Piping	Mechanical	1990	4	NA	NA	<5
Electrical Service Panel	Electrical System	1990	NA	NA	2	6-10
MCC	Electrical System	2020	NA	NA	2	11-20
Site	Civil	1990	2	NA	NA	6-10
Electrical conduits	Electrical	2020	NA	NA	2	6-10

Unk = Unknown installation date
NA = Asset not assessed by specified discipline

The following general observations and concerns from the City were noted:

- No sunshades over MCC or service panel so not protected from UV
- Net on wet well hatch
- The wet well floats, pump rails and MCC are new and are in good condition. The rest is from the early 1990s
- Severely corroded pump discharge pipe elbows near top of wet well. Need to be replaced as soon as possible
- Pumps may have been replaced in the past
- Interior surface of wet well appears to be in good condition
- Valve vault piping partly corroded
- Check valves are severely corroded and should be replaced as soon as possible
- No grate at valve vault hatch. Should be added for safety
- Interior walls of valve vault OK but starting to show some coating failure
- Abandoned junction box inside the wet well is corroded and should be removed so it does not fall into the flow

4.2.1.3 Improvements and Timing

In order to address the deficiencies identified during the inspections, Table 11 indicates recommended improvements and timing – whether the project is recommended as a short-term

project (<5 year timeframe), mid-term project (5-to-10-year timeframe), or long-term (11-to-20-year timeframe). A rough order of magnitude costs was developed for each of the recommended improvement projects based on engineering experience. Note that the packaging of improvements projects and identifying funding sources will be determined as part of the development of the capital improvement projects planning.

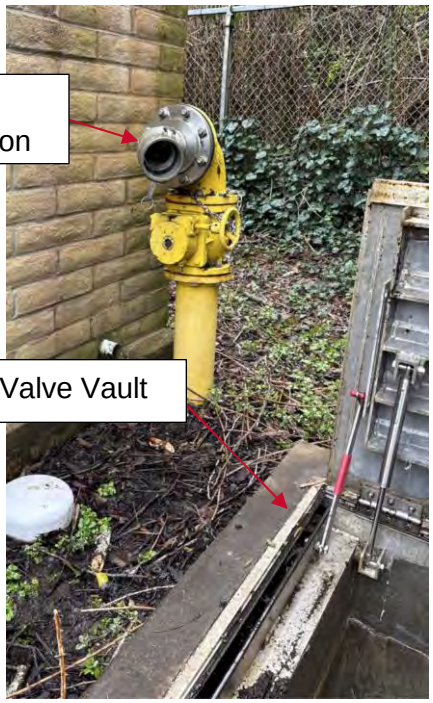
Table 13: Noyo Pump Station Recommended Improvements

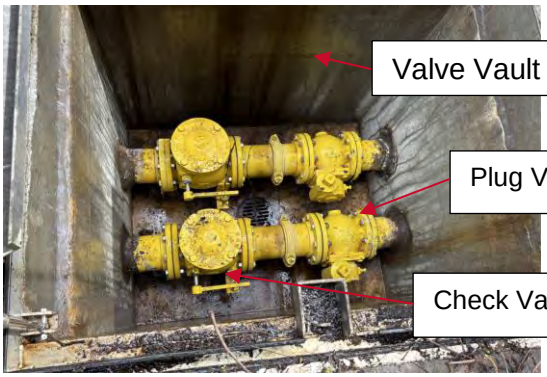
Improvement	Funding	Timing	Cost Estimate
Replace MCC panel support		6-10	$3,000
Replace wet well floats and rails		6-10	$4,000
Replace the pump discharge elbows		<5	$1,500
Repair/recoat the valve vault coating		6-10	$1,500
Replace the valve vault piping and valves		<5	$15,000
Add nets or grates under the wet well and valve vault hatches		<5	$3,000
Provide sunshade over MCC and electrical service panel		<5	$5,000
Regrade site		6-10	$2,000
Remove abandoned electrical junction box in wet well		<5	$500
		Total Cost	**$35,500**

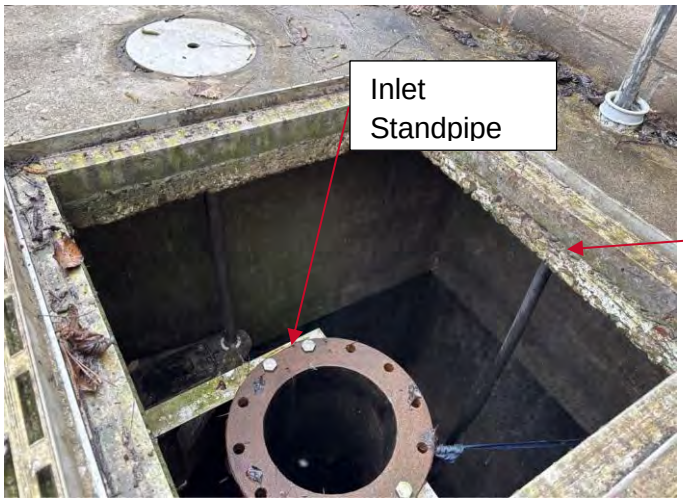
A

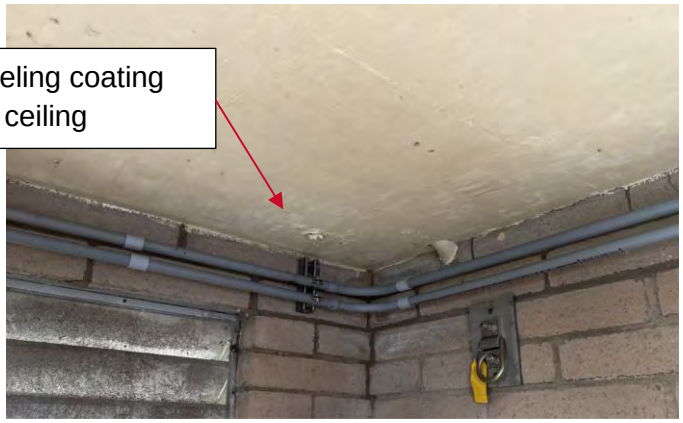
Appendix A – Photographs

South Noyo Pump Station

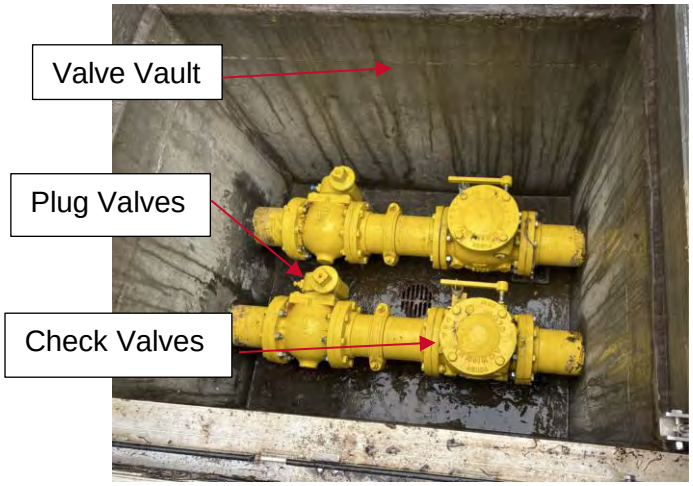


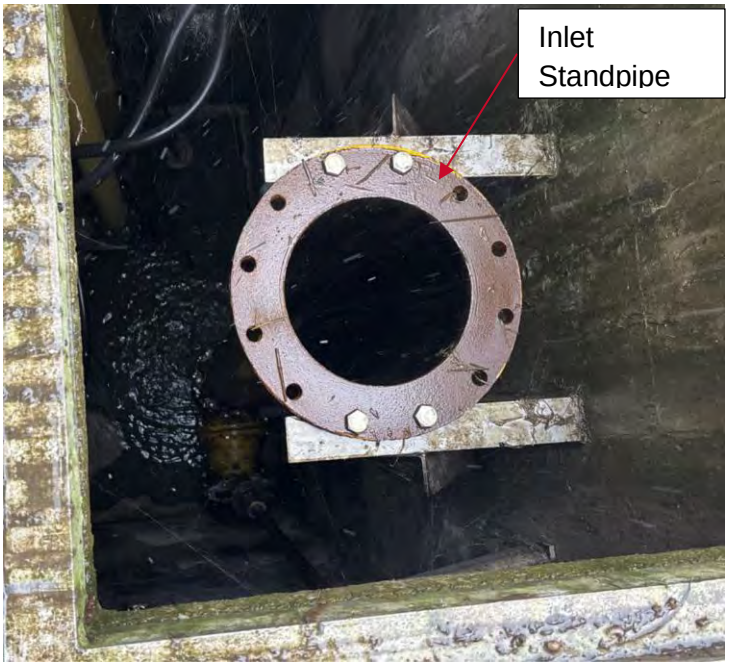




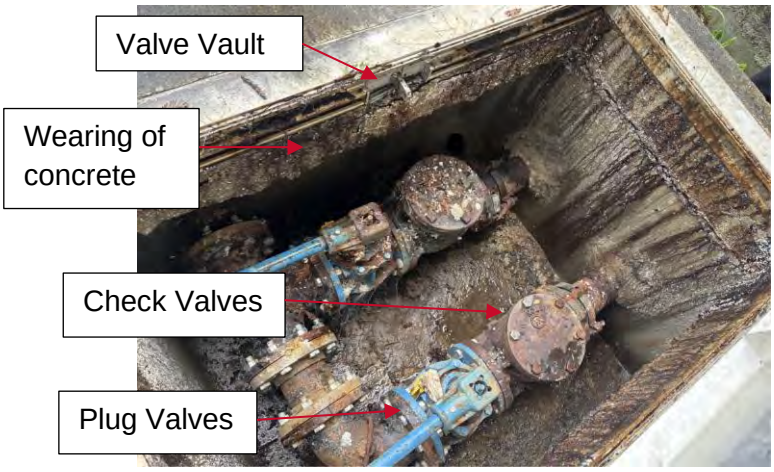


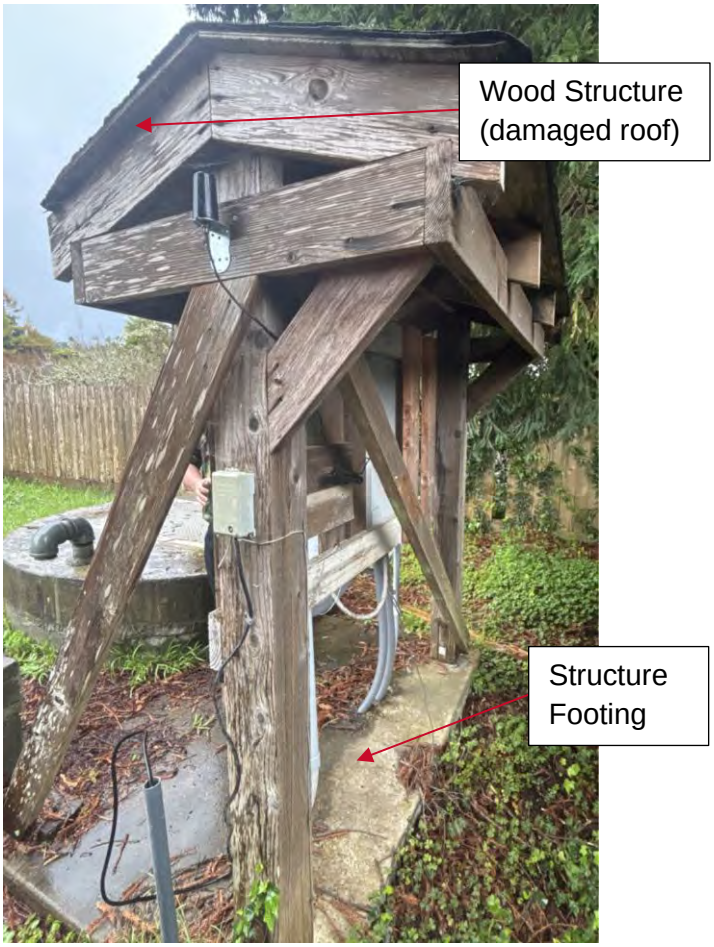
North Noyo Pump Station



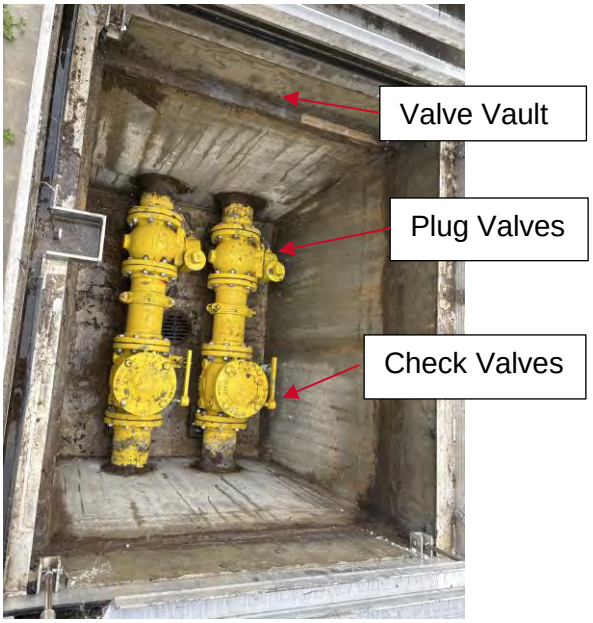


Sanderson Pump Station

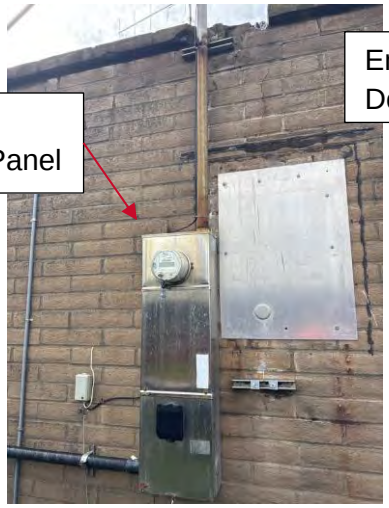


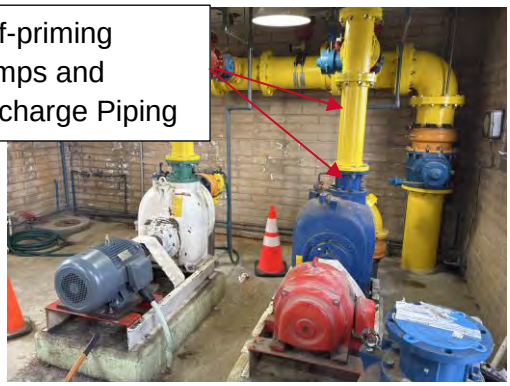


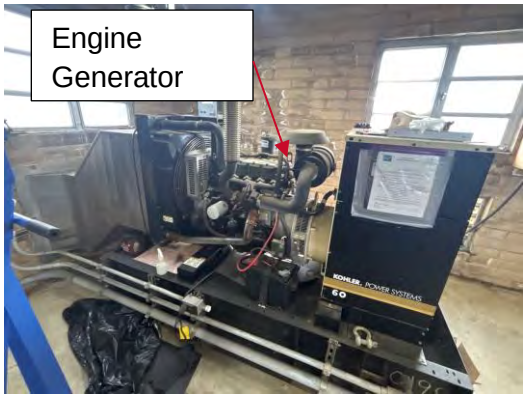
Pudding Creek Pump Station



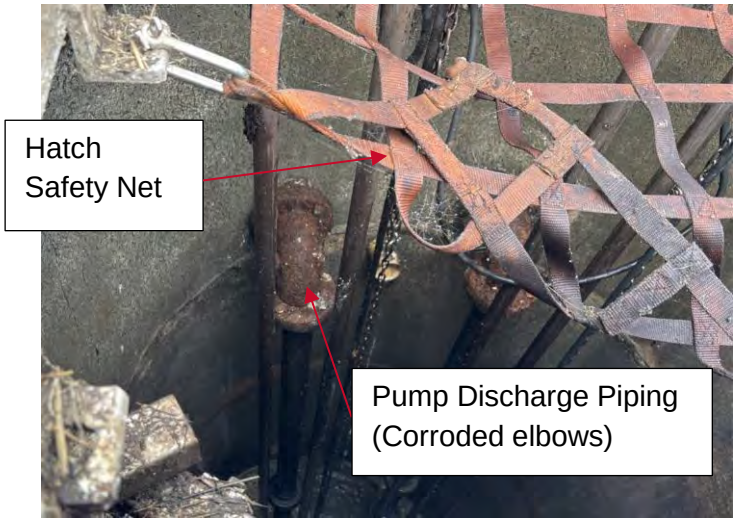
Elm Pump Station

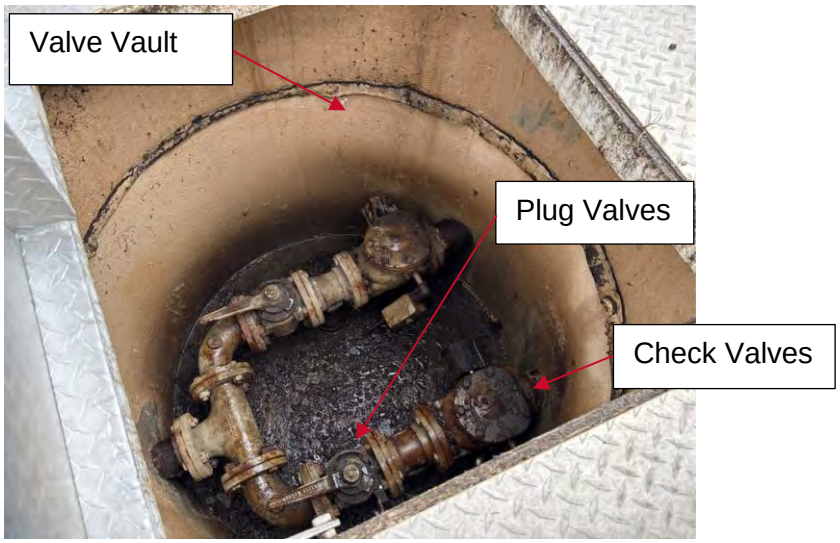






Noyo Point Pump Station





Appendix H. Climate Resilience

Climate Resilience Assessment

Technical Memorandum

Wastewater Collection System Master Plan

City of Fort Bragg

January 23, 2026

Table of Contents

CHAPTER 1.0 Introduction 1
CHAPTER 2.0 Climate Analysis 2
2.1 Overview 2
2.2 Historic Climate Trends 2
2.2.1 Flooding (Coastal, Storm Surge, and Riverine) 2
2.2.2 Precipitation 4
2.2.3 Coastal Bluff Erosion (Coastal) & Landslides 7
2.2.4 Temperature / Extreme Heat 9
2.2.5 Wildfire 11
2.2.6 Drought 12
2.3 Projected/Possible Climate Scenarios 13
2.3.1 Flooding (Sea Level Rise, Storm Surge and Riverine) 13
2.3.2 Precipitation 15
2.3.3 Coastal Bluff Erosion (Coastal) and Landslides 19
2.3.4 Temperature/Extreme Heat 19
2.3.5 Wildfire 20
2.3.6 Groundwater 21
2.3.7 Drought 21
2.4 Conclusion/Key Findings 22
CHAPTER 3.0 Climate Resilience Assessment 24
3.1 Approach 24
3.2 Interdependency CRA 26
3.2.1 Overview 26
3.2.2 CRA Per Category 30
3.2.3 Energy and Electrical 31
3.2.4 Telecommunications 31
3.2.5 Critical Infrastructure 31
3.2.6 Impacted Communities 32
3.2.7 Natural Systems 32
3.2.8 Key Findings 32
3.3 Wastewater Collection System CRA 33
3.3.1 Overview 33
3.3.2 CRA per Assets 36

3.3.3 CRA Operations and Maintenance 42
3.3.4 Key Findings 42
CHAPTER 4.0 Recommendations 45
4.1 Regional Recommendations 45
4.2 Wastewater Collection System Recommendations 45
4.3 Next Steps/Further Studies 48
CHAPTER 5.0 References 49

List of Tables

Table 1. Compilation of Key Climate Hazards 23
Table 2 - Interdependency CRA – Summary Table 33
Table 3 - Vulnerability Per Asset Type 43
Table 4 - Prioritization Per Asset Type 44
Table 5 - Resilience Strategies for Interdependencies 45
Table 6 - Resilience Strategies for Sanitary Sewer Lines 46
Table 7 - Resilience Strategies for Manholes and Junction Boxes 46
Table 8 - Resilience Strategies for Lift Stations 47
Table 9 - Resilience Strategies for SCADA 47

List of Figures

Figure 1 – Project Area, City of Fort Bragg Wastewater Collection System 1
Figure 2 – FEMA 100-Year Event Flood Risk 4
Figure 3 – Observed Annual Maximum 1 Day Precipitation [in inches] at Fort Bragg 5 N Station (1950-2023) 5
Figure 4 – Observed Total Annual Precipitation at Fort Bragg 5 N Station (1950-2023) 6
Figure 5 – Observed Number of Days Where Rainfall Exceed 1 Inch (blue), 2 Inches (green), 3 Inches (orange), 4 Inches (red), with Trendlines Plotted in Each Respective Color 6
Figure 6 – Geologic Hazards, Fort Bragg 8
Figure 7 – Relative Slope Instability in the Fort Bragg Area (After CGS Map 58, 2011) 9
Figure 8 – Observed Annual Mean Maximum Temperature at Fort Bragg 5 N station (1950-2023) . 10
Figure 9 – Observed Annual Mean Minimum Temperature at Fort Bragg 5 N station (1950-2023) .. 11
Figure 10. Wildfire Risk. The City of Fort Bragg is circled in red 12
Figure 11 – Flooding Risk Projected: Highest Water Levels Mapped in the Regional Water Level Viewer, Equal to 10 Feet SLR over the MHHW Elevation 15
Figure 12 – Projected Total Annual Precipitation for Fort Bragg Based on Climate Scenario RCP 4.5 16

Figure 13 – Projected Total Annual Precipitation for Fort Bragg Based on Climate Scenario RCP 8.5 17
Figure 14 – Projected Number of Days with Greater Than 1 Inch of Precipitation for Fort Bragg Based on Climate Scenario RCP 4.5 18
Figure 15 – Projected Number of Days with Greater than 1 Inch of Precipitation for Fort Bragg Based on Climate Scenario RCP 8.5 18
Figure 16 – Existing Coastal Erosion Risk 19
Figure 17 – Annual Average Maximum Temperature for Mendocino County (Source: Drought Resilience Plan, Mendocino County. May 2025) 20
Figure 18 – Illustration of Steps for Developing a Climate Resilience Assessment (CRA) 24
Figure 19 – Vulnerability Matrix 25
Figure 20 – Risk Matrix 25
Figure 21 – Regional Critical Assets 27
Figure 22 – Regional Asset Map and Flooding Risk 28
Figure 23 – Regional Asset Map of Existing Landslide and Coastal Erosion Risk 29
Figure 24 – Regional Asset Map of Existing Wildfire Risk 30
Figure 25 – Wasteater Collection Assets Map 35
Figure 26 – Wastewater Collection Assets Map and Flooding Risk 37
Figure 27 – Wastewater Collection Assets Map and Erosion and Landslide Risk 38
Figure 28 – Wastewater Collection Assets Map and Wildfire Risk 39

EXECUTIVE SUMMARY

The Climate Resilience Assessment (CRA) for Fort Bragg's wastewater collection system evaluates how climate change will impact infrastructure reliability and community health. Using historical climate data and future projections, the assessment identifies vulnerabilities and outlines strategies to strengthen resilience against extreme events. In summary, these vulnerabilities are:

Climate Risks and System Challenges: Fort Bragg is exposed to sea level rise, flooding, wildfires, landslides, and erosion. Rising seas accelerate erosion, increase saltwater intrusion, and shorten the lifespan of pipes and equipment. More intense storms raise flooding and infiltration risks in low-lying areas, while drought–rainfall swings increase erosion and landslide potential. Wildfires threaten pump stations and can disrupt power and monitoring systems.

Regional Infrastructure Vulnerabilities: The water treatment plant and Fire Station #2 are near wildfire-prone areas, posing risks to emergency response and system continuity. Regional transportation and energy infrastructure that supports water operations is also vulnerable. Highway 1 bridges require ongoing erosion assessment with Caltrans, and wildfire-prone energy transmission lines could disrupt pumping. Because many of these assets are not City-owned, strong interagency coordination is essential.

Wastewater Collection System Priorities: The CRA identifies sanitary sewer lines as the highest priority for resilience improvements due to their flood exposure and potential impact on underserved communities. Lift stations are highly vulnerable, with failures likely to cascade across the system. Manholes and junction boxes, while moderately at risk, are essential for maintaining system functionality. SCADA systems require ongoing monitoring to ensure operational integrity and rapid response capability.

Strategic Recommendations: Resilience strategies focus on reducing single points of failure, enhancing redundancy, and improving adaptive capacity across interconnected systems. By addressing vulnerabilities holistically and collaborating with regional partners, Fort Bragg can maintain service continuity, protect critical assets, and safeguard public health during extreme climate events.

Key Takeaways:

- Sanitary sewer lines and lift stations are top priorities for resilience investments.
- Regional collaboration is essential to address transportation and energy vulnerabilities.
- Monitoring and adaptive strategies for SCADA systems will ensure operational continuity.
    - A One Water[i1]–based integrated planning approach will protect community health and keep essential services running during extreme events by addressing potable water, stormwater, and wastewater together.

[1] https://www.epa.gov/waterreuse/links-referenced-article-epa-spearheads-water-reuse-one-water-tool-climate-resilient

CHAPTER 1.0 INTRODUCTION

This CRA overview provides information for the development of a Climate Action Plan that will identify and better prepare the Fort Bragg Collection System for climate-related hazards.

For this report, resiliency is defined as the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. The step-by-step analysis utilizes historic climate trends to set the baseline for understanding projected future climate trends for the Wastewater System (Figure 1) and supporting infrastructure. It is based on best available information providing for a framework that can be updated with new information when available.

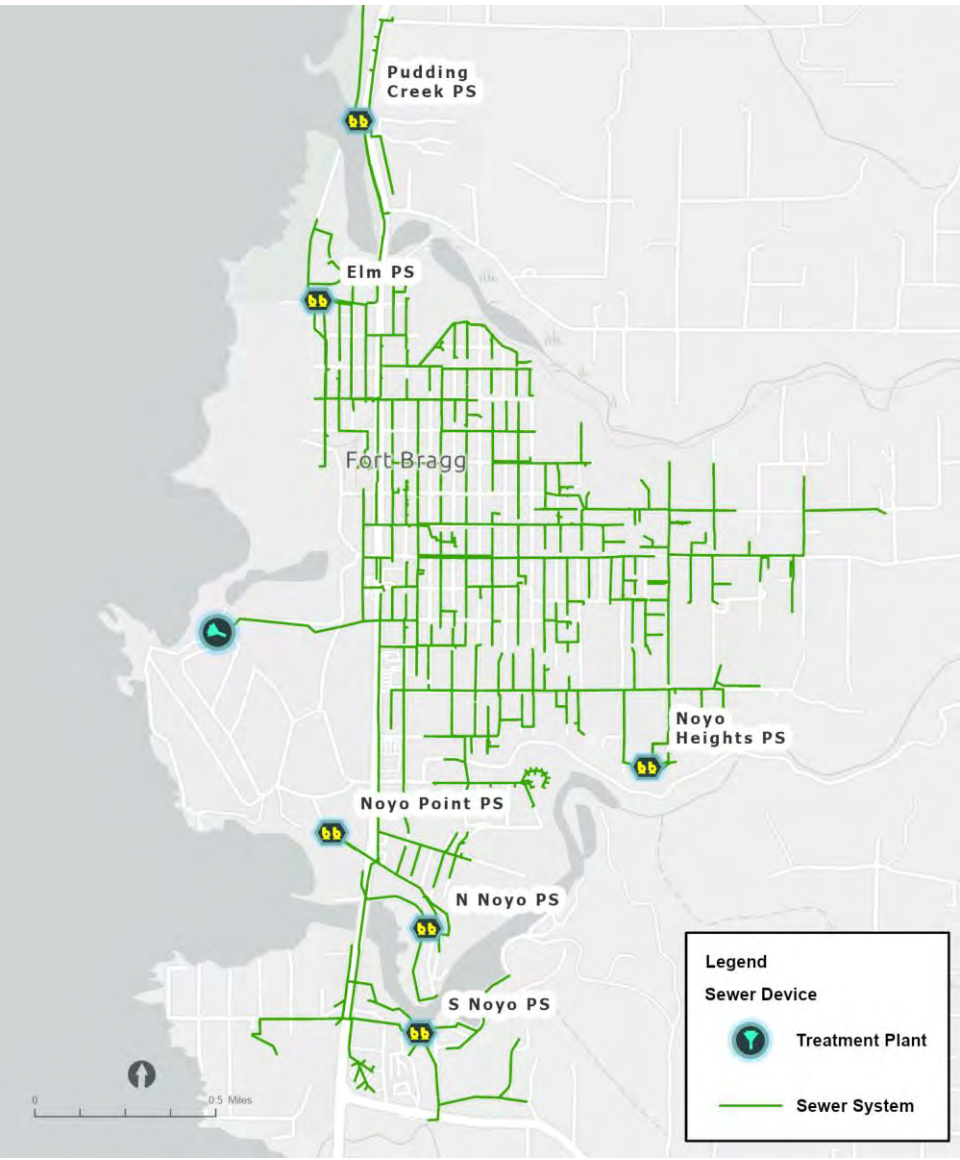


Figure 1 – Project Area, City of Fort Bragg Wastewater Collection System
(Source: HDR GIS based on Fort Bragg database)

CHAPTER 2.0 CLIMATE ANALYSIS

2.1 Overview

The City of Fort Bragg, California, is located within Mendocino County. Positioned on the north-central coast of California, the city's climate is strongly influenced by the cool waters of the eastern Pacific Ocean. Fort Bragg has an estimated population of 6,970 (2021) and an official elevation of 85 feet above sea level.

This study assesses how climate change is expected to impact environmental hazards and threats to the City's Wastewater Collection System. It examines current conditions and provides guidance on anticipated future changes driven by evolving climate patterns. The climate analysis draws on the technical memorandum prepared for the Distribution Master Plan and incorporates updated information as of October 2025.

The key hazards are listed below excluding seismic risk which is addressed in the Geotechnical section of the Master Plan:

- Flooding (SLR, Storm Surge, and Riverine).
- Precipitation.
- Landslides / Slope Instability / Erosion.
- Temperature / Extreme Heat.
- Wildfire.
- Groundwater.
- Drought.

The time horizons selected for the project align with the state-adopted planning timeframe and the 50-year design life of the Collection System. Climate scenarios were developed for baseline conditions (based on historical records), mid-term projections for 2050, and long-term projections for 2070. These scenarios are based on data from the Coupled Model Intercomparison Project Phase 5 (CMIP5), using NASA's GDDP downscaling for Representative Concentration Pathways (RCP) 4.5 and 8.5. RCP 4.5 assumes emissions will rise until 2050 and then gradually decline, while RCP 8.5 reflects a trajectory of continuously increasing emissions through the end of the century.

2.2 Historic Climate Trends

An analysis of climatic trends provides perspective on the climate projections and evolution of anticipated future climate threats that is discussed in Section 2.3.

2.2.1 Flooding (Coastal, Storm Surge, and Riverine)

Fort Bragg's location along the California coast at the mouth of the west-east oriented Noyo River and Pudding Creek makes it susceptible to a combination of ocean swell, storm surge, wind waves, and astronomical tides, as well as a tsunami originating anywhere within the "Ring of Fire" surrounding the adjacent Pacific Ocean. As can be seen in Figure 2, FEMA base flood elevations

(BFEs) along the coast (Zone VE) range from 29 to 36 feet along the bluffs, 19 feet at the beach immediately north of the Noyo River mouth, and 40 feet at the mouth of the Noyo River and adjacent bluff within the bay. These values represent 100-year recurrence interval water levels at current sea level conditions, including wave setup and runup. Wave setup and runup are dependent on the slopes of the terrain, both below the stillwater level and above it along beaches and bluffs. The variability in mapped water levels is based on the differing conditions at individual transects in the FIS study, which are indicated on the map as dashed lines numbered 25 through 31 within the City.

Elevated tides and higher wave heights can occur coincidentally with high river flows on the Noyo River. The FEMA floodplain modeling and Zone designations along the Noyo River are based on mean higher-high water at current climactic conditions and do not include elevated tides or future climate changes. Therefore, when riverine flows are combined with high tides, the water levels along the Noyo River, particularly closer to the mouth of the river, may be higher than indicated by the BFEs.

An analysis of year-over-year coastal water surface elevations shows that the highest annual water surface elevations in the region are the result of thermal expansion of the Pacific Ocean during years of significant El Niño conditions (i.e., 1992, 1997-1998, 2015, and 2023).

Outside the scope of this analysis but worth noting is the threat of a tsunami, although rare, is ever-present in the region of the north-central California coast. Any one of the hundreds of earthquake faults surrounding the Pacific Rim can produce a tsunami that could reach the City of Fort Bragg. The California State Department of Conservation maintains a website devoted to the transfer of knowledge and information regarding Mendocino County Tsunami Hazard Areas.[2] This website provides real-time information about what to do before, during, and after a tsunami event.

[2] https://www.conservation.ca.gov/cgs/tsunami/maps/mendocino

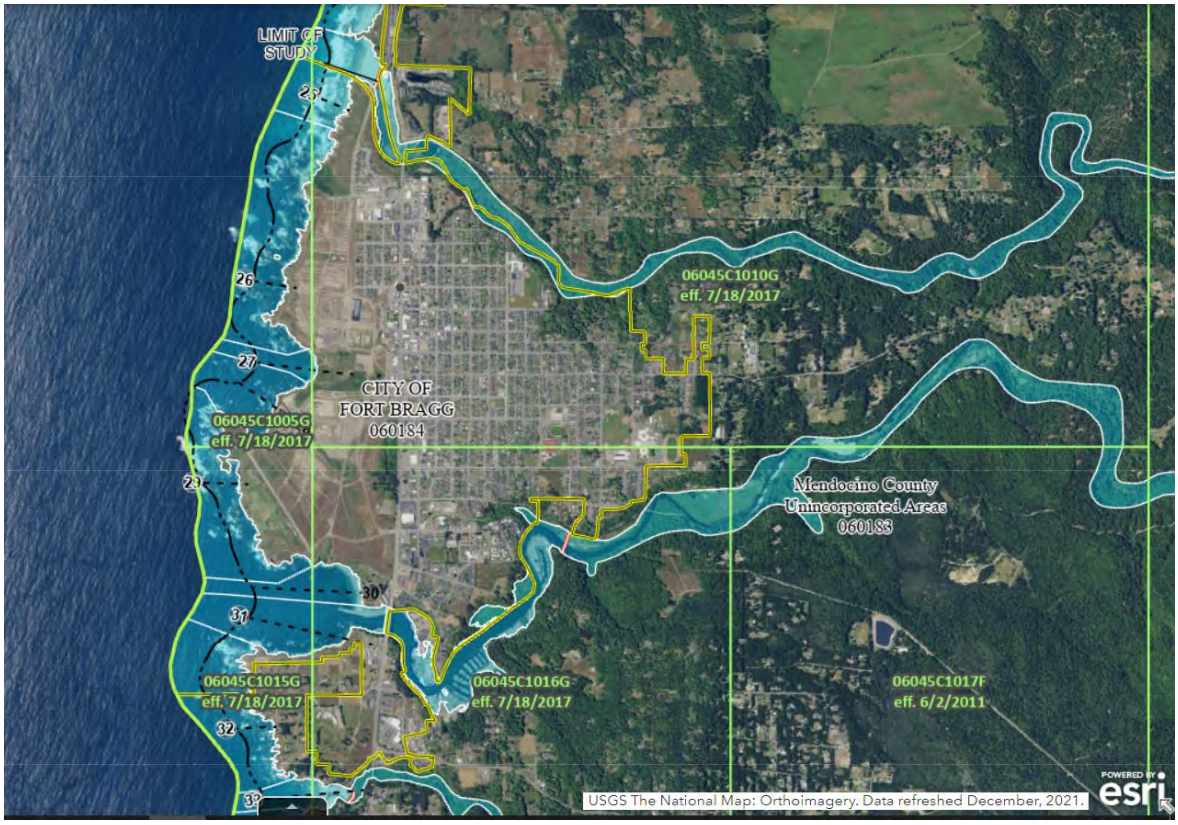


Figure 2 – FEMA 100-Year Event Flood Risk
(Source: FIRM map at *https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd)*

2.2.2 Precipitation

Historic climate trends are critical to setting a relationship between observed changes in the climate and projected changes in the future climate. They represent the “here and now” of climate hazards and how those hazards have changed over time in the observed record. This section investigates current and future extrapolated climate trends, so that those extrapolations can be compared with future climate scenarios for the following environmental parameters.

The National Center for Environmental Information (NCEI) was the primary source of data for historical observations, which were developed from the Fort Bragg 5 N (Station ID: USC00043161) meteorological reporting station located 5 miles north of Fort Bragg (Figure 3). The reporting station is used for a period of record (POR) from 1950 to present day for temperature and precipitation data.

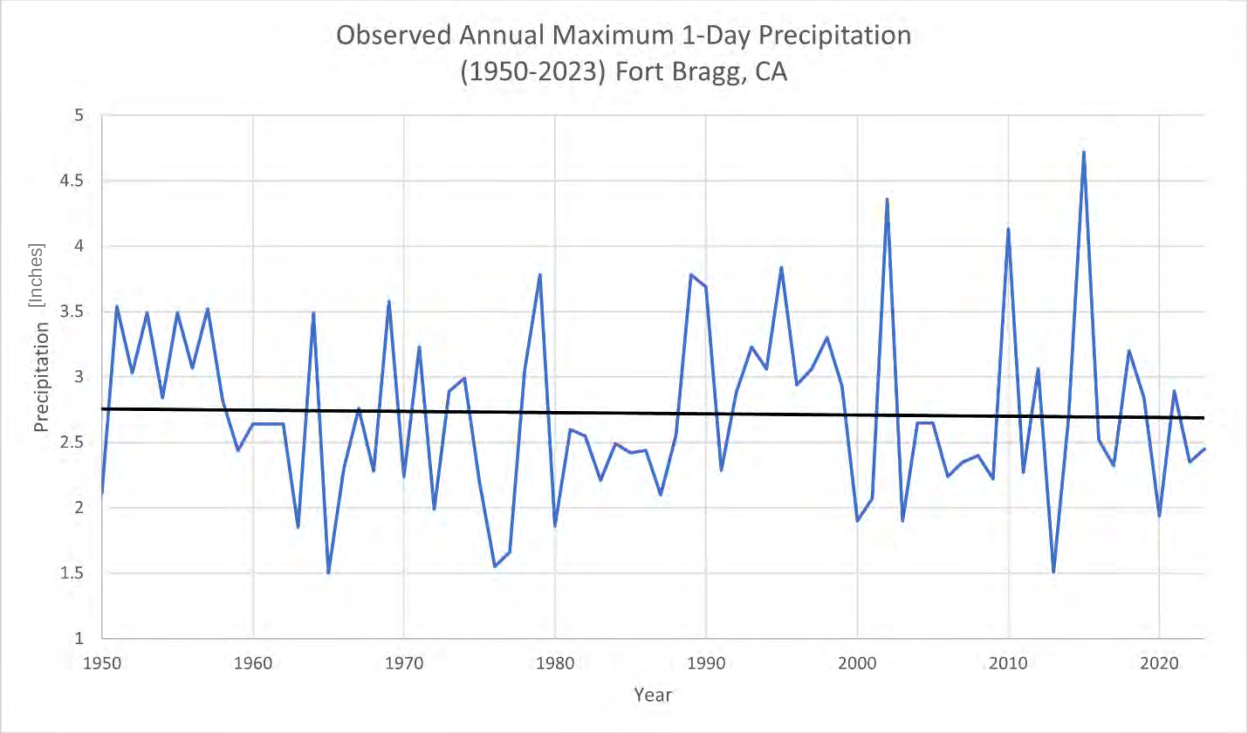


Figure 3 – Observed Annual Maximum 1 Day Precipitation [in inches] at Fort Bragg 5 N Station (1950-2023)

(Source: NCEI)

The observed maximum single day precipitation in Figure 3 shows a flat trend (neither decreasing nor increasing) from 1950 to present day. However, this trendline does not highlight the increasingly variable nature of single-day precipitation events. Precipitation events across the region and in Fort Bragg are increasing in relative intensity and variability. In other words, while a similar amount of rain may fall each year, that rain will likely be concentrated into heavy rainfall events interspersed with more intense dry periods.

This seasonal variability is also reflected in the Observed Total Annual Precipitation shown in Figure 4. While the trendline of total annual precipitation is also relatively flat, the intensity has increased dramatically in recent years. For example, in Figure 4, it is observed that since the early 1980s, there have been 15 years where the difference in precipitation from one year to the next is greater than 15 inches. Another way of measuring the increasing variability is through the standard deviation of the precipitation, or in other words, how much does the rainfall varies from year to year. In Fort Bragg, the standard deviation of the total annual precipitation from 1950-1986 was 7.68 inches. From 1987-2023 it increased to 11.83 inches. Therefore, it is shown that statistically speaking, the amount of precipitation that falls annually in Fort Bragg is becoming more variable from year to year.

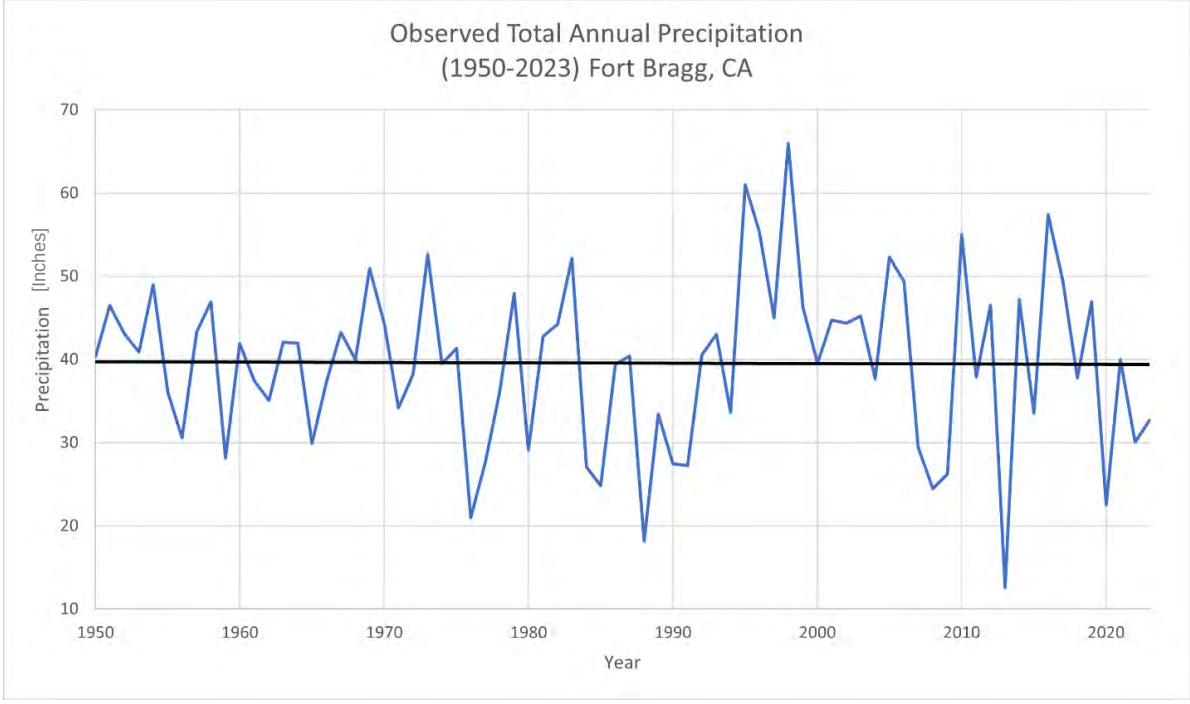


Figure 4 – Observed Total Annual Precipitation at Fort Bragg 5 N Station (1950-2023)
(Source: NCEI)

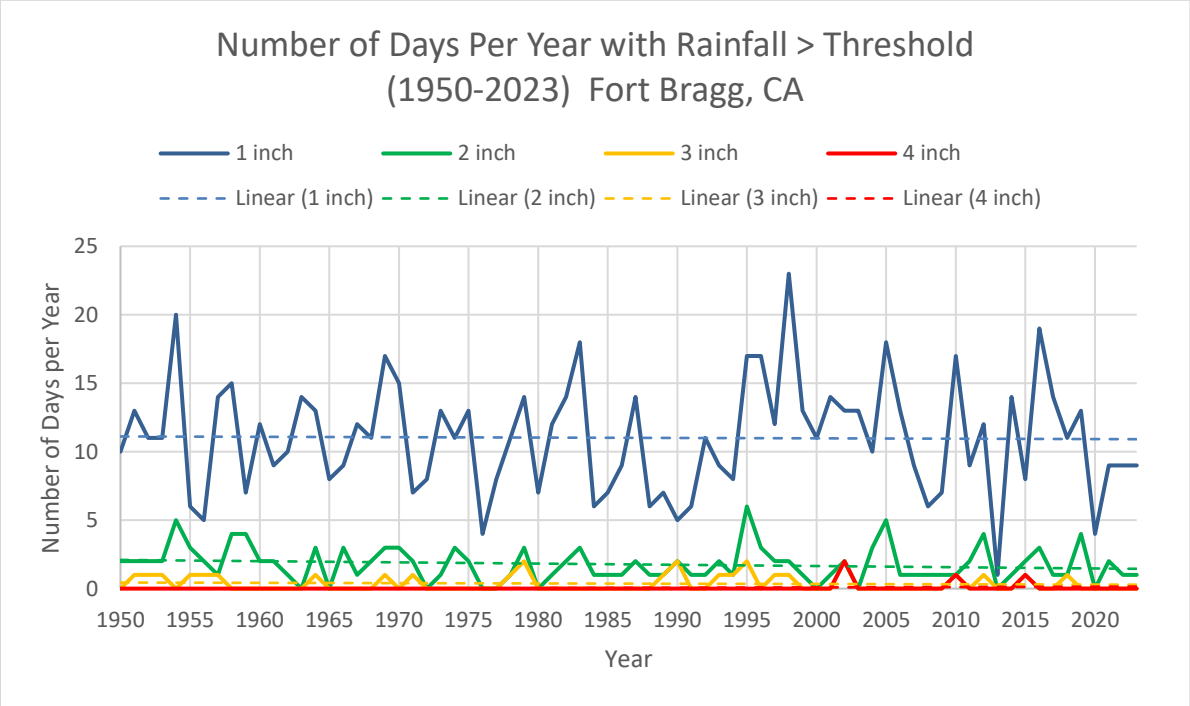


Figure 5 – Observed Number of Days Where Rainfall Exceed 1 Inch (blue), 2 Inches (green), 3 Inches (orange), 4 Inches (red), with Trendlines Plotted in Each Respective Color
(Source: NCEI)

The number of days that experience extreme rainfall events can be associated with increasing variability and relative intensity of rainfall in the region. Figure 5 highlights the number of days each year with 1-4 inches of rainfall on a single day. The associated trendlines are especially helpful in understanding the rate of increase in the heaviest rainfall events with a slight decline in moderate rainfall. While the blue trendline (1-inch rainfall days) remains relatively flat, the green (2-inch) and orange (3-inch) trendlines decrease slightly, which gives rise to the extreme red (4-inch) trendline visible in the bottom right of the figure. This demonstrates that there has already been an increase in the extreme rainfall events in the past 20 years where we see fewer 2- and 3-inch rainfall events per year and instead see occasional 4-inch or greater rainfall days, which have historically over-stressed City water management and breached riverine flood barriers.

It is important to note that as the historic record shows an increase in storms producing greater than 4 inches of daily precipitation, the increased flows because of these storms in Virgin Creek, Pudding Creek, and the Noyo River will increase the likelihood of coincidental coastal flooding.

2.2.3 Coastal Bluff Erosion (Coastal) & Landslides

Bluff erosion is influenced by sea level rise in addition to the mechanisms that impact landslides inland and need to be evaluated concurrently. Figure 6 below documents geologic hazards with risk of erosion and landslides.

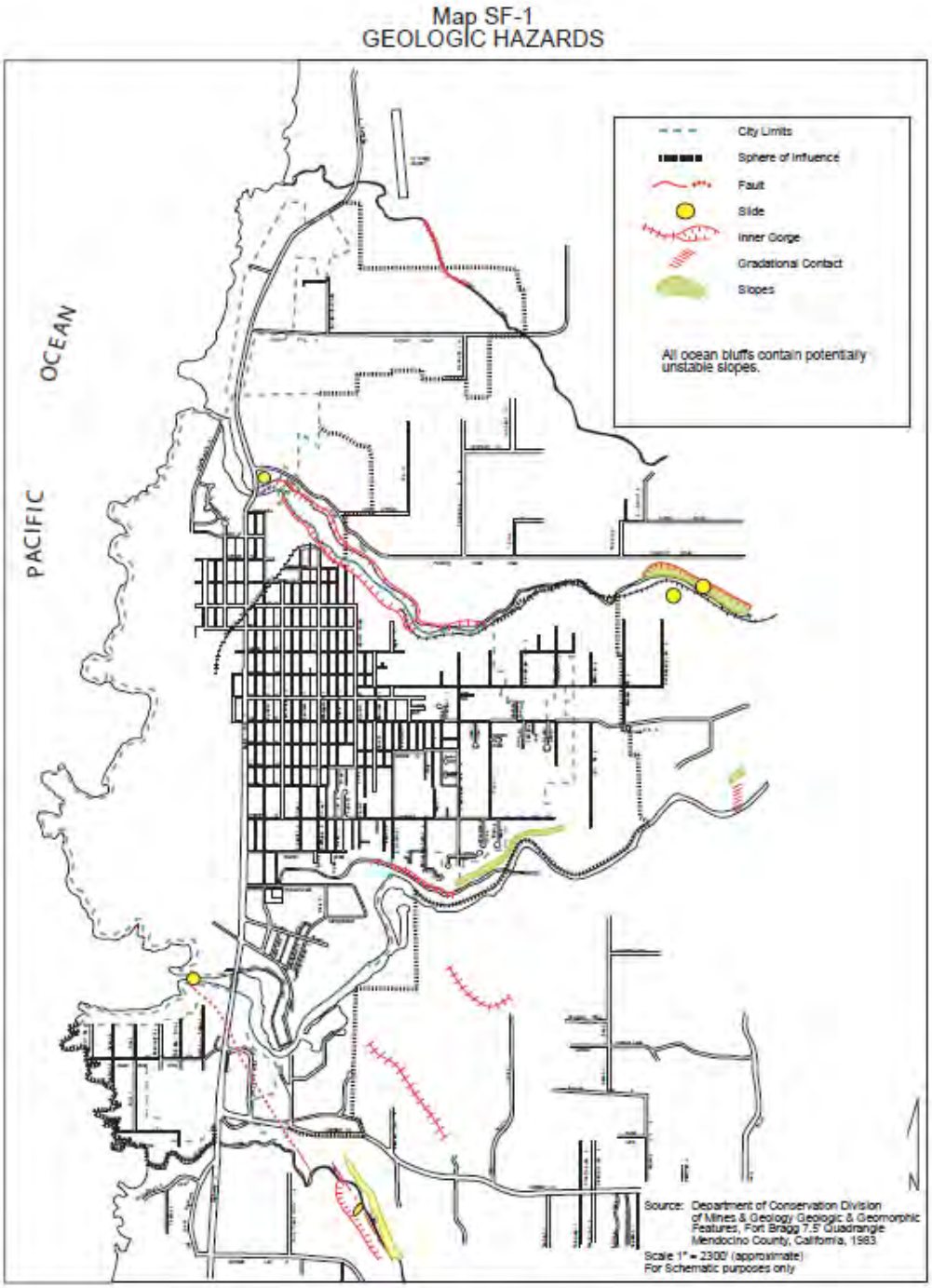


Figure 6 – Geologic Hazards, Fort Bragg
(Source: Department of Conservation Division of Mines& Geology. 1983)

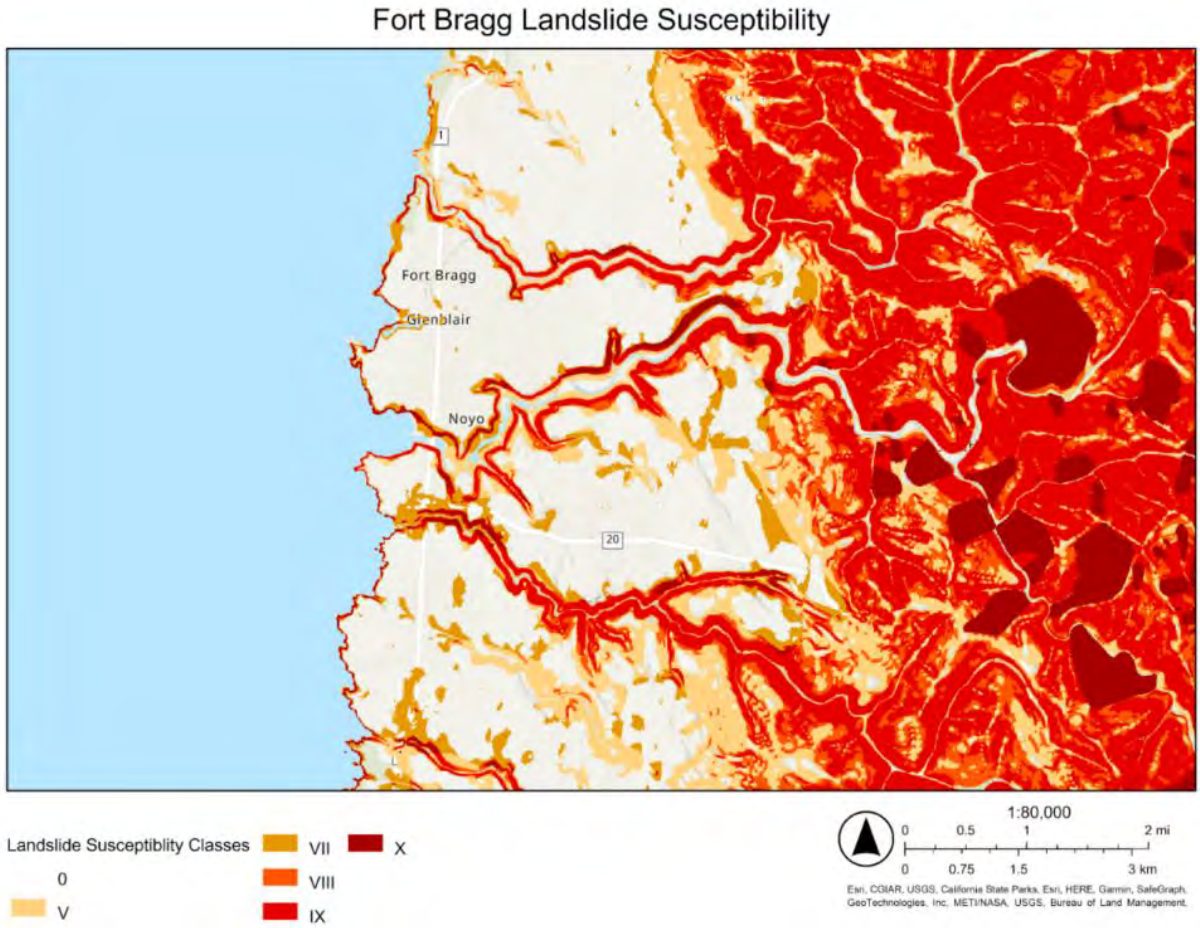


Figure 7 – Relative Slope Instability in the Fort Bragg Area (After CGS Map 58, 2011)

Figure 7 above shows the rankings from “Susceptibility to Deep-Seated Landslides” from beige to red. This is not identified landslides, but an evaluation of the risk of land sliding. Based on this map of the system, the sections near the creeks and rivers appear vulnerable. According to the 2021 Multijurisdictional Hazard Mitigation Plan (JMHMP), the areas identified as instability zones in the 2011 map may warrant reclassification to a more severe risk category, underscoring the need to elevate slope failure as a high priority concern countywide.”

2.2.4 Temperature / Extreme Heat

A similar scenario is seen with the observed temperature in Fort Bragg as has been shown with observed precipitation. The trendline is flat in the observed annual mean maximum temperature for the period from 1950-2023 (Figure 8). However, the variability of the annual mean maximum temperature is plainly seen in the last 30 years. In this case, the standard deviation of the annual mean maximum temperature nearly doubles in variability from the first half of the dataset to the most recent half. From 1950-1986 the standard deviation of temperature was 0.97 °F. From 1987-2023 it increased to 1.63 °F. Therefore, it is shown that statistically speaking, the average hottest days in Fort Bragg each year are becoming more variable.

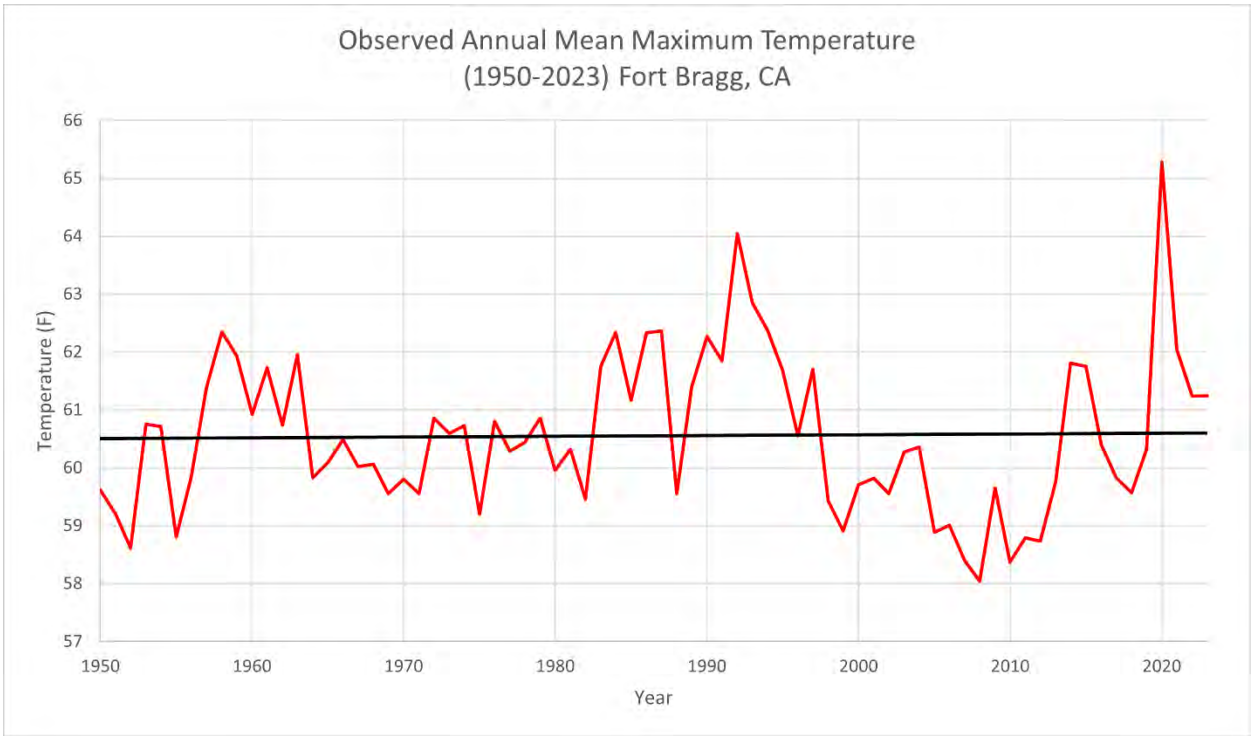


Figure 8 – Observed Annual Mean Maximum Temperature at Fort Bragg 5 N station (1950-2023)
(Source: NCEI)

Interestingly, the observed annual mean minimum temperature (Figure 9) shows a decreasing trend, meaning that on average the coldest days are getting colder in Fort Bragg. In terms of statistical variability, there is a small increase in variability in the second half of the annual mean minimum temperature data, which is consistent with the rest of the temperature and precipitation data and supports the overall trend towards more variable weather patterns depicted in the climate section.

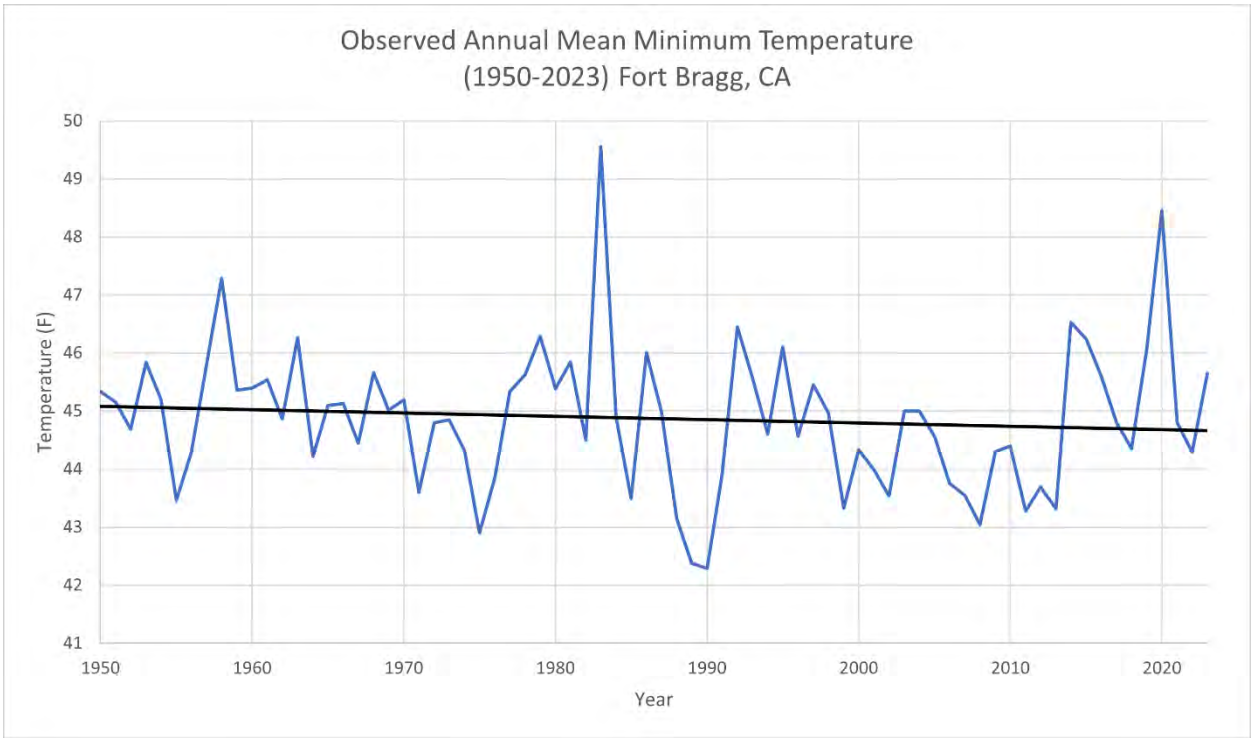


Figure 9 – Observed Annual Mean Minimum Temperature at Fort Bragg 5 N station (1950-2023)
(Source: NCEI)

2.2.5 Wildfire

The California Air Resources Board (CARB) has unequivocally stated that, "Climate change, primarily caused by the burning of fossil fuels, is increasing the frequency and severity of wildfires not only in California but also all over the world. Since 1950, the area burned by California wildfires each year has been increasing, as spring and summer temperatures have warmed, and spring snowmelt has occurred earlier (CARB, 2023)." As seen in the graph of annual precipitation and annual maximum temperatures (Figure 4 and Figure 8), the most recent drought in California (2020-2022) was accompanied by increased air temperatures as well. This combination of lack of precipitation, increased temperatures, and even increasing wind events has resulted in a dramatic increase in the frequency and intensity of wildfire in all of California.

As shown in Figure 10 from the 2021 Multi-Jurisdictional Hazard Mitigation Plan (JMHMP), based on data from the California Department of Forestry and Fire Protection (Cal Fire), most of the county is characterized as having high to extremely high wildfire risk.

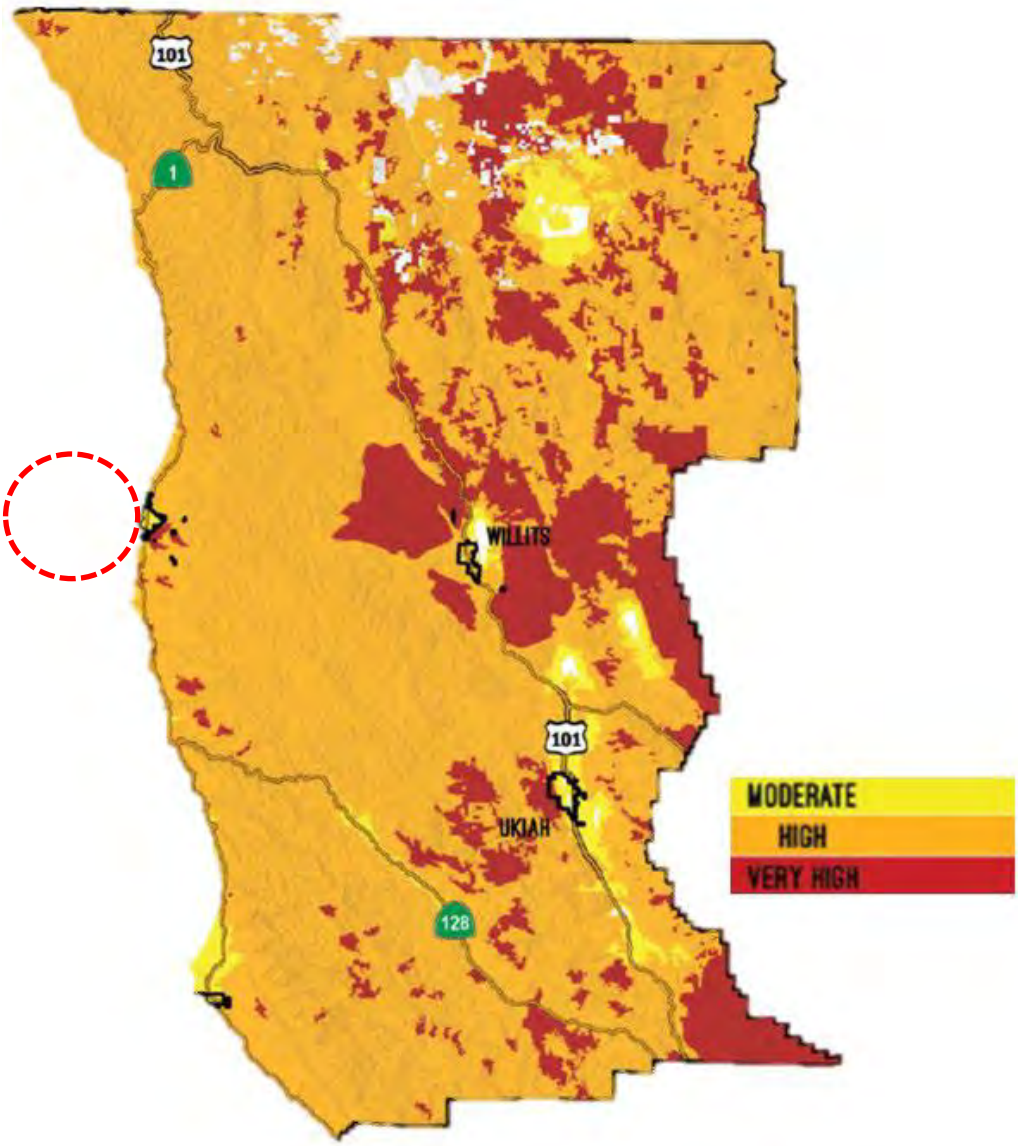


Figure 10. Wildfire Risk. The City of Fort Bragg is circled in red.
(Source: Mendocino County. Local Multi-Jurisdictional Hazard Mitigation Plan (MJHMP); 01-25-2021) https://mendoready.org/oes-documents/

2.2.6 Drought

Precipitation has historically been highly variable within California. This was particularly true in the last six years, where the water year 2016-2017 produced well above normal precipitation in northern California, while 2020-2022 were years of significantly below normal precipitation. The water year 2022-2023, in turn, produced record snowfall in the Sierras and well-above normal precipitation elsewhere in the state. That year-over-year variability will continue to challenge water managers in the future and will require continued conservation efforts during times of drought.

2.3 Projected/Possible Climate Scenarios

Climate change projections are based on global climate models using future emissions scenarios. This study uses two Representative Concentration Pathways (RCPs): RCP 4.5, where emissions peak mid-century and then decline, and RCP 8.5, where emissions continue to rise through 2100. Data comes from the U.S. Climate Resilience Toolkit (CRTCE, 2023), which uses CMIP5 model outputs. While CMIP6 is more current and likely shows stronger trends, CMIP5 still provides a reliable view of expected changes in temperature, precipitation, and related hazards.

2.3.1 Flooding (Sea Level Rise, Storm Surge and Riverine)

Sea level rise is accelerating along the California coast and will continue to rise substantially during the 21st century, threatening coastal communities, natural resources, cultural sites, and infrastructure. *State of California Sea Level Rise Guidance: 2024 Science and Policy Update* ("2024 State Guidance") was published by the California Ocean Protection Council (OPC) to provide recommendations for evaluating proposed projects against future sea level rise scenarios. The 2024 State Guidance includes relative sea level rise projections for a series of NOAA tide gauges along the California Coast. The closest tide gauge to the project location is the Arena Cove, CA gauge, located 45 miles south of Fort Bragg, which indicates 1.2 ft to 2.8 ft of sea level rise by 2070 and between 2.9 ft and 6.4 ft by 2100 under the Intermediate and high sea level rise projection scenarios, respectively. Though the exact amount of sea level rise for a specific location in a certain year is unclear, we know that water levels are rising, and communities need to be prepared. Coastal wave events and king tides, in combination with current and rising sea levels, will increase flood impacts on land, which will exacerbate the impact on coastal assets. Rising sea levels may also raise groundwater tables, cause increased flooding and lead to impacts that will further damage buried and low-lying infrastructure[3].

Sea level rise projections were selected based on the 2024 State Guidance. For planning purposes, and in alignment with California Coastal Commission guidance[4], the high sea level rise projection scenario was selected to determine conservative SLR projections at the Project location (OPC 2024). Sea level rise values corresponding to the nearest NOAA tide gauge to the Project location, Arena Cove, CA, were used. The high sea level rise projections for mid-, late- and end of century at Fort Bragg are as follows:

- Baseline (observed 2000-2020) 1-2".
- 2050: 1.1 feet.
- 2070: 2.8 feet. (1.2-2.8).
- 2100: 6.4 feet. (2.9-6.4).

[3] https://climateresilience.ca.gov/overview/impacts.html#:~:text=The%20daily%20maximum%20average%20temperature,worsen%20drastically%20throughout%20the%20state.

[4] https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/infrastructure/#:~:text=The%20goal%20of%20the%20Commission's,managers%2C%20and%20other%20stakeholders%20with

In alignment with current guidance, this analysis evaluates a conservative range of sea level rise (SLR) projections over time to inform climate resilience planning. While the "High" scenario may not be used as the design basis for the proposed work, it has been considered in the broader assessment, particularly for critical infrastructure. It is important to note that the timing at which specific SLR values may be reached remains uncertain. As such, while the design does not require accommodation of the High scenario at this stage, an Adaptation Management Plan may be necessary at a future stage to ensure future flexibility and responsiveness to evolving conditions. Although the implications for collection systems may be limited, the potential impacts on interdependencies—such as energy, access, and emergency response—suggest that a comprehensive approach through an Adaptation Management Plan would be prudent.

Sea level rise mapping data was pulled from the NOAA Sea Level Rise Viewer (NOAA 2022). The sea level rise values are projected over mean higher-high water (MHHW) elevations, representing sea level rise under daily conditions. This mapping of sea level rise over MHHW is shown below (Figure) for reference, because it is the best available mapping currently for the location, although it does not correspond directly to the future BFE scenarios described above.

Sea level rise is anticipated to impact the interactions between the Noyo River and the Pacific Ocean. It is anticipated that sea level rise will cause coastal backwaters to propagate up through the Noyo River which may impact portions of the Fort Bragg’s wastewater collection system that interact with this river including intakes or outfalls. Beyond the Noyo River, sea level rise is not anticipated to have a significant impact on the wastewater collection system infrastructure.

Determining water levels in detail is beyond the scope of this planning-level study. More detailed hydraulic modeling of the combined riverine and coastal conditions is recommended when developing projects, particularly at the Noyo River and Pudding Creek. More detailed hydraulic modeling would be required to assess the relative contributions to riverine water levels from sea level rise and riverine flows.

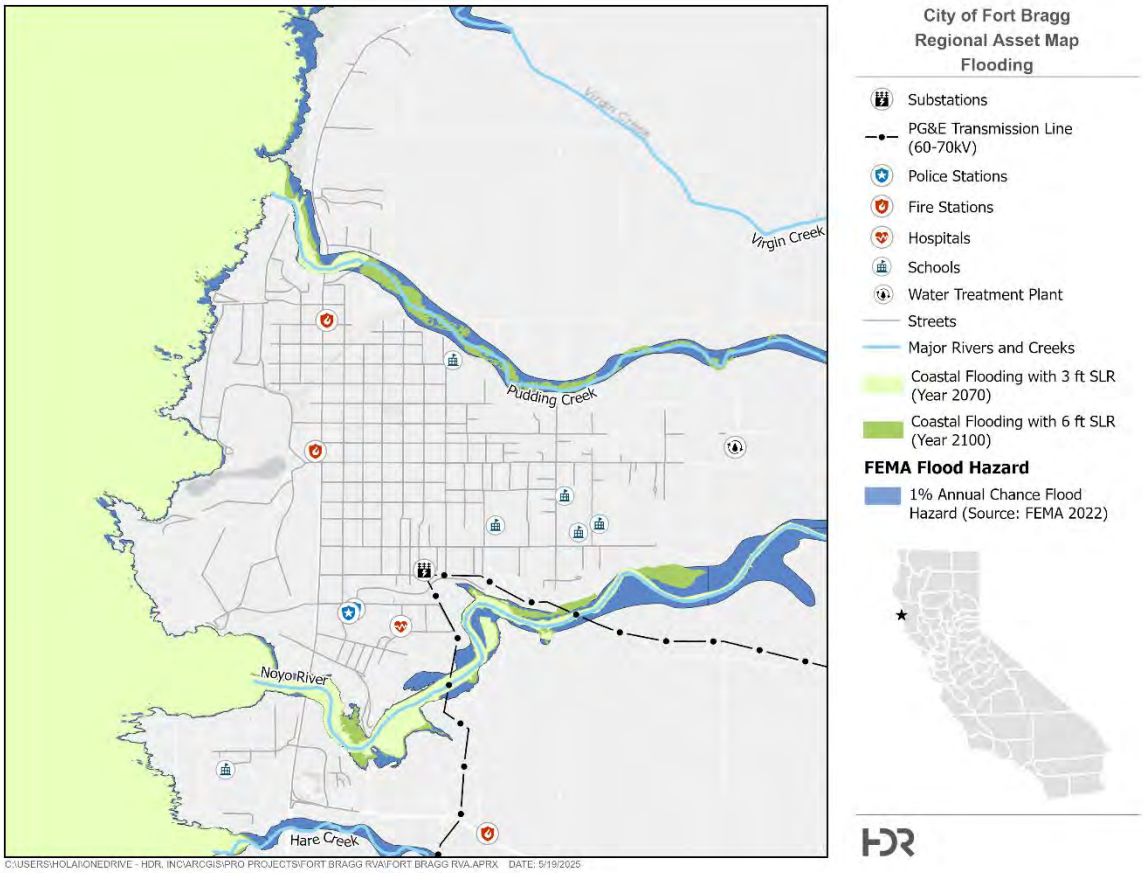


Figure 11 – Flooding Risk Projected: Highest Water Levels Mapped in the Regional Water Level Viewer, Equal to 10 Feet SLR over the MHHW Elevation
(HDR based on NOAA Sea Level Rise Viewer (NOAA 2022). FEMA historic flooding risk)

The coincidental occurrence of heavy rains, high stream flows, SLR, storm surge, and high astronomical tides are expected to increase the threat of coastal inundation in the future. Rainfall runoff occurring simultaneously with high tides will result in inundation areas greater than what is shown. As sea levels rise, this situation is expected to be exacerbated during times of storm, king tide, or both.

2.3.2 Precipitation

California is known for its highly variable precipitation and has the highest variability of year-to-year precipitation in the contiguous United States. California's variable precipitation is also characterized by multi-year wet or dry periods. As a result, future average precipitation is difficult to predict (figures 12 and 13) but may likely not change substantially when measured by annual precipitation. However, there is high confidence in projections that even if precipitation remains stable or increases, drought severity and the number of dry years will increase, even as more extreme precipitation events may occur. Warming air temperatures will increase moisture loss from soil, which will lead to drier seasonal conditions even if precipitation increases. The snowpack in

California's mountains is a key source of surface and groundwater in the state, and rising temperatures will cause a decline in snowpack by more than a third by 2050 and more than half by 2100, even if precipitation levels remain stable[5].

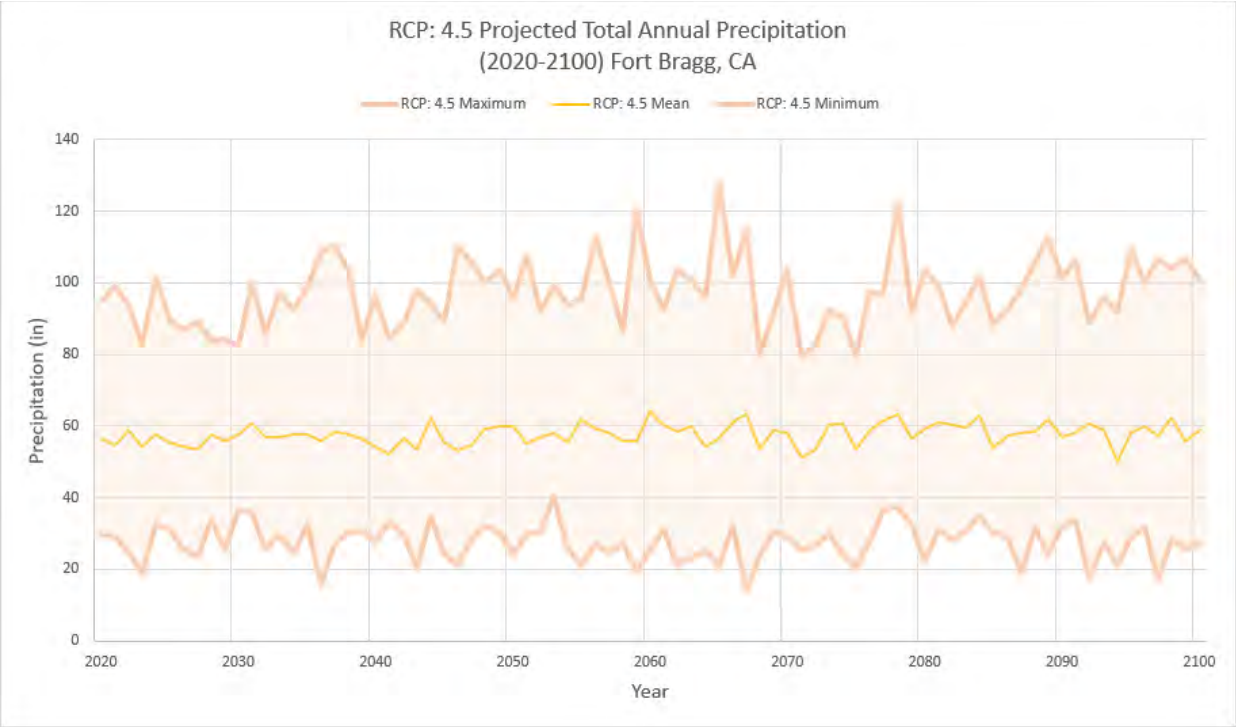


Figure 12 – Projected Total Annual Precipitation for Fort Bragg Based on Climate Scenario RCP 4.5

[5] https://climateresilience.ca.gov/overview/impacts.html#:~:text=The%20daily%20maximum%20average%20temperature,worsen%20drastically%20throughout%20the%20state

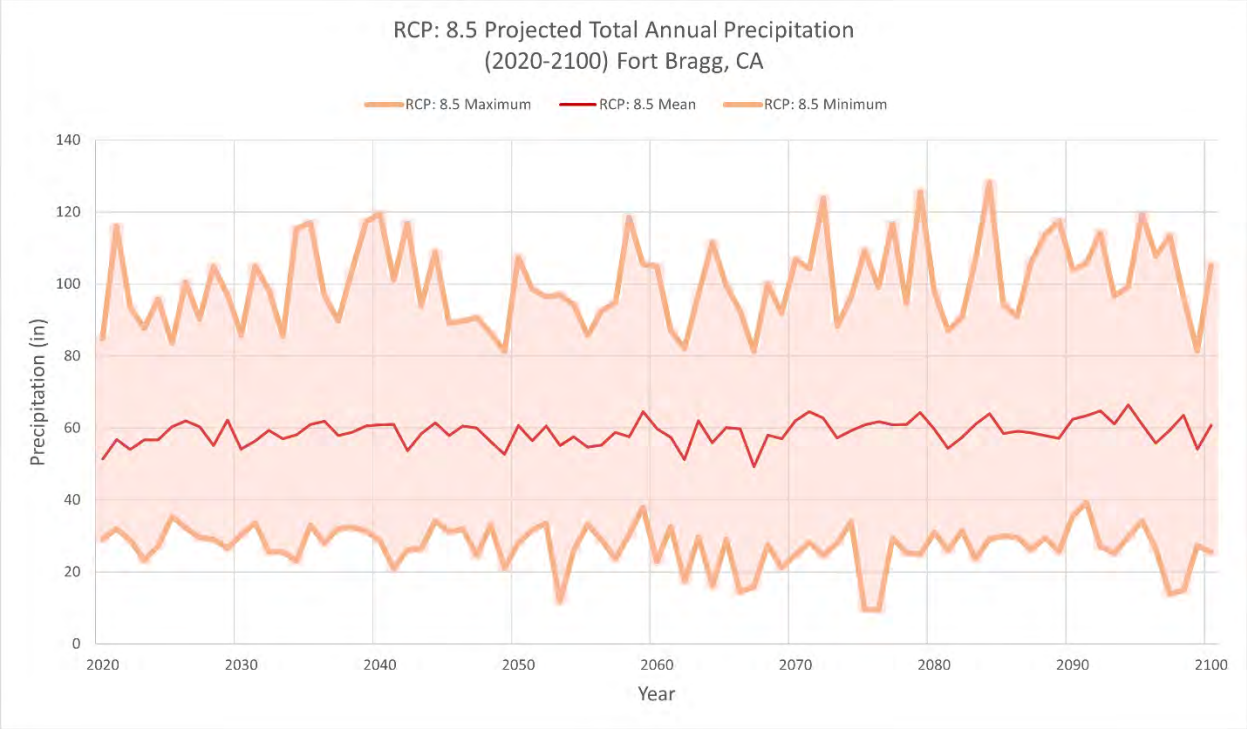


Figure 13 – Projected Total Annual Precipitation for Fort Bragg Based on Climate Scenario RCP 8.5

Figure 12 shows projected annual precipitation changes for Fort Bragg under RCP 4.5. Precipitation intensities rise mid-century, then stabilize as emissions decline. Figure 13 shows a similar trend under RCP 8.5, despite higher emissions. Both scenarios suggest total annual rainfall remains steady, but concentrated in fewer, more intense storms—raising flood risk.

In figures 14 and 15, the projected number of days that will see 1 inch or more of rainfall is shown for RCP 4.5 and 8.5, respectively. This set of projections shows that in either case (4.5 or 8.5) there is expected to be an increase in the number of days each year where Fort Bragg receives 1 inch or more of rain. While a single inch of rain in a day is not always cause for concern, this highlights the general trend of increasing variability where the amount of rain that falls per year is expected to be stable, but the events in which it falls are expected to be less frequent and more intense, producing periods of drought between heavier rainfall events.

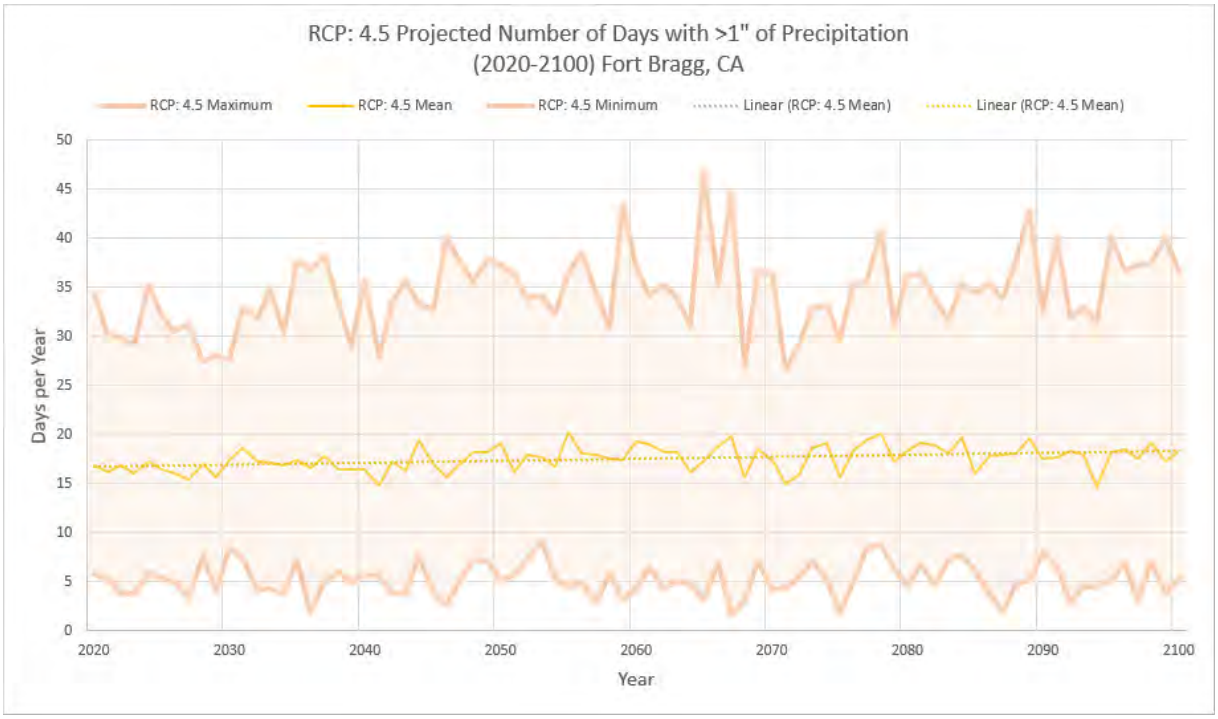


Figure 14 – Projected Number of Days with Greater Than 1 Inch of Precipitation for Fort Bragg Based on Climate Scenario RCP 4.5

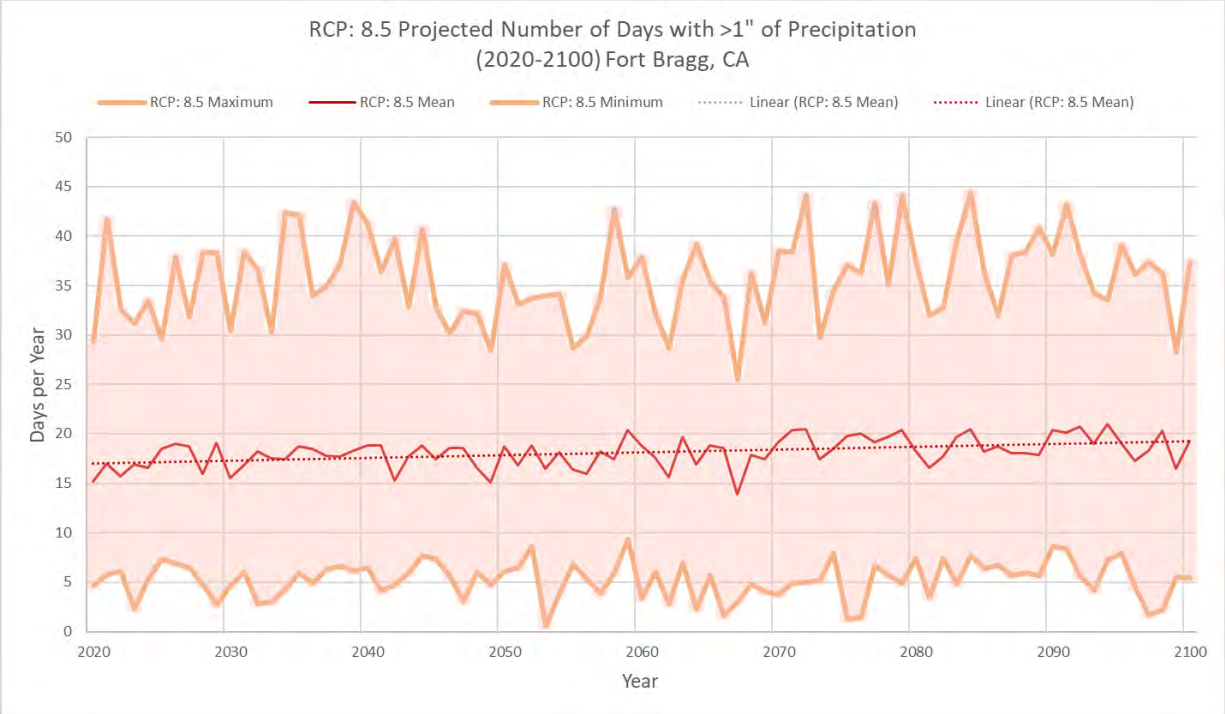


Figure 15 – Projected Number of Days with Greater than 1 Inch of Precipitation for Fort Bragg Based on Climate Scenario RCP 8.5

2.3.3 Coastal Bluff Erosion (Coastal) and Landslides

The noted increase in year-over-year precipitation variability is likely to result in bank destabilization and increase in slope instability during the water years with greater precipitation. The compound effect of drought years killing off vegetation that might otherwise stabilize a hillside followed by years of heavy precipitation that cause the soils to destabilize and produce landslide. This would be further exacerbated by drought years that produce significant wildfire in the watersheds above the city of Fort Bragg.

Bluff erosion is also driven by sea-level rise (SLR) as well as the processes that cause inland landslides. Cliff retreat data was obtained from the Coastal Storm Modeling System's Coastal Cliff Retreat dataset (Barnard et al., 2022). This dataset assumes an unmanaged retreat scenario, where cliffs are allowed to recede regardless of existing armoring. The boundary shown in Figure 16 represents the projected uncertainty band for the future cliff-top edge.

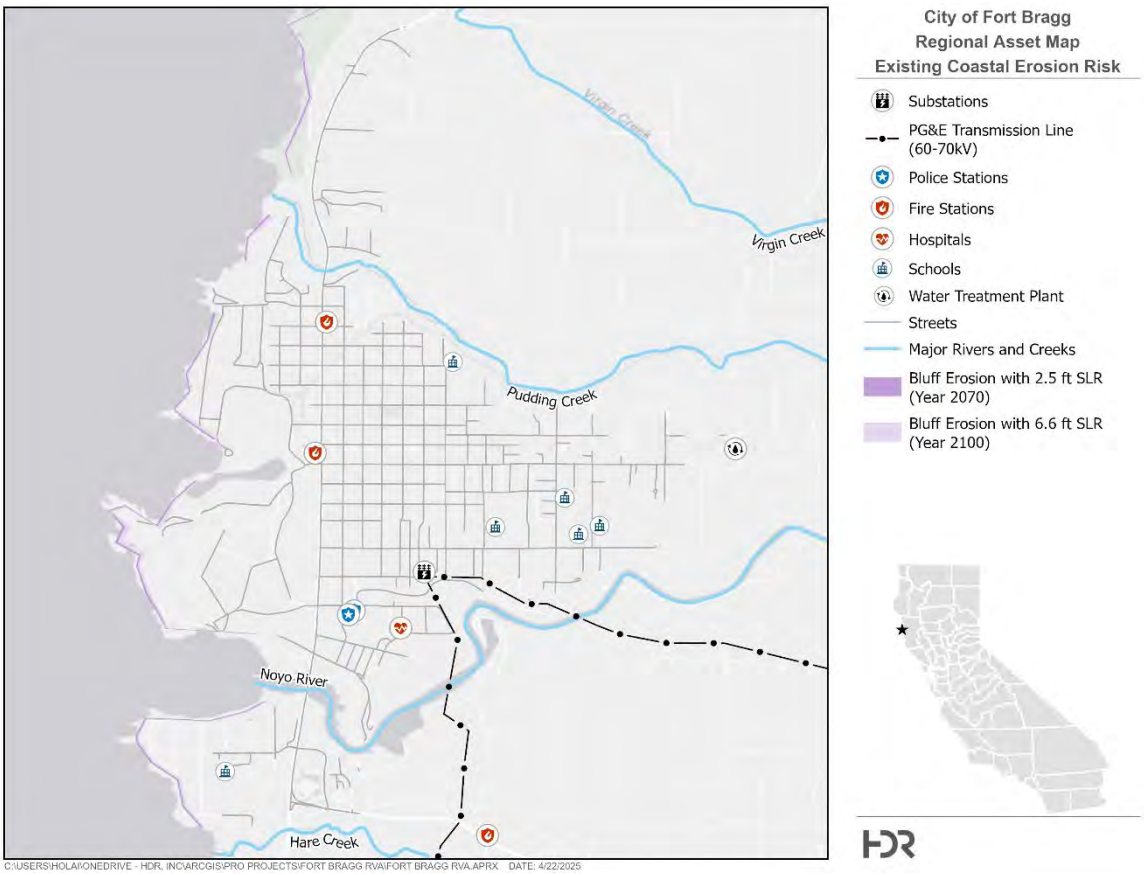


Figure 16 – Existing Coastal Erosion Risk
(Source: Coastal Storm Modelling System (CoSMoS), US geological Survey (USGS), 2022)

2.3.4 Temperature/Extreme Heat

Annual temperature increases experienced over most of California have already exceeded 1°F, with some areas exceeding 2°F. The daily maximum average temperature, an indicator of extreme temperature shifts, is expected to rise 4.4°F–5.8°F by mid-century and 5.6°F–8.8°F by late century.

Heat-Health Events (HHEs), which better predict risks to populations vulnerable to heat, will worsen drastically throughout the state. By midcentury, the Central Valley is projected to experience average HHEs that are two weeks longer, and HHEs could occur four to ten times more often in the Northern Sierra region[6]. Figure 17 illustrates that the annual mean maximum temperature is projected to increase over time.

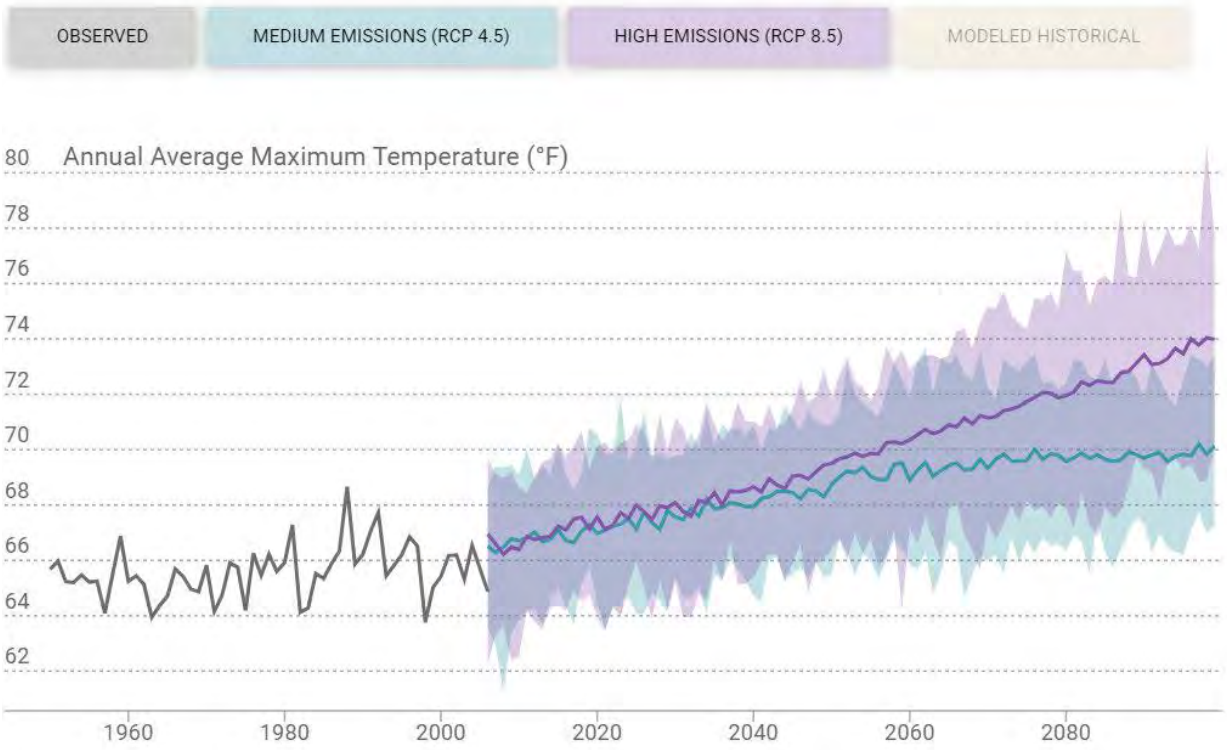


Figure 17 – Annual Average Maximum Temperature for Mendocino County (Source: Drought Resilience Plan, Mendocino County. May 2025)

2.3.5 Wildfire

The year 2020 was the largest wildfire season recorded in California's modern history, with nearly 10,000 fires that burned over four million acres in total. However, fewer than 40 fires accounted for most of the area burned, pointing to the accelerating severity and frequency of extreme fires. In 2021, California experienced 4 of the 20 largest wildfires in the state's history, with 8,000 wildfires burning over 2.5 million acres. A model developed for California's Fourth Climate Change Assessment projected up to a 77 percent increase in average area burned and a 50 percent increase in the frequency of fires exceeding 25,000 acres by 2100[7].

---

[6] https://climateresilience.ca.gov/overview/impacts.html#:~:text=The%20daily%20maximum%20average%20temperature,worsen%20drastically%20throughout%20the%20state.)

[7] https://climateresilience.ca.gov/overview/impacts.html#:~:text=The%20daily%20maximum%20average%20temperature,worsen%20drastically%20throughout%20the%20state.)

Fortunately, Fort Bragg was spared from the recent Mendocino Complex Fire but that does not mean that the threat of wildfire to the region is not being exacerbated by climate change. Per the 2021 Multi-Jurisdictional Hazard Mitigation Plan (JMHMP), report, wildfire should be a high priority county-wide.

As noted earlier in this document, the increased year-over-year variability in precipitation and air temperatures is expected to continue to increase the threat of wildfires. The greatest threat will come in years that are hot and dry following a year, much like water year 2022-2023, that has significantly above normal rainfall contributing to brush and ground cover growth. Peak months for the likelihood of wildfires in the region are from August through September during periods of strong offshore winds or during times when thunderstorms can produce dry lightning in the region.

The threat of wildfire is expected to increase. This will require resilient actions on the part of local, regional, and state agencies because the City is dependent on surface water for its drinking water supply. The intense heat related to wildfires drastically changes the runoff characteristics of a watershed and increases the threat of sedimentation and severe water quality issues. Wildfire heat will also negatively impact pipe integrity and poses a threat to the City's raw water pipeline infrastructure.

2.3.6 Groundwater

The same factors driving increased year-over-year variability in drought and heavy precipitation will also affect groundwater availability in the region. As observed in other western locations (Jensen, M.N., 2016), groundwater supplies may be further stressed by rising evapotranspiration due to higher air temperatures.

Sea-level rise will elevate groundwater levels. The rate of this rise depends on local soil conditions, which is beyond the scope of this study. However, because most of Fort Bragg is situated at a relatively high elevation, this is likely not an immediate concern.

2.3.7 Drought

Historic year-over-year precipitation variability between years of flood and drought is expected to be exacerbated by climate change in the region. Increasing air temperatures combined with years of below normal precipitation will produce a multiplying effect on water usage through increasing demand, evaporation, evapotranspiration, and, of course, the increased risk of wildfire during drought years[8].

[8] Mendocino County Drought Resilience Plan, May 2025. https://www.mendocinocounty.gov/departments/water-agency/drought-water-conservation/drought-resilience-plan

2.4 Conclusion/Key Findings

Historic climate trends provide a baseline for understanding projected future conditions. Future Risks can be classified as follows:

Critical – Represents extreme, widespread impacts. Recovery is prolonged or even irreversible.

High – Represents severe and impacts that destabilize multiple systems. Recovery takes time and concerted efforts.

Medium – Represents significant damage and disruption at a more localized level. Recovery can be swift and manageable by fewer actors.

Minor – Represents impacts that are insignificant and even familiar. Recovery is almost instantaneous.

The primary climate risks identified for the Wastewater Collection System are:

<u>Critical and High Risks</u>

- Sea Level Rise & Landslides/Erosion: Increased saltwater intrusion may impair treatment performance. Infrastructure on steep slopes is vulnerable to damage, and landslides can block emergency access.
- Riverine Flooding (High Risk): Rising sea levels and more intense precipitation are expected to increase flood frequency and severity. Low-lying assets, such as pump stations, face heightened risk. Increased inflow and infiltration will stress the collection system.
- Drought: Multi-year droughts are likely, reducing customer baseflow and causing soil drying, which may lead to joint separation and settlement issues.
- Wildfires: Drought-driven fires south of the Noyo River pose severe risk.

<u>Medium Risks to Monitor</u>

- Precipitation: Rainfall is projected to occur in fewer but more intense events.
- Tsunami: Trends remain uncertain; coastal bluff erosion could threaten WWTP structures and flood low-lying assets, including generators stored at the WWTP.
- Groundwater: Levels are currently stable, but saltwater intrusion is possible. Dry wells are highly susceptible to drought.
- Winds: Strong coastal winds may damage power supply and exacerbate wildfire spread.

These risks are summarized in Table 1, which integrates quantitative climate projections from established models—per the sources cited and parameters presented in this section—with expert judgment to address information gaps, as documented in the comment column of Table 1.

Table 1 - Compilation of Key Climate Hazards

Event	Natural Hazard	Baseline/ Observed	Mid-Century Projections (2050s)	Long-term Projections (2070s)	Preliminary High Level Impact *(design, operations & maintenance)*	Comments	Ranking
Flooding	Sea Level Rise	1"-2" (2000-2020)	+1.1	+1.2-2.8	Efficacy of biological and sedimentation treatment with increased saltwater composition (from I&I). Longevity of piping and other infrastructure.		
	Tsunami	Medium	Medium	Medium	Coastal bluff erosion, jeopardizing WWTP structures. Flooding of low lying assets such as pump stations	Trends are unknown.	
	Inland Flooding/ Riverine	19' BFE	20.3'	22'	Flooding of Low lying assets such as pump stations. Increase in Inflow and infiltration (I&I)	Sea Level Rise and projected increase in precipitation intensities will increase flood frequency and severity.	
	Extreme Precipitation	Low	Medium	Medium	Inflow and infiltration surcharge. Increase in treatment volume.	Precipitation is projected to be delivered in fewer, but more intense rainfall events. (Days ≥ 1" precip.)	
	Groundwater	Low	Medium	High	Land subsidence and differential settlement of infrastructure. Float of pipes and corrosion as SLR raises groundwater level	Groundwater levels are stable. Saltwater intrusion is possible as a result of SLR. Dry wells are highly susceptible to drying out.	
Water Stress	Drought	Medium	High	High	Baseflow in system from Inflow and Infiltration. Lower baseflow from customers if water conservation measures must be taken. Joint separation from settlement as soil moisture pores dry.	Projected increase in drought severity as well as likelihood of multi-year droughts.	
Geo Hazards	Landslides/ Erosion	High	Critical	Critical	Assets within steep slopes can be exposed and damaged. Assets at base of steep slopes can be damaged by landslides. Accessibility for hazard response can be blocked	Higher risk for compound impact of drought and projected more extreme rain events and increased heat will increase soil instability.	
	Sinkholes	Low	Low	Low	N/A	No sink hole hazard identified	
	Earthquakes	Medium	Medium	Medium	N/A	Outside scope	
Extreme Temperature	Extreme Heat	0 days HI >90	0.2 days HI>90	1 day HI>90	Impact for outdoor workers.	Change in days with heat index >90 will go from 0 to 1.	
	Hot Days	67 Annual Max	+4.5°F to 5.8°F	+5.6°F to 8.8°F	Additional condensate in sanitary system. In extreme conditions, more energy demand for AC, resulting in taxed electric grid.	Hot day is considered HI > 77 Source: First Street	
	Extreme Cold	Low	Low	Low	A freeze, especially a consecutive days below freezing could damage pipes	Freezing temps are reached occasionally on winter nights. Average low temp in winter is 39 degrees.	
	Snow Events	0	0	0			
Other	Extreme Wind	Medium	Medium	Medium	Damage to wastewater infrastructure Power Supply. Spread wildfires	Trends are unknown. Strongest winds occur along coastline.	
	Tornadoes	Low	Low	Low	N/A		N/A
	Wildfires	High	Critical	Critical	Damage to Pump Station and Pump Station/ WWTP power supply	Only south of the Noyo River	
	Lightning	Low	Low	Medium	Disruption or damage to monitoring and control equipment.	Not directly a concern, but can ignite fuel during droughts and cause wildfires.	

Ranking:
- Critical
- High
- Medium
- Low

CHAPTER 3.0 CLIMATE RESILIENCE ASSESSMENT

3.1 Approach

The Climate Resilience Assessment (CRA) approach is based on existing conditions and aligns with best practices adapted to Fort Bragg's unique context. Preliminary findings reflect the City's priorities in assessing risk and identifying key actions. The CRVA process includes three steps: first, assessing exposure to potential climate risks; second, evaluating vulnerability based on asset sensitivity and adaptive capacity; and third, conducting a risk assessment that considers the consequences of asset failure and the likelihood of climate threats. These steps (Figure 18) guide the prioritization of critical assets and inform the development of a resilience implementation plan.

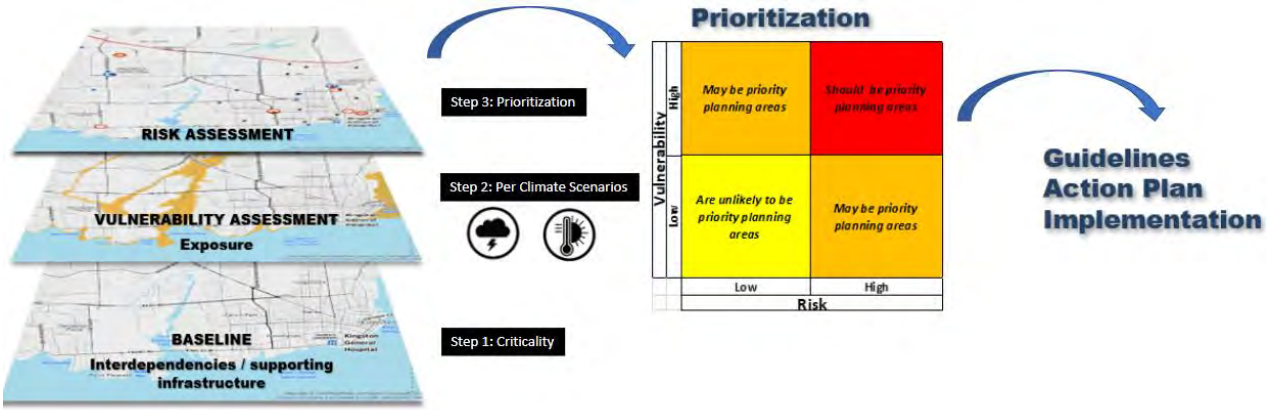


Figure 18 – Illustration of Steps for Developing a Climate Resilience Assessment (CRA)
(Source: HDR)

Vulnerability is a function of exposure, sensitivity, and adaptive capacity.

- Exposure determines which assets are exposed to climate risks using the best available information. For the purposes of this study, exposure is considered for the primary climate parameters as identified within the scope and resources of climate analysis in Section 2.
- Sensitivity is the degree to which an asset can be affected by a hazard. For this initial assessment, it is assumed that all assets exposed to a hazard are sensitive to it.
- Adaptive Capacity is assessed based on whether assets had technological or operational protections in place and system-wide redundancy to help mitigate or cope with the impacts of exposure.

For this high-level assessment, vulnerability (Figure 19) has been assessed by exposure defining sensitivity.

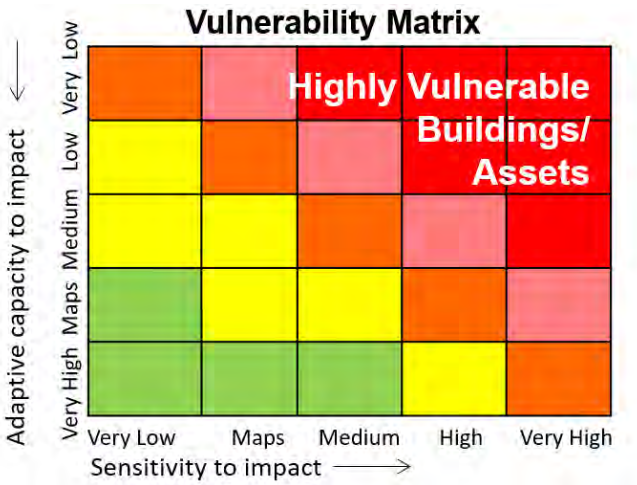


Figure 19 – Vulnerability Matrix
(Source: HDR, Adapted from ICLEI)

Risk is a function of consequences (of an asset failing) and the likelihood/probability it will occur (e.g., observed or projected) as illustrated in Figure 20. Likelihood was scored as either "High" or "Highest" (as informed by the exposure to the identified climate scenarios) while consequence of failure could be scored as "Low," "Medium," or "High" per anticipating possible consequences.

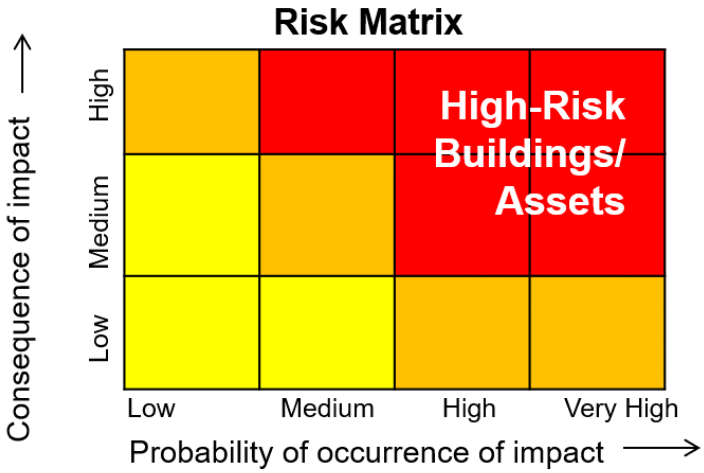


Figure 20 – Risk Matrix
(Source: HDR, Adapted from ICLEI)

Prioritization is the last step in risk and vulnerability assessment. Prioritization takes in all the information gathered related to vulnerability and risk and allows for a final assessment of infrastructure or assets that may or may not be a priority for focus. The prioritization of critical assets and infrastructure can then lead to better guidelines for climate-related issues and can focus an action plan on assets that are a higher priority, and, therefore, introduce changes to help assets become more resilient.

3.2 Interdependency CRA

The purpose of the Interdependency CRA is to identify regional infrastructure critical to supporting Wastewater Collection System operations and to highlight vulnerable communities at greater risk in the event of system failure.

3.2.1 Overview

Risks and vulnerabilities were assessed for the following interdependent asset categories:

- Transportation Systems: Transportation networks are essential for accessing Wastewater Collection System assets to conduct timely repairs, maintenance, and operations.
- Energy and Electrical Systems: Reliable and safe power delivery is required to support pump station operations as well as leak detection, monitoring equipment, and other electrically dependent infrastructure.
- Interconnected Water Infrastructure: The performance of the wastewater system is closely linked to potable water intake and treatment facilities, as well as stormwater management infrastructure. Ensuring the reliability of these upstream systems is critical for maintaining safe and continuous service.
- Telecommunication/IT Systems: Many Wastewater System assets and operational procedures rely on stable telecommunication and data connectivity for monitoring, control, and emergency response.
- Critical Facilities: Emergency response, public safety, and other essential facilities play a key role in stabilizing service disruptions and restoring community functions. These facilities must be identified and prioritized for protection.
- Serviced Communities: Customer demographics influence adaptive capacity and vulnerability. Low-Income and Disadvantaged Communities (LIDACs) within the service area should be specifically identified due to potentially heightened sensitivity to failures and service interruptions.
- Natural Systems: Wastewater discharge enters the Pacific Ocean just off the coastline. Marine environments provide ecosystem services to Fort Bragg and beyond. Their health and integrity must be protected. . Natural land cover, riparian ecosystems, and urban tree canopies also provide essential ecological functions such as flood mitigation, water quality enhancement, wind breaks, and air purification.

Figures 21 through 24 illustrate key components of the Interdependency Climate Risk Assessment (CRA) that rely on or support the Wastewater System. Figure 21 shows the boundaries of the assessment, encompassing the Fort Bragg Wastewater Collection System and extending to interconnected systems at a larger scale. Figure 22 depicts areas of flooding risk within the service region, highlighting potential impacts on water infrastructure and access routes. Figure 23 presents landslide and erosion risk zones, which may affect source water reliability and system integrity.

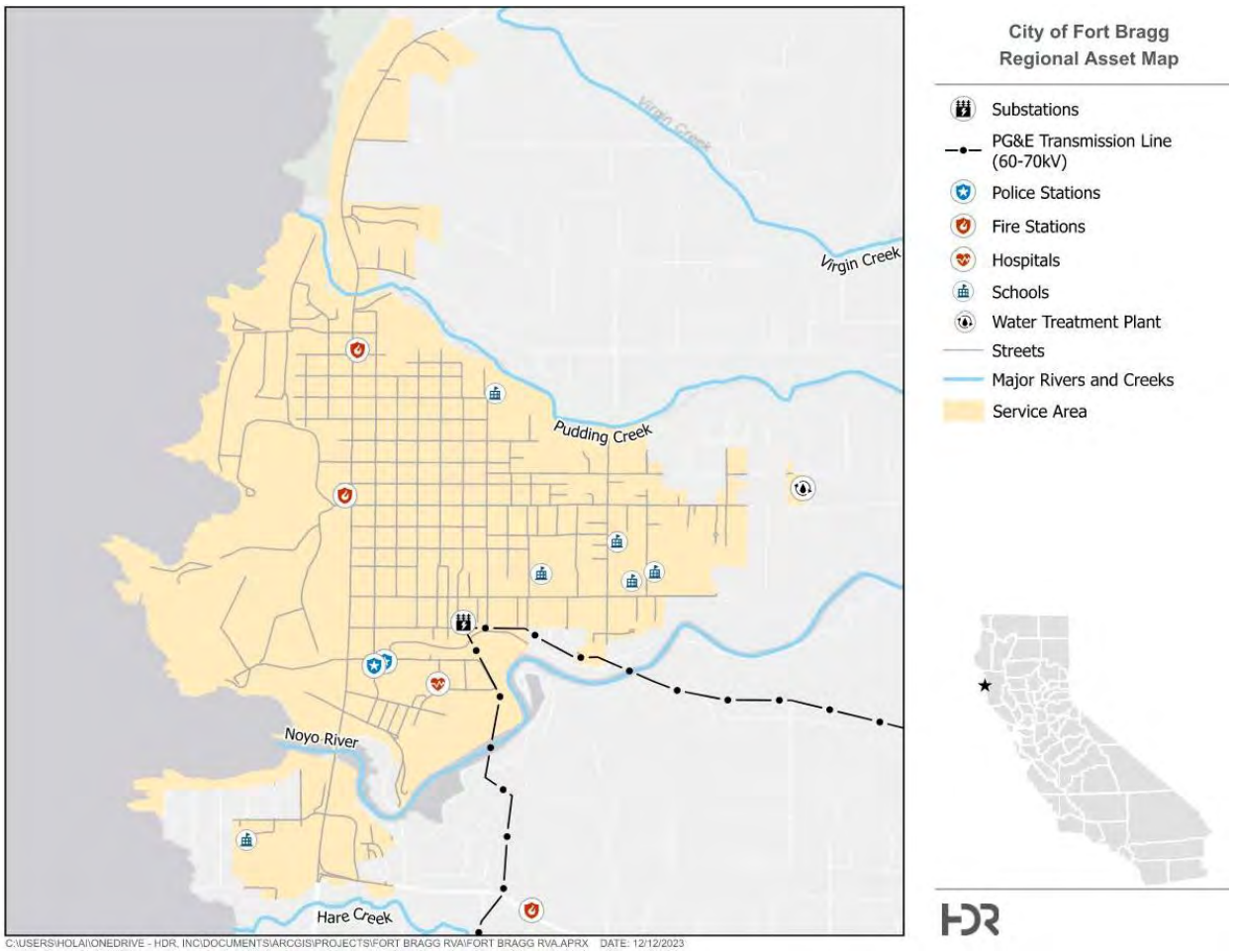


Figure 21 – Regional Critical Assets
(Source: HDR GIS Fort Bragg)

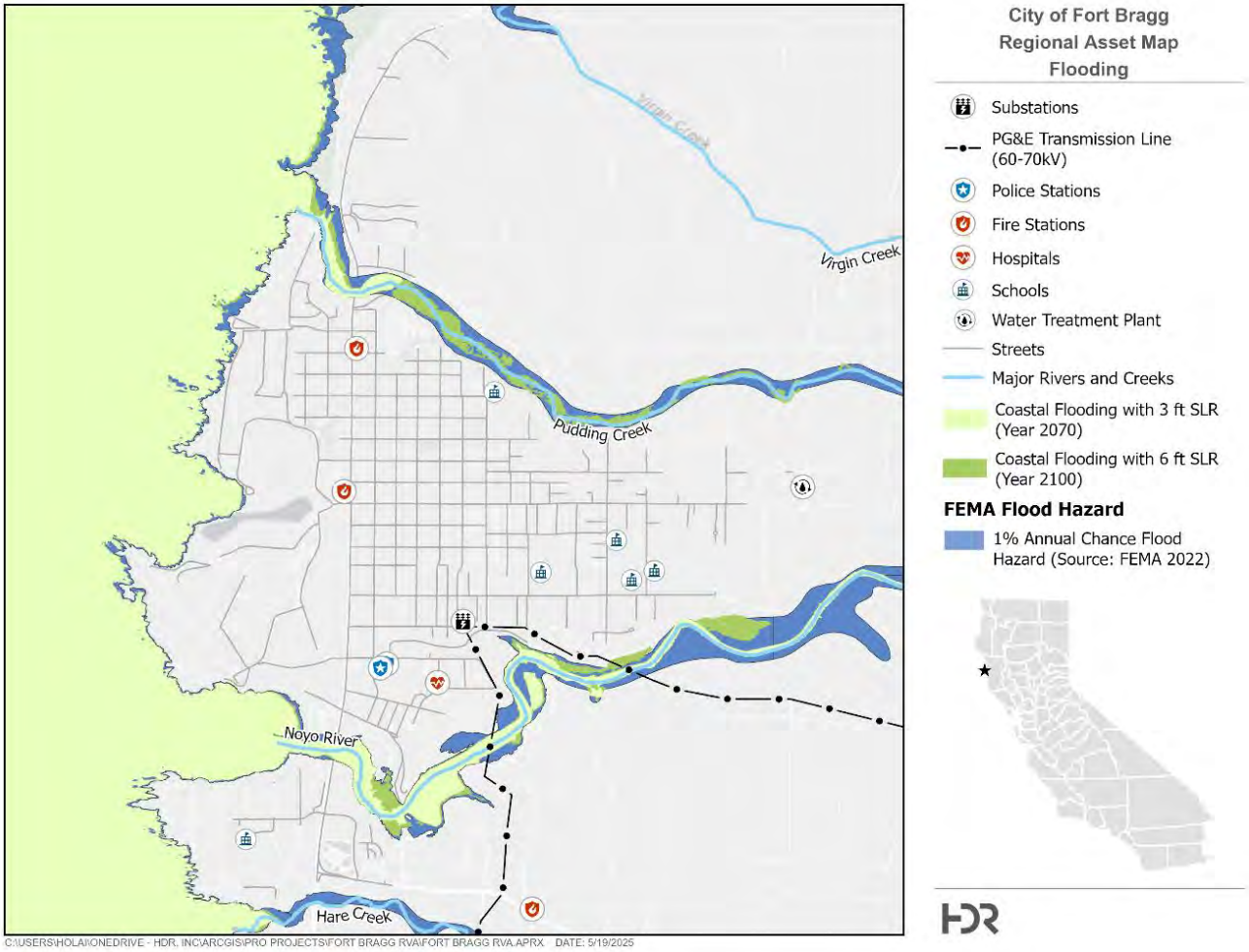


Figure 22 – Regional Asset Map and Flooding Risk
(Source: HDR GIS based on Fort Bragg database; FEMA 2022)

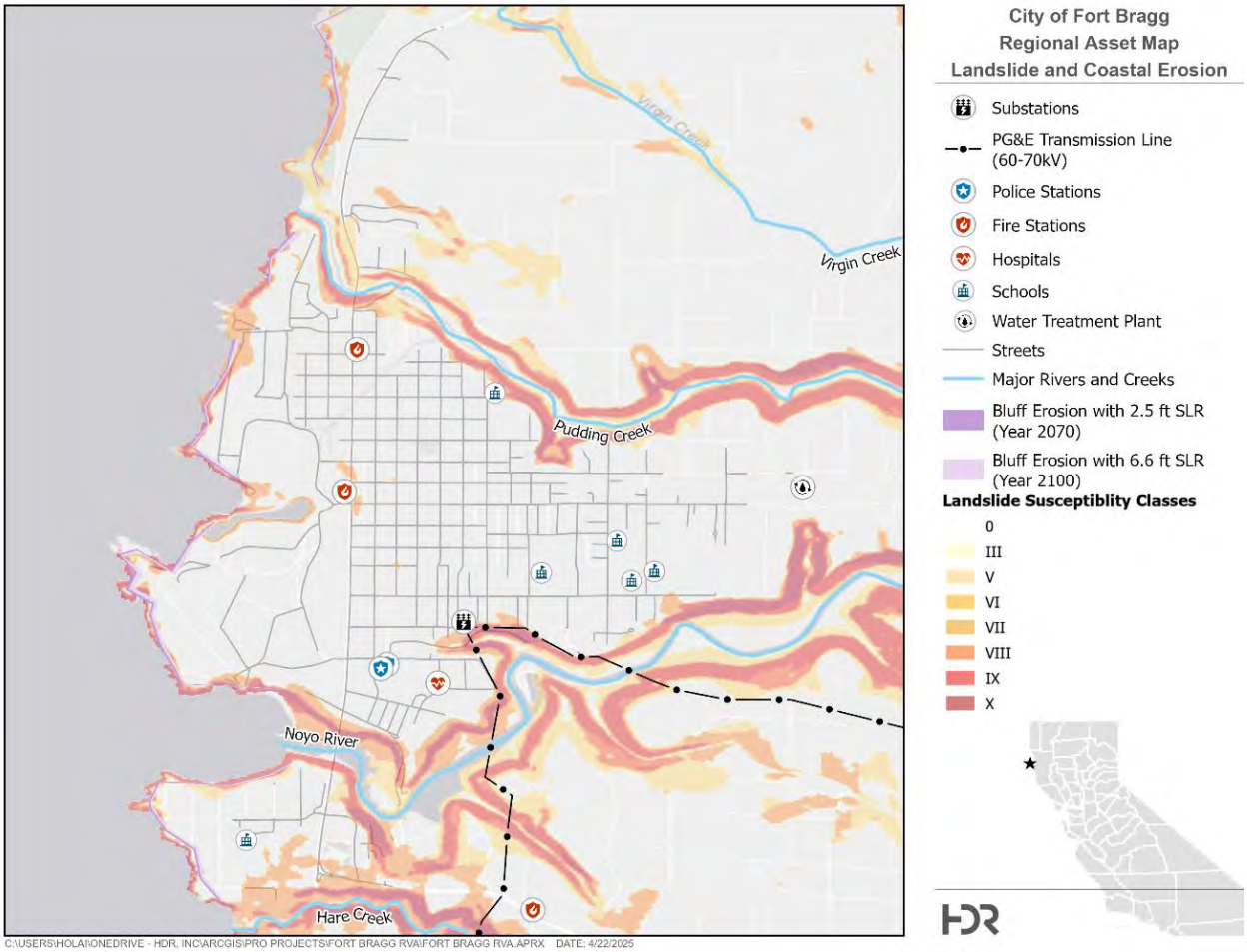


Figure 23 – Regional Asset Map of Existing Landslide and Coastal Erosion Risk
(After CGS Map 58, 2011)

Figure 24 illustrates the relationship between identified interdependent assets and wildfires.

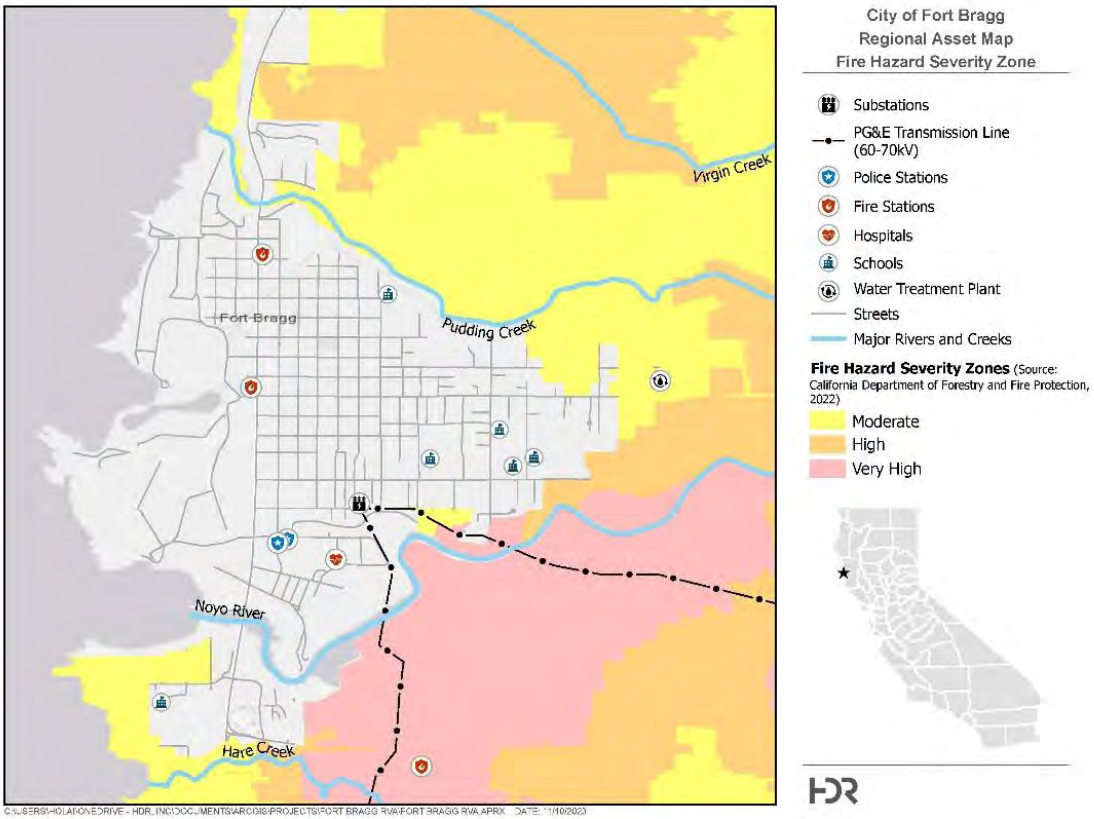


Figure 24 – Regional Asset Map of Existing Wildfire Risk
(Source: HDR GIS based on Fort Bragg database; CA Department of Forestry 2022)

3.2.2 CRA Per Category

TRANSPORTATION

Reliable access routes are essential for timely repair, maintenance, and operation of wastewater collection and conveyance infrastructure. Climate change stressors such as increased frequency of extreme precipitation events, landslides, and wildfire-related road closures can severely limit access during emergencies.

- The Noyo River Bridge is the single means for automobiles to cross the Noyo Basin and River. Erosion, landslides, and other acute or chronic conditions could result in premature bridge failure.
- Bridge closure can prevent access to Water System assets for repairs or maintenance.
- The assets most at risk are those south of Noyo River; resources, staff, and equipment are primarily located on the north side.

3.2.3 Energy and Electrical

Energy and Electrical systems are critical to the continuous operation of Fort Bragg's wastewater collection and treatment processes. Reliable power ensures functionality of pump stations, disinfection systems, and monitoring equipment. Any disruption to these systems can result in significant service interruptions and public health risks. Identified at risk:

- Single Point of Dependency: Fort Bragg relies on one electrical substation to power all community assets, including the South Harbor Drive pump station and the Water Treatment Plant's on-site sodium hypochlorite generation (OSHG) system, which requires continuous electricity for disinfection.
- Substation Risk: Based on current information, the substation itself is not considered at risk.
- Transmission Line Vulnerability: Transmission lines feeding the substation are highly vulnerable to wildfire because they are primarily wooden and traverse forested corridors. Damage to these lines could result in a complete loss of power for all water system operations.
- Distribution Line Risk: While distribution lines were not assessed in this study, there is an elevated risk of outages between the substation, pump station, and treatment facility.

3.2.4 Telecommunications

SCADA systems, remote sensors, and automated controls require stable telecommunication connectivity for real-time monitoring and operational decision-making. Wildfires and severe storms can disrupt communication networks, compromising system reliability. No dedicated telecommunication assets are currently associated with the Water System infrastructure. However, if remote system management is implemented in the future, reliance on telecommunications will increase.

- While telecom assets themselves are not considered at risk, their dependence on the electrical grid—which may be vulnerable to climate-related disruptions such as wildfires or extreme weather—introduces an indirect risk that should be evaluated.

3.2.5 Critical Infrastructure

Emergency operations centers, fire protection systems, and health facilities must be prioritized for water service continuity. Wildfire poses a major threat to these facilities, increasing demand for water during fire suppression and recovery efforts. For this study, critical infrastructure includes support emergency infrastructure and schools:

- Fire station: There are three fire stations. The two facilities north of Noyo River are not at risk, as informed by our current available information. The facility south of Noyo River (Fort Bragg Fire Station 2) is at risk of wildfire. Because the facility is at the furthest limits of the Water System the water pressure may be low. Additionally, the water main does not appear to be looped, thus reducing capacity for fire protection.
- Hospital: There is one hospital serving Fort Bragg. This facility is not at risk, as informed by our current available information.

- Schools: There are six schools served by the Water System – five north of Noyo River, and one south. These facilities are not at risk, as informed by our current available information.

3.2.6 Impacted Communities

The CalEnviroScreen was used as a proxy to assess socio-economic vulnerability in Fort Bragg. It shows the city has a higher vulnerability score (>50–60) compared to surrounding areas (0–10), with slightly elevated social vulnerability east of Main Street and south of Oak Street. Key Vulnerability:

- Higher CalEnviroScreen scores indicate Fort Bragg is more susceptible to environmental and socio-economic stressors than neighboring regions.
- Variability in adaptive capacity among low-income and disadvantaged communities increases risk during climate-related events (e.g., droughts, heat waves, wildfire evacuations).

Refined data sources will be needed to better identify and prioritize Environmental Justice (EJ) communities for targeted resilience strategies.

3.2.7 Natural Systems

Fort Bragg's comprehensive water system and hydrology rely on three primary surface sources: Waterfall Gulch (tributary to Hare Creek), the Noyo River, and the Summers Lane Reservoir. While the collection system operates somewhat independently, its failure could significantly impact Fort Bragg's water distribution supply. Key Vulnerabilities:

- Collection system failure can disrupt natural hydrology, increase erosion, damage marine, and aquatic ecosystems; all of which are critical for long-term resilience.
- Collection system failure could also lead to contamination of surface water sources (e.g., Noyo River, Waterfall Gulch, Summers Lane Reservoir). The City maintains a Sewer System Management Plan (SSMP) and an SSO Emergency Response Plan to mitigate this risk through proactive maintenance, monitoring, containment, and rapid response.
- Increasing variability of drought and extreme precipitation events threatens substrate and bank integrity.
- Sea-level rise and salinity intrusion currently pose minimal risk.

3.2.8 Key Findings

Table 2. Interdependency CRA, highlights critical vulnerabilities across transportation, energy, water, telecommunications, and community systems. Fort Bragg's reliance on single points of failure — such as the Noyo River Bridge and electrical substation—creates significant risk during extreme events. Climate stressors like flooding, wildfire, and drought threaten infrastructure integrity, access routes, and water reliability. Socio-economic vulnerability amplifies these risks, underscoring the need for targeted resilience strategies and integrated planning to maintain service continuity and protect public health.

Table 2 - Interdependency CRA – Summary Table

Category	Key Risks	Impacts
Transportation	Noyo River Bridge failure; landslides; wildfire closures	Loss of access for repairs; isolation of assets south of river
Energy & Electrical	Single substation dependency; wildfire risk to transmission lines	Complete power loss halts pumping and disinfection
Water/Wastewater	Bluff erosion; drought; saltwater intrusion	Wastewater plant damage; reduced raw water availability
Telecommunications	Wildfire/storm disruptions; indirect grid dependency	Compromised remote monitoring and control
Critical Facilities	Fire Station 2 at wildfire risk; low water pressure	Reduced fire suppression and emergency response
Communities	High socio-economic vulnerability; low adaptive capacity	Greater hardship during climate events
Natural Systems	Drought variability; extreme precipitation; erosion	Reduced water supply resilience; watershed degradation

It is important to note that this interdependency risk assessment was conducted at a qualitative, high-level scale and does not represent a detailed quantitative analysis.

3.3 Wastewater Collection System CRA

This Climate Resilience Assessment (CRA) for the specific assets of the Collection System evaluates their vulnerability under existing climate risks and projected scenarios outlined in Section 2. The goal is to identify potential weaknesses that will inform resilience strategies for enhancing system resilience.

3.3.1 Overview

The Climate Risk Assessment (CRA) evaluates the risk for each asset group within the wastewater collection system, using the same methodology applied in the interdependency analysis but tailored to key assets in this system. The assessment incorporates sensitivity and adaptive capacity specific to each asset.

Assets included in the CRA are:

- Sanitary sewer mains.
- Manholes and junction boxes.
- Outfalls.
- Sanitary pump stations.
- SCADA systems.

The wastewater treatment plant is outside the scope of this project; however, a high-level risk assessment—limited to its parcel boundaries—has been conducted due to its critical role in overall system operations.

The following wastewater collection system assets were not included in this initial high-level assessment:

- Service laterals.
- Bends and fittings.
- Water quality sensors.
- Illegal stormwater connections.

Although these assets may still be vulnerable to identified climate hazards, their associated risk is assumed to be lower than that of the assets included in the CRA.

Figure 25 identifies key assets included in the collection system risk assessment.

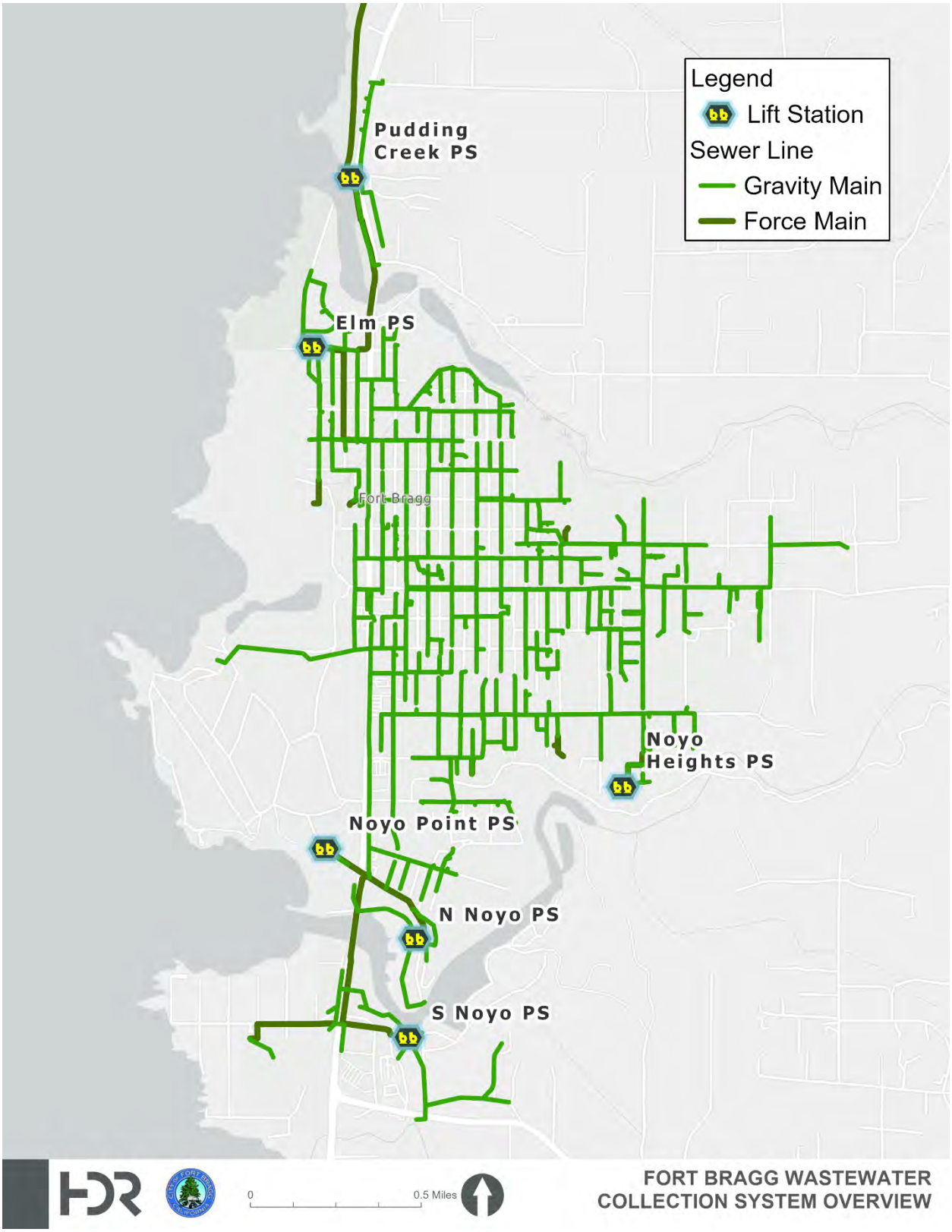


Figure 25 – Wastewater Collection Assets Map
(Source: HDR GIS based on Fort Bragg database)

3.3.2 CRA per Assets

The Risk and Vulnerability Assessment was conducted for assets within the geographic boundaries shown inwhile Figure 26 illustrates exposure between wastewater collection system assets and flooding/SLR. Figure 27 shows the relationship between wastewater collection system assets and coastal erosion.

Figure 26 – Wastewater Collection Assets Map and Flooding Risk
(Source: HDR GIS based on Fort Bragg database; NOAA 2023; FEMA 2022)

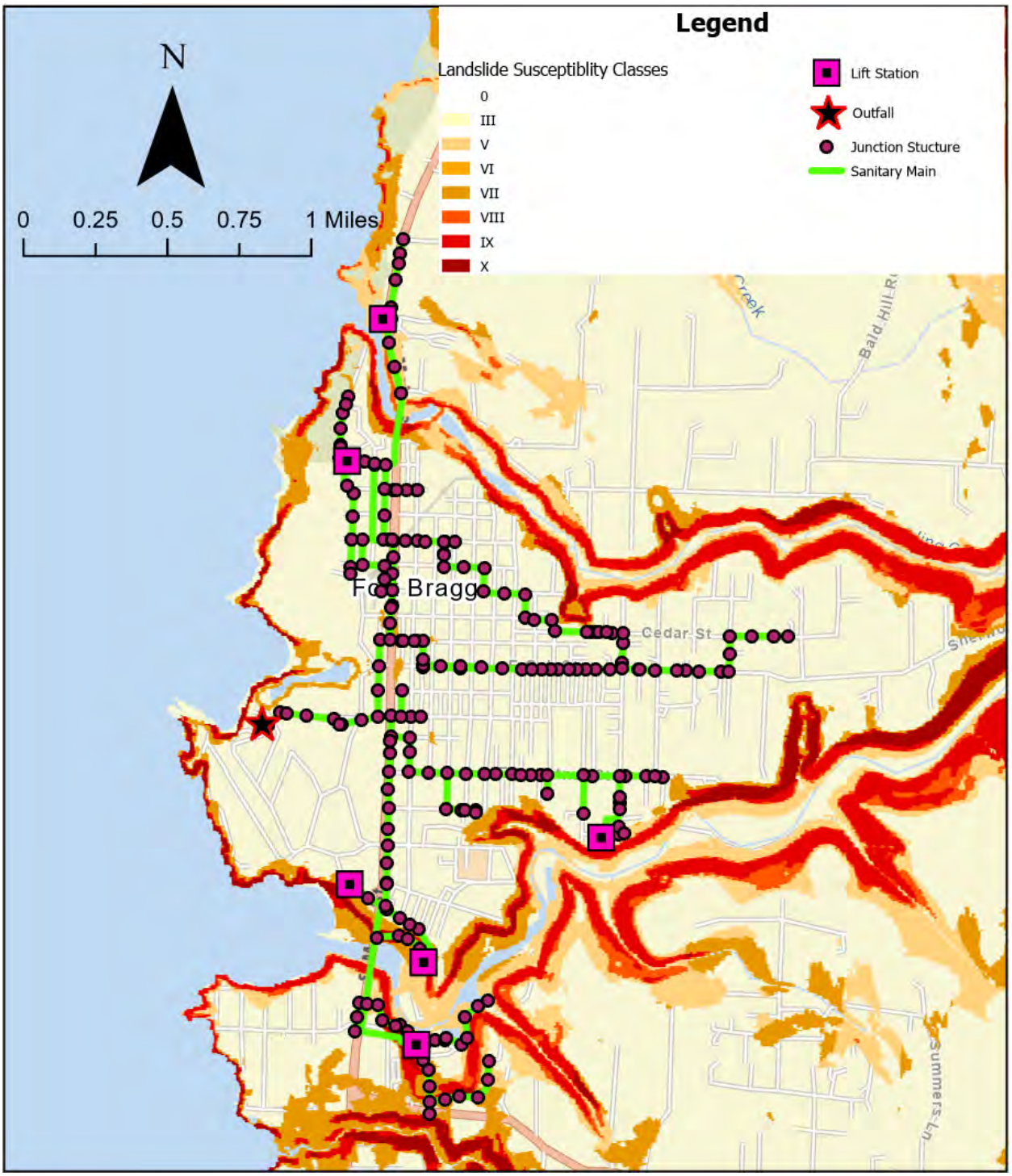


Figure 27 – Wastewater Collection Assets Map and Erosion and Landslide Risk
(Source: HDR GIS based of Fort Bragg database; CA Department of Conservation 2011; CoSMoS 2022)

Figure 28 illustrates the relationship between Wastewater Collection System assets and wildfires.

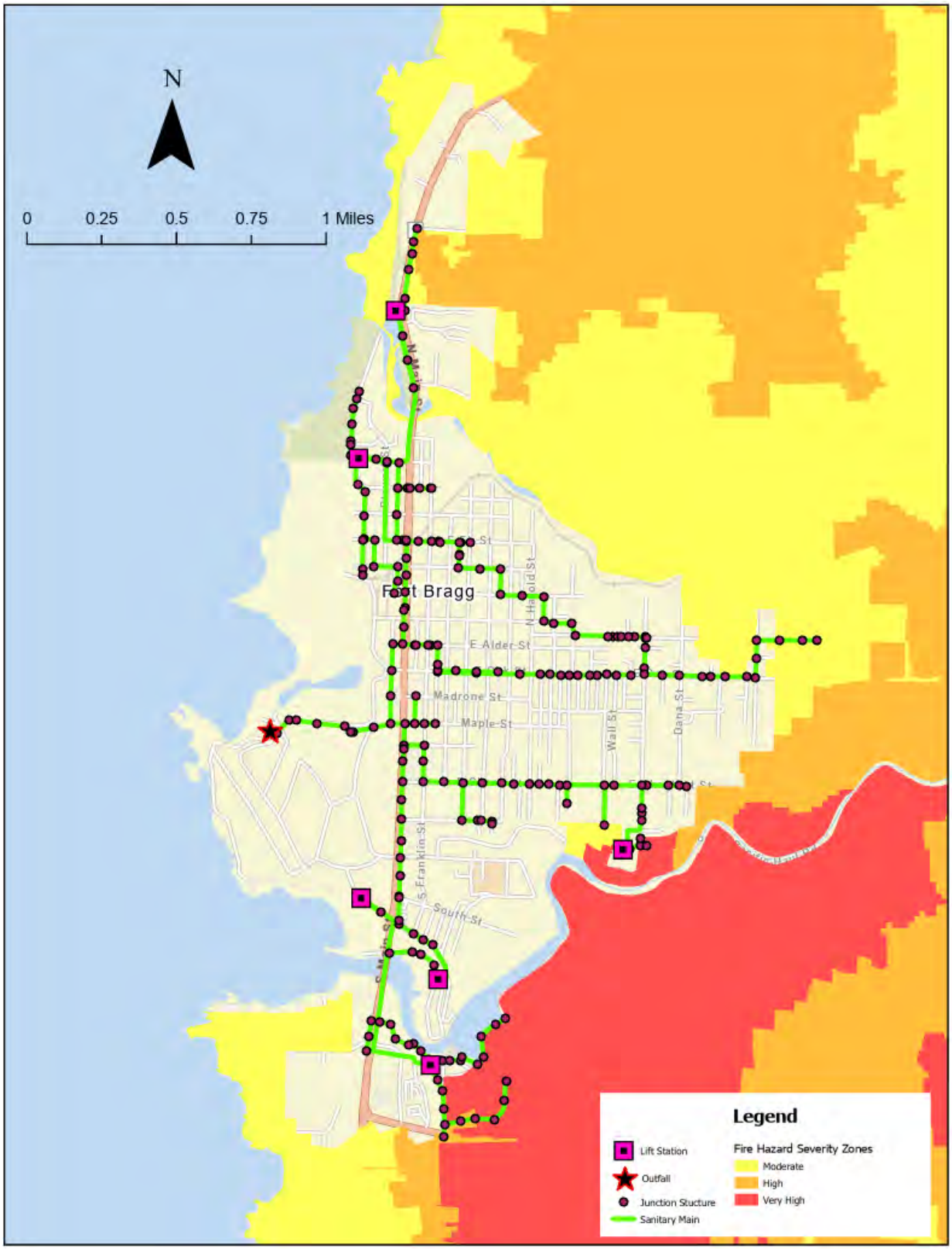


Figure 28 – Wastewater Collection Assets Map and Wildfire Risk
(Source: HDR GIS based on Fort Bragg database; CA Department of Forestry 2022)

SANITARY SEWER MAINS

Wastewater collection mains include gravity-fed lines and low-pressure lines pumped from lift stations near the Noyo River and Pudding Creek. Sanitary mains adjacent to the Noyo River are vulnerable to bank erosion and landslides. Exposed pipe can be compromised and cause effluent discharge into the Noyo River and contaminate groundwater. Pipes in the lower-lying areas—namely the valleys of the Noyo River and Pudding Creek—are vulnerable to flotation and premature corrosion as sea levels rise, raising groundwater levels.

Vulnerability identified in two specific locations:

- Noyo River: One force main cross under the Noyo River. While assumed properly encased and not directly vulnerable to sea-level rise or erosion, flooding can generate substantial inflow, overwhelming lift stations and causing pressure surges. This line is one of the lowest points in the system, increasing rupture risk during surge events.
- Pudding Creek: Another force main crosses under Pudding Creek with similar conditions and risks to the Noyo River crossing.

Assessment of Main Risks are:

- Bank Erosion & Landslides.
  - Adjacent mains susceptible to exposure and structural compromise.
  - Exposed pipe can discharge effluent into surface water and groundwater.
- Sea-Level Rise & Groundwater Rise:
  - Low-lying pipes are vulnerable to flotation and accelerated corrosion.
- Flooding & Hydraulic Surge:
  - Force mains assumed encased, direct erosion risk minimal.
  - Flood-induced inflow can overwhelm lift stations, causing pressure surges and water hammering.
  - Lowest hydraulic grade line points increase rupture risk during surge events.

MANHOLES AND JUNCTION BOXES

Distributed across the network within the service area, these allow for access and maintenance and combine flow from multiple lines. Several manholes and junction boxes are within the 100- and 500-year floodplain of the Noyo River. These are vulnerable to inflow during heavy precipitation events, which can surcharge the system and cause overflows or pipe ruptures.

- Flooding:
  - Located within mapped floodplains.
  - Susceptible to inflow during heavy precipitation, leading to system surcharge, overflow, and potential pipe failure.

OUTFALL

The only outfall within the scope of this study is the discharge outfall to the wastewater treatment plant. The sanitary sewer outfall to the wastewater treatment plant is not at risk as informed by best available information.

SANITARY LIFT STATIONS

Six lift stations are located within the collection system network:

- Pudding Creek Pump Station
- Elm Street Pump Station
- North Noyo Pump Station
- Noyo Heights Pump Station
- Noyo Point Pump Station
- South Noyo Pump Station

The Noyo Heights pump station is moderately at risk of wildfire. The South & North Noyo pump stations and the Pudding Creek pump stations are just outside the mapped Sea-Level Rise (SLR) + Mean Higher-High Water Mark. No layer could be identified that accounted for SLR + 100-year flood; however, it is likely these two lift stations would fall within that compounded hazard zone. Lastly, all lift stations are at risk of power failure during an outage (see Interdependency section for associated electrical system hazards).

Vulnerability in Specific Locations:

- Noyo Heights pump station: Moderate wildfire exposure.
- South & North Noyo pump stations, and Pudding Creek pump station: Just outside SLR + Mean Higher-High Water Mark; likely within SLR + 100-year flood hazard zone.
- All Lift Stations: Vulnerable to power failure during outages.

Assessment of Main Risks are:

- Wildfire.
    - Noyo Heights pump station exhibits moderate exposure.
- Sea-Level Rise + Flooding.
    - Two stations are likely within compounded hazard zone (SLR + 100-year flood).
- Power Failure.
    - All stations are at risk during outages.

SCADA SYSTEMS

Intelligent monitoring and control systems (SCADA) are connected to all six lift stations. These systems require a continuous electricity supply for proper operation. SCADA is typically housed inside lift stations, making it susceptible to hazards affecting those stations.

Vulnerability in Specific Locations:

- All SCADA Systems: Dependent on uninterrupted electricity; power outages disrupt monitoring and control.
- Three Lift Stations with Hazard Exposure: SCADA components within stations exposed to flooding or wildfire can be damaged or impaired.

Assessment of Main Risks:

- Power Outage
    - SCADA requires continuous electricity; outages disrupt monitoring and control functions.
- Flooding & Wildfire
    - SCADA is housed within lift stations; exposure can damage components and impair functionality.

3.3.3 CRA Operations and Maintenance

Although detailed analysis of CRA operations and maintenance was outside the primary scope of this high-level assessment, it is important to consider risks inherent to the current emergency response plan and incorporate human factors related to staff safety during potential climate-driven events.

EMERGENCY RESPONSE

The current emergency response framework is strong, with at least one generator per pump station and additional units for redundancy. However, all generators are stored at the wastewater treatment plant (WWTP), which is in a flood-prone area.

- **Risk:** During a major flood event, access to backup power could be compromised, reducing system resilience.

STAFF SAFETY

Personnel face risks related to communication and mobility during extreme events. Limited real-time communication systems may fail to prevent staff from traveling under hazardous conditions such as flooding, landslides, erosion, or wildfire.

- **Risk:** Increased exposure to physical danger and operational delays.

3.3.4 Key Findings

The vulnerability and risk assessment identifies which key infrastructure elements are most at risk of being impacted by climate change events, consequently placing the wastewater collection system at risk.

Table 3 synthesizes the key findings of this section by summarizing asset vulnerability across categories. Vulnerability is assessed based on exposure to climate hazards, sensitivity to stressors

such as flooding or landslides, and adaptive capacity, including system redundancy. The analysis indicates that lift stations are the most vulnerable assets, while sanitary sewer lines also exhibit high vulnerability.

Vulnerability ranges from low to critical, with assets shifting along this scale based on their combined exposure, sensitivity, and adaptive capacity. “Low” indicates minimal expected impact and strong coping capacity; “Medium” reflects moderate sensitivity with impacts that are manageable; while “High” to “Critical” signals limited resilience and the potential for severe system disruption.

Table 3 - Vulnerability Per Asset Type

Ranking:
Critical
High
Medium
Low

	Severe Drought	Localized Flooding	Extreme Heat	Sea Level Rise	Wildfire	Landslide	Strong Winds	Erosion	Lightning	Risk
	Likelihood + Consequence									
Collection System RVA										
1. Conveyance Infrastructure										
Sanitary Lines										C
Manholes and junction boxes										H
Outfalls										L
2. Pumping and Treatment										
Lift stations										H
3. Monitoring and Control										
SCADA systems										M

Table 4 shows the recommended prioritization of asset types, informed by vulnerability and risk determined by the likelihood and consequences of an asset type failing. Likelihood is based on climate scenarios, while consequences are assessed through expert judgment for this high-level evaluation. Prioritization is determined by the higher of the two factors—risk or vulnerability. Key findings include:

- **Sanitary lines** should be a priority for resilience improvements primarily because of risk: flooding is highly probable under climate scenarios, and consequences could be severe for critical facilities and underserved communities.

- **Lift stations** are also critical, mainly due to their high vulnerability—exposure to flooding and lack of adaptive capacity—and the cascading impact their failure would have on the entire collection system.

As outlined in Section 3.1 (Approach), vulnerability is characterized as the combined effect of an asset's exposure, sensitivity, and adaptive capacity. Risk builds on this by evaluating both the consequences of asset failure and the likelihood that such failure will occur. The prioritization process then integrates all vulnerability and risk findings, providing a clear basis for identifying which assets or infrastructure elements should be considered priorities for further attention or action.

Table 4 - Prioritization Per Asset Type

	Vulnerability	Risk	Prioritization*
Collection System RVA			
1. Conveyance Infrastructure			
Sanitary Lines	H	C	Critical
Manholes and junction boxes	M	H	High
Outfalls	L	L	Low
2. Pumping and Treatment			
Lift stations	C	H	Critical
3. Monitoring and Control			
SCADA systems	M	M	Moderate

** Prioritization is determined as the higher of the two factors, Risk and Vulnerability*

CHAPTER 4.0 RECOMMENDATIONS

This section focuses on strategies to strengthen the wastewater collection system, informed by a Climate Risk Assessment (CRA) and supported by regional measures where relevant.

4.1 Regional Recommendations

The table below summarizes key hazards, associated risks, and recommended resilience strategies for infrastructure systems that indirectly support the operations and functioning of the wastewater collection system, as well as critical equipment that relies on it. These strategies aim to reduce single points of failure, enhance redundancy, and strengthen adaptive capacity across interconnected systems. By addressing vulnerabilities holistically—rather than in isolation, Fort Bragg can maintain service continuity, safeguard critical assets, and protect community well-being during extreme events.

Some strategies may involve collaboration with other agencies or entities to ensure regional benefits and shared resilience outcomes.

Table 5 - Resilience Strategies for Interdependencies

Category	Hazards	Risk	Recommendations
Transportation		Noyo River Bridge failure; landslides; wildfire closures	Redundant access routes; slope stabilization & vegetation management; emergency transportation plan
Energy & Electrical		Single substation dependency; wildfire risk to transmission lines	Grid hardening; distributed energy resources (microgrids, backup generators); fuel & energy storage
Water/Wastewater		Bluff erosion; drought; saltwater intrusion	Source diversification; erosion control; drought contingency planning
Telecommunications		Wildfire/storm disruptions; indirect grid dependency	Independent power supply for telecom nodes; redundant communication channels; network hardening
Critical Facilities		Fire Station 2 at wildfire risk; low water pressure	Facility relocation or hardening; dedicated water storage; integrated emergency response
Communities		High socio-economic vulnerability; low adaptive capacity	Equity-focused planning; community education & engagement; financial assistance programs
Natural Systems		Drought variability; extreme precipitation; erosion	Watershed restoration; green infrastructure; adaptive water management

4.2 Wastewater Collection System Recommendations

The following tables provide for high-level strategies developed for critical assets within the wastewater collection system, prioritized by risk associated with specific hazards and exposures. These strategies were derived from a technical climate resilience assessment focused primarily on infrastructure vulnerabilities.

Table 6 - Resilience Strategies for Sanitary Sewer Lines

Hazard	Risk	Sanitary Sewer Lines
Severe Drought	Moderate	
Localized Flooding	High	Prevent illegal stormwater interconnects. Ensure pressure relief for lines crossing under Noho River and Pudding Creek.
Extreme Heat		
Sea Level Rise	Critical	Line or replace sewer mains exposed to saline groundwater as sea levels rise.
		Pipe Anchoring & Corrosion Protection: Install anti-flotation devices and apply advanced coatings or cathodic protection in low-lying areas.
		Surge Mitigation: Incorporate surge relief valves and pressure monitoring at critical low points.
Wildfire		
Landslide	Critical	Harden steep slopes with engineered stabilization measures.
Strong Winds		
Erosion	Moderate	
Lightning		

Table 7 - Resilience Strategies for Manholes and Junction Boxes

Hazard	Risk	Manholes and Junction boxes
Severe Drought	Low	
Localized Flooding	High	Prevent illegal stormwater interconnects. Ensure pressure relief for lines crossing under Noho River and Pudding Creek.
		Floodproofing: Elevate or seal manhole covers; install watertight gaskets to reduce inflow.
		Inflow/Infiltration Control: Deploy check valves and improve drainage grading around structures.
Extreme Heat	Low	
Sea Level Rise	High	Line or replace sewer mains exposed to saline groundwater as sea levels rise.
Wildfire		
Landslide	High	Harden steep slopes with engineered stabilization measures.
Strong Winds		
Erosion	Moderate	
Lightning		

Table 8 - Resilience Strategies for Lift Stations

Hazard	Risk	Lift Stations
Severe Drought	Moderate	
Localized Flooding	High	Have back-up generators located nearby, but not on site. Seal the structure's openings. Stock pile sand bags for rapid deployment
Extreme Heat	Low	
Sea Level Rise	Critical	Have back-up generators(generators, battery storage) located nearby, but not on site, and automatic transfer switches.
		Flood Adaptation: Elevate electrical components and SCADA panels; consider submersible pumps for stations in hazard zones.
Wildfire	Low	
Landslide	Moderate	
Strong Winds	Low	
Erosion	Low	
Lightning	Moderate	

Table 9 - Resilience Strategies for SCADA

Hazard	Risk	SCADA
Severe Drought		
Localized Flooding	Moderate	
Extreme Heat	Moderate	
Sea Level Rise	High	Elevate equipment in the lift station. Have back up power source.
		Redundant Communication & Power: Integrate backup power and remote monitoring capability.
Wildfire	Moderate	
Landslide		
Strong Winds	Low	
Erosion		
Lightning	Moderate	

4.3 Next Steps/Further Studies

Although operations and maintenance were not included in this technical assessment, they are recognized as critical for ensuring continuity of services during and after disruptive events. Therefore, complementary operational strategies should be identified to strengthen emergency response and staff safety, bridging the gap between physical resilience and organizational preparedness. Below are examples that could be developed as part an integrated water system master plan:

- Enhancing protocols for remote coordination and situational awareness.
- Investing in robust communication systems and staff training.

Further analysis may be required to refine and better operationalize strategies. Below are examples of detailed analyses that could be conducted as part of an integrated water system master plan:

- Developing improved flooding scenarios.
- Evaluating land subsidence, particularly as it relates to decreasing soil moisture caused by droughts.
- Conducting wildfire risk assessments for the Water Treatment Plant and Fire Station #2
- Forecasting salinity levels at intake points along the Noyo River, Waterfall Gulch, and Newman Gulch.

While the scope of this project focuses on the Wastewater Collection System, it is important to emphasize that this system is part of an interconnected and interdependent network of infrastructure, economics, community, ecology, and hydrology, which must perform and adapt to sustainably serve Fort Bragg. Some systems are more critical than others, and their interdependence must be considered in future planning.

CHAPTER 5.0 REFERENCES

California Air Resources Board (CARB), 2023. Wildfires and Climate Change. Website: https://ww2.arb.ca.gov/wildfires-climate-change

Jensen, M.N., 2016. How Climate Change Will Affect Western Groundwater. University of Arizona. Website: https://news.arizona.edu/story/how-climate-change-will-affect-westerngroundwater#:~:text=Groundwater%20already%20is%20being%20withdrawn,those%20aquifers%2C%20the%20researchers%20report.

IPCC, 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge Univ

University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

Cal-Adapt database. (as of 09-2023). https://cal-adapt.org/about/

CalEnviroScreen, 4.0 Tool (September 2023) Maps & Data - CalEnviroScreen - OEHHA - CA.gov

Critical Infrastructure at Risk: Sea Level Rise Planning Guidance for California's Coastal Zone. California Coastal Commission. (2021)https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/infrastructure/

California Adopts Level Rise Guidance. California Ocean Protection Council (OPC). (2018). https://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

U.S. Climate Resilience Toolkit Climate Explorer (CRTCE), 2023. Observed and Future Climate Projections for Fort Bragg, CA. Website: Fort Bragg | Climate Resilience Toolkit Climate Explorer. National Environmental Modeling and Analysis Center (NEMAC), University of North Carolina Asheville.

National Centers for Environmental Information (NCEI), 2023. Daily Observational Data, Fort Bragg 5 N, CA US. Website: NCEI Daily Observations. NCEI GIS Team, Asheville, NC.

Drought Resilience Plan, Mendocino County. May 2025 (https://www.mendocinocounty.gov/departments/water-agency/drought-water-conservation/drought-resilience-plan)

Multi-Jurisdictional Hazard Mitigation Plan; Mendocino County. Volume 1 and Volume 2. 2021. (https://mendoready.org/oes-documents/)

i

Appendix I. Desktop Geotechnical Assessment

Geotechnical Evaluation of City of Fort Bragg Seismic Safety Elements Related to Water Distribution Facilities

Fort Bragg Distribution System Master Plan

City of Fort Bragg

April 1, 2025

Table of Contents

1 Executive Summary 1
1.1 Scope 1
1.2 Topography and Geology 1
1.3 Emergency Access 2
1.4 Risks to Water Supply and Distribution 2
1.5 Geologic Hazards 3
1.6 Other Geologic Related Concerns 4
1.7 Non-Geologic Hazards 5
1.8 Areas of Concern for Rehabilitation of Water Distribution Facilities 6
1.9 Recommended Future Actions 6
2 Introduction 8
3 Approach 8
4 Background 9
5 Topography and Geology 11
5.1 Mapped Units 12
6 Emergency Access 17
7 Water Supply and Distribution 17
8 Geotechnical Conditions Assessments 18
8.1 Geologic Hazards 20
8.2 Other Geologic Related Concerns 26
9 Areas of Concern for Rehabilitation of Water Distribution Facilities 30
9.1 Densification and Liquefaction 31
9.2 Corrosivity 31
9.3 Groundwater 32
9.4 Seismic Response 32
9.5 Bluff Erosion 32
10 Recommended Future Actions 32
11 Limitations 34
12 References 34
Attachment A – Summary of Geotechnical Conditions Depicted by City-Provided Geotechnical Reports 36
Attachment B – NCRS Soil Survey Map and Select Data 43

List of Figures

Figure 1 – City of Fort Bragg Water Distribution System Schematic (no scale) 10
Figure 2 – Area Topography 11
Figure 3 – Excerpt Geologic Mapping by Durham, 1979 14
Figure 4 and Figure 5 – Excerpt from Noyo Watershed Mapping Relative Landslide Potential with Geology and Geomorphic Features (Manson et Al. 2001) 15
Figure 6 – Postulates Path of Historical Drained Beneath the City (No Scale) 16
Figure 7 – Location Map – Reference Geotechnical Investigations 19
Figure 8 – Quaternary Fault Map (Source USGS.maps.arcgis.com/apps) 21
Figure 9 – Tsunami Hazard Area - Shaded (source Cal OES MyHazard) 22
Figure 10 - Relative Slope Instability in the Fort Bragg Area (After CGS Map 58, 2011) 30

List of Tables

Table 1 – Geotechnical Reference Provided by City of Fort Bragg by Area 23

Version History

Version	Date	Comments/Description
rev0	12/12/2023	Draft Submitted to City of Fort Bagg
rev1	04/01/2025	Revised Draft – City of Fort Bragg review comments addressed

1 Executive Summary

1.1 Scope

HDR has been retained by the City of Fort Bragg (City) to develop a water distribution system master plan. The purpose of this memorandum is to:

- Provide input on the geotechnical section of the Seismic Safety Components of the General Plan as they relate to the water distribution system,
- Develop a high-level summary description of geotechnical and geologic conditions within the City's area of influence, and

Provide discussion regarding critical elements of the analysis of six geotechnical studies for City and private development projects, provided from the City representing subsurface conditions in different areas across the City, and geotechnical data available online related to the former Georgia-Pacific Lumber Company site closure. The study did not include an exhaustive investigation of applicable geotechnical reports that may be contained in City records and does not provide a site-specific seismic hazard analysis. This Executive Summary should not be referenced alone as it is a summary and does not contain specific discussions and details provided in the body of the report.

The data and discussion presented in this memorandum are organized as follows:

- Topography and Geology
- Emergency Access
- Water Supply and Distribution System
- Geotechnical Condition Assessment
- Geologic and Non-Geologic Hazards
- Areas of Concern for Rehabilitation of Water Distribution Facilities
- Limitations

HDR's review of the subsurface conditions as described in the provided reports is briefly summarized in Attachment A. Although some portions of this memorandum may include discussions on climate change, a separate report is being prepared by HDR addressing climate change implications.

Although the memorandum was prepared specifically as part of the water distribution master planning effort, it is applicable to other City agencies responsible for infrastructure such as the stormwater and sewer system.

1.2 Topography and Geology

The City is located on an uplifted terrace along the California Pacific North Coast. The uplifted terrace has created a coastal bluff that is approximately 50 feet tall at Soldier Point near the existing City's Wastewater Treatment Plant and 85 feet tall at Pomo Bluffs State Park. Site grades slope gently upward towards the east to approximately El. 400 feet where the terrace meets the western edge of the Coastal Range Mountains. A high-level discussion of the City topography and mapped

geology is provided in the memorandum based on review of available published information. Review of other geotechnical studies contained in the City files could be a benefit to better understand subsurface conditions that could impact the water distribution (or other) system. Former creek channels may be present beneath the City that became obscured as the terraces were uplifted.

1.3 Emergency Access

Subsurface conditions and the response to strong seismic shaking or a large storm event can impact City features such as vehicle access. The main vehicle access (and emergency evacuation/access routes) into and out of the City is Highway 1, which includes bridges that cross Hare Creek, Noyo River, and Pudding Creek (from south to north). If these bridges were damaged during a seismic event or a large storm event, such as an intense storm washing out the bridge approaches or a tsunami damaging the bridge foundations, access would be limited. Highway 1 provides the main emergency access in and out of the City over bridges maintained by California Department of Transportation (Caltrans). Caltrans reports that the Noyo and Pudding Creek bridges have undergone seismic structure upgrades and plans to perform Hare Creek Bridge seismic structure upgrades in the future. In addition, the 2020 Medocino County Hazard Mitigation (MCHMP) plan identifies slope failure and wildfire risk as having highly likely and critical impact on the city of Fort Bragg while earthquake would be an extreme risk though it is a less likely hazard (see figure 2-2, City of Fort Bragg Risk Assessment, MCHMP Vol 2 2020), both briefly discussed in subsequent sections of this report.

1.4 Risks to Water Supply and Distribution

The City water supply system, described in the memorandum, consists of water collection points, treatment facilities and storage structures, and distribution system interconnected by pipelines. The water main line system connects the storage system to the end user and these pipelines likely have additional structural connections to a network of smaller diameter pipes forming the distribution system. Each part of the system is subject to geologic hazards including strong seismic shaking, seismic-induced differential movement at connections, seismically induced ground settlement and, potentially, ground failure. Also, soil chemistry can cause corrosion to steel and concrete materials. Each needs to be evaluated based on site-specific conditions and in accordance with the appropriate design code.

Distribution piping itself can be at risk due to many geotechnical causes, such as:

- Corrosive soils that weaken the pipe itself
- Differential settlement or pipe lengthening due to land sliding, bluff retreat, soil densification, or liquefaction resulting in large magnitude settlements or lateral spreading, static settlement due to change of overburden or imposed loads, or hydro-compression due to changes in saturation
- Differential movement during earthquake, such as at service or distribution connections like large maintenance holes or bridge crossings

Also, the City fire hydrant system must be operational for small and large seismic events and wildfires.

1.5 Geologic Hazards

1.5.1 Seismicity

The City of Fort Bragg is in an area that is known for seismic activity; however, the City is not within a currently established State of California Earthquake Fault Zone for surface fault rupture hazards and there are no known active fault traces in the immediate project vicinity. The following active faults are located within 60 miles of the City

- North San Andreas Faults System – 6.5 miles west
- Maacama Fault Zone – 21 miles east
- Mendocino Fault Zone – 60 miles north

The Pacific Star Fault is a recently identified potentially active fault located northeast of the City as is the Pudding Creek Fault. They are reported as being connected to the San Andreas Fault but have not been located in the State of California Special Studies Zone. USGS estimates that there is a 64.92% chance of an earthquake with a magnitude greater than 5 to occur in the next 50 years.

1.5.2 Fault Offset, Strong Ground Motion, Liquefaction and Tsunami Impacts

The fault offset hazard in the City of Fort Bragg is very low. There are no Alquist Priolo Hazards Zones identified within or near the City (www.conservation.ca.gov). The City will be subject to strong ground shaking that could induce densification of loose to medium dense terrace deposits, and slope movement within the steeply incised river and creek channels and along the coastal bluff. Loose, saturated, cohesionless soils are susceptible to liquefaction, including sediments that have accumulated within and at the mouth of the coastal, river, and creek channels and potentially in eolian (windblown) derived terrace deposits that become saturated due to groundwater.

The State of California Office of Emergency Services online MyHazard maps (myhazards.caloes.ca.gov) does not identify Fort Bragg as having a mapped liquefaction zone; however, the risk of liquefaction is judged to be moderate in the terraces and high in the river and creek channels and could occur in the event of strong ground shaking.

Tsunamis would impact the coastal areas, the Noyo Harbor, and upstream areas of Noyo River, Pudding Creek, and Hare Creek. The Pacific Institute has prepared a graphic showing the effects of a 55-inch sea level rise and the effect combined with a tsunami. Sea level rise would raise river levels in Noyo River and Hare Creek to above the 100-year flood level. Sea level rise combined with a tsunami would impact all three river/creeks and cause saltwater intrusion to the existing raw water intake on the Noyo River. Recent high tides have also caused saltwater intrusion and impacted the raw water intake.

1.5.3 Non-seismic Hazards

Non-seismic hazards include presence of unstable soils on steep slopes, continued bluff retreat, and presence of weak and/or unstable soils.

- The presences and mitigation, if required, would be determined on a project-specific investigation/basis. It would be beneficial to document the past performance of the water distribution system (Geographical information System [GIS], mapping, and tabular format),

including areas of past pipe repairs/leak/breaks and areas of known surface (street pavement and hardscape) distress to identify areas that may be underlain by weaker soils.

A more detailed description of the regional geology and the near-surface geology and surface conditions is included in the body of this document. Of particular importance is that groundwater conditions documented in the reference reports represent conditions observed at the time of investigation and are generally poorly understood. Groundwater (at depth) and near-surface perched groundwater are two different groundwater occurrences and both have been reported. Additional groundwater investigations would be required to better understand the current temporal variations in groundwater at a specific site within the City's area of influence. The assumptions related to groundwater levels have a significant impact on the occurrence of liquefaction induced by strong ground shaking and the values reported in the different documents should not be relied on for future projects.

The Georgia-Pacific Site cleanup documentation provides detailed maps showing groundwater conditions west of Highway 1 in the central portion of the City Coastal Area. The City of Fort Bragg has recently began to track shallow groundwater condition for the stormwater and water projects in the city.

1.6 Other Geologic Related Concerns

1.6.1 Mineral Resources

The Fort Bragg General Plan does not identify any locally important mineral resource recovery sites or sites being utilized for Surface Mining and Reclamation Act (SMARA) activities.

1.6.2 Corrosion

Limited studies have identified that the terrace deposits are acidic and have cation exchange capacity, being more acidic closer to the ocean.

The terrace deposit soils should be considered corrosive to steel and slightly corrosive to concrete unless specific testing is performed or the performance of buried structures can be determined from visual inspection. A testing standard should be developed for all corrosion testing so that a "Zone" database can be developed by the City to aid in their management of the water system.

1.6.3 Erosion

Removal of vegetation and redirection of surface water could induce erosion on any area of the City. Care must be taken to restore disturbance to reduce the risk of developing areas of concentrated surface water flow that could induce erosion. Care must be taken to install trench dams along lengthy pipelines and in elevation transitions so that the pipeline trench does not act as collection, drawing and redirecting concentrated seepage to the trench outlet causing ground saturation and potential slope failure and erosion.

1.7 Non-Geologic Hazards

1.7.1 Flooding

Flooding hazard is typically determined for a 100-year flood level for insurance purposes using maps developed by the Federal Emergency Management Agency (FEMA). The FEMA updated flood maps for the Fort Bragg area are dated as being published in 2017 and show larger 100-year flood hazard than shown in the Coastal General Plan Map. The Inland Zone General Plan includes Map SF-3 Tsunami Inundation Map and Map SF-4 100-year Sea Level Rise Inundation Area, which is the Pacific Institute map previously referred to as an additional source document for this memorandum. The most recent FEMA Flood Mapping and the Pacific Institute mapping of sea level rise are recommended as references for assessing flooding impacts.

1.7.2 Fire

The City's fire hydrant system is critical infrastructure for public safety. Significant fires have occurred in Northern California in the last few years and the ability to protect the City from structure fires and wildfire is important. The fire hydrant system is also critical after a large seismic event.

In 2022, California Department of Forestry and Fire Protection (CALFIRE) published maps depicting Fire Hazard Severity Zones for Mendocino County as part of the Fire and Resource Assessment Program. The City is outside the jurisdiction of CALFIRE and the City itself is zoned as a local responsibility area (LRA). The Fire Hazard Zone Severity Viewer is no longer available online . The MCHMP does include earlier viersions of these maps that show the area south and east of the Noyo River zoned as Very High risk and the area north and east of the City as Moderate risk. High risk zones are located east of the City on the north side of the Noyo River and east of the north Coastal Area. The south Coastal Area is located in a Moderate risk zone west of Highway 1 and in the lower elevations east of Highway 1.

1.7.3 Extreme Weather Events

In February 2023, the United States Department of Agriculture USDA) declared Mendocino County a Disaster Area due to severe winter storms and flooding. The occurrence of heavy storms and storm events characterized as Atmospheric Rivers, defined by National Oceanic and Atmospheric Administration (NOAA) as long narrow regions in the atmosphere that transport most of the water vapor out of the tropics that have an equivalent flow at the mouth of the Mississippi River and exceptionally strong events can have 15 times that amount. The Pineapple Express is a strong atmospheric river bringing moisture from the tropics near Hawaii to the west coast. The rain events can induce slope instability and rapid slope movement and debris flows.

The ranking of deep-seated landslide susceptibility is presented on California Geological Survey (CGS) Sheet 58 that show the areas to the east and along the incised channel banks having the highest potential for slope instability and deep-seated sliding. The susceptibility of landslides impacting the City water supply and distribution system or evacuation routes directly or from debris flows should be evaluated on a case-by-case basis. It should be noted that climate change may increase the risk of slope instability.

1.7.4 Chemically Impacted Sites

A review of the DTSC GeoTracker website showed the locations of numerous identified chemically impacted sites that range from small underground storage tanks to large facility clean-up activity. Many of the sites are identified as having closed files, meaning that the sites have been remediated to meet cleanup goals set forward by regulatory agencies. It should be noted that there may be residual chemically impacted soils at these sites that did not require removal but, should they be excavated, may require special testing and handling to determine material reuse or disposal. The GeoTracker site and associated data should be checked as part future system upgrade or rehabilitation projects to be aware of potential impacted sites.

1.8 Areas of Concern for Rehabilitation of Water Distribution Facilities

The following geotechnical factors should be considered when addressing water distribution design or rehabilitation.

- Densification and Liquefaction
- Corrosivity
- Seismic Response
- Bluff Erosion

1.9 Recommended Future Actions

To better understand geologic risk to specific portions of the water distribution system, a more detailed understanding is needed at the location of critical components of the system. Specifically, the following should be determined:

- The peak ground acceleration based on current code requirements, typically expressed as the design earthquake return period. Depending on the age of the facility, the current design code may be different than what was used at the time the component was designed and constructed.
- The thickness of fill and/or terrace deposits at the site, the depth to bedrock and an understanding of the groundwater depth and seasonal fluctuation. Past geotechnical investigations associated with the original design of the component/facility, or a report prepared for an adjacent property combined with review of the as-built grading plans would typically provide data regarding the site soil stratigraphy and depth to bedrock. Understanding groundwater conditions below the site would likely require additional study, discussed below. This information is required as input into a seismic vulnerability assessment for understanding the potential for seismic densification or vertical or lateral deformation because of liquefaction, if potentially liquefiable soils are present at the specific site.
- Mapping of areas of slope instability along pipeline corridors and within 300 feet of a component or facility at a local scale will provide the input to assess the current hazards slope instability pose to the facility as well as allow comparison for changes in the risk, specifically after major storms/flood events or a large seismic event. Each specific area of concern should be mapped at a scale of 1 inch = 50 feet and fixed reference points set, such as rebar hubs setback (above) the area of instability in readily accessible areas that can be

used to easily identify changes visually and hand measurement. Each location will need to be assessed on a case-by-case basis to establish the limits of mapping and location and number of reference points. Use of fixed features such as a fence, fire hydrant, or street curb may not be sufficient as they can be modified or damaged over time.

The depth to bedrock could be evaluated by performing limited geophysical surveys (seismic refraction) that is a non-invasive and lower cost method of field investigation. The geophysical surveys, in combination with other geotechnical or environmental investigation reports that the City has, could provide the level of detail required without the expense of drilling soil borings. Understanding the depth of groundwater and fluctuation over time could require installation of a strategically placed monitoring well or wells to understand the source and direction of groundwater flow and the effects of rainwater and irrigation infiltration. An initial widely spaced grid of wells could be established and monitored semi-annually to quarterly to develop an understanding of groundwater behavior. The wells could be supplemented if an areas data seems erratic of if additional detail is desired.

Planning for such a study should be proceeded by a desktop study reviewing available data contained in City files and interviewing local civil/geotechnical and geological consultants familiar with area soil and geologic conditions that may bring specific knowledge from past experience within the City limits. All the groundwater, soil, and bedrock depth and slope instability data can then be collected in a geographic information system (GIS) and reviewed to determine where more detailed study would be warranted. The information would need to be reviewed and updated to provide a living document that can be used by all City departments for planning and risk assessment.

2 Introduction

HDR has been retained by the City of Fort Bragg (City) to develop a water distribution system master plan. The purpose of this evaluation is to:

- Provide input on the geotechnical section of the Seismic Safety Components of the general plan as it relates to the water distribution system,
- Develop a high-level summary description of geotechnical and geologic conditions within the City's area of influence, and
- Provide discussion regarding critical elements of the water supply system that should be considered as part of master planning and future distribution system maintenance/rehabilitation efforts.

This study is limited to review of the City's existing general plans for the Inland and Coastal Zones, review of available published geotechnical and geologic information, review of six geotechnical studies for City and private development projects provided from the City representing subsurface conditions in different areas across the City, and geotechnical related data available online related to the former Georgia-Pacific Lumber Company site closure. This is not an extensive review of all potentially available geotechnical reports or related documents that may be contained in the City's records or from local consultants, which is beyond the scope of this study. This evaluation also does not provide specific geotechnical hazards assessments for the specific components of the water distribution system. The scope of site-specific hazards assessments would need to be developed after a detailed review of each specific component which has not been performed for this evaluation.

3 Approach

The data and discussion presented in this evaluation are organized as follows:

- Topography and Geology
- Emergency Access
- Water Supply and Distribution System
- Geotechnical Conditions Assessment
  - Geologic and Non-Geologic Hazards
- Areas of Concern for Rehabilitation of Water Distribution Facilities
- Recommended Future Actions
- Limitations

HDR's review of the subsurface conditions as described in the provided reports is briefly summarized in Attachment A. Although some portions of this evaluation may include discussions on climate change, a separate report is being prepared by HDR addressing climate change implications.

4 Background

The City is located along the coast of Mendocino County. The City is approximately 2.92 square miles in size and includes five island areas (non-contiguous land) totaling 0.15 square miles in size and comprised of city-owned property that was annexed on April 7, 1997.

While Fort Bragg is a small community, it is the largest city on the coast between San Francisco and Eureka and is a popular tourist and recreational destination. Commercial land uses in the City are located along the California State Route 1 (Highway 1) and Franklin Street corridors. The Central Business District, located between Oak Street and Pine Street, is the historic, civic, and cultural core of the community. Industrial lands are located on the Georgia-Pacific Mill property located west of Highway 1 on North Franklin Street, immediately north of the Central Business District, and on Highway 1 north of Pudding Creek. Residential neighborhoods are located east of the commercial core and in the west Fort Bragg area.

For planning purposes, the City is divided into the Coastal Zone as described in Coastal Act Section 30150 (July 2008 Land Use Element Fort Bragg Coast General Plan) and the Inland Zone for areas within the City influence but outside of the Coastal Zone (bounded by the City limits on the north and east, and the coastal zone to the south [Walnut Street] and west [Highway 1]). These zones are shown on Map LU-1, Land Use Designations and LU-2 City Boundary and Sphere of Influence, both contained in the updated 2012 Inland General Plan. The Coastal zone includes a specific plan area in the Timber Resources Industrial Land Use Designation (former Georgia-Pacific Properties) between Walnut Street to the South and Elm Street to the North and Highway 1 on the east.

Figure 1 presents a graphic showing the existing City water distribution system that consists of a network of pipes within the central portion of the City, primarily in the Inland Zone with supply provided to the south of the Noyo River in the Pomo Bluffs area north of Hare Creek, and to the north across Pudding Creek to the Fort Bragg Airport area. The coastal area west of Highway 1 and the main part of the City was previously occupied by the now closed Georgia-Pacific Mill with limited connection to the water distribution system.

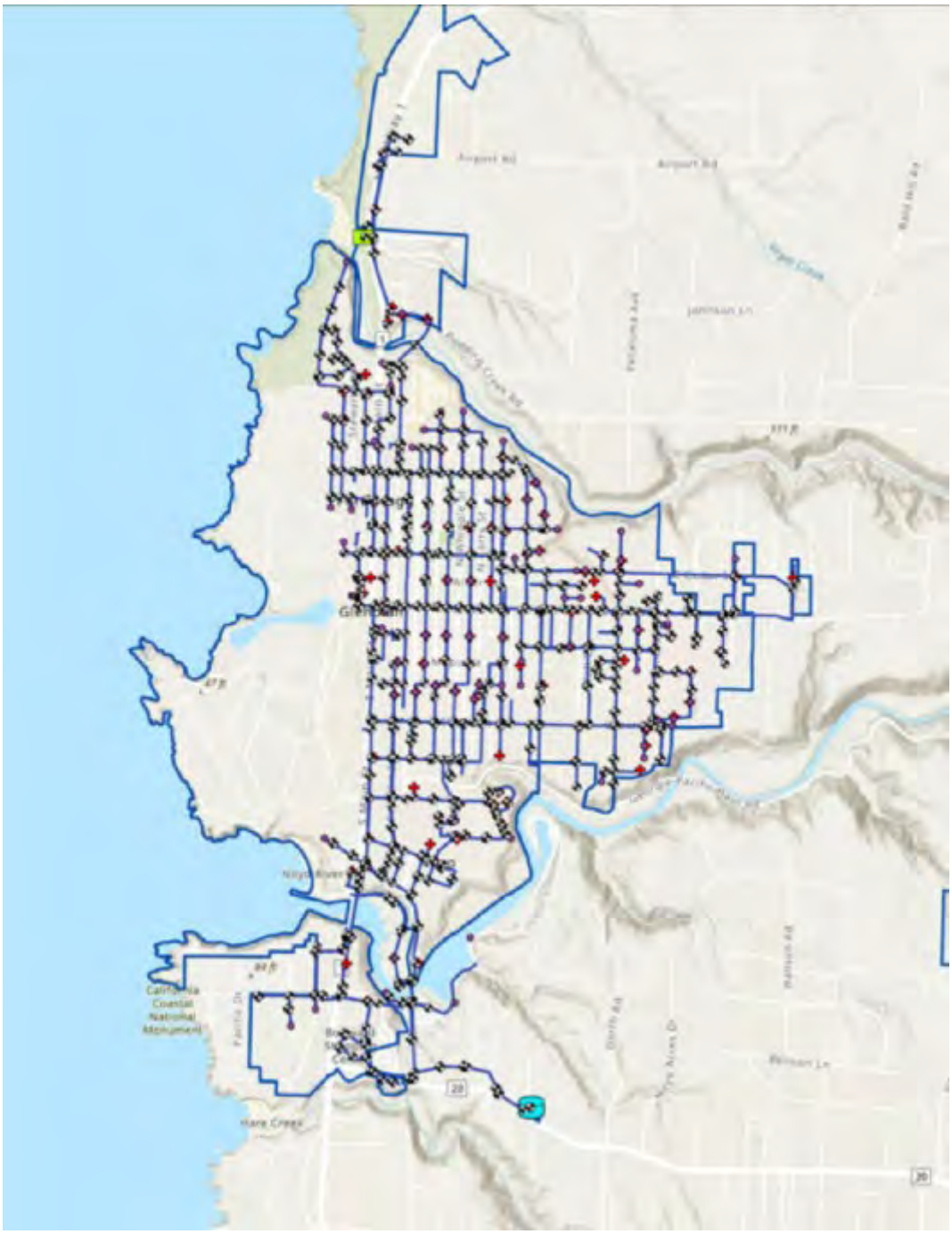


Figure 1 – City of Fort Bragg Water Distribution System Schematic (no scale)

5 Topography and Geology

The City is located on an uplifted terrace along the California Pacific North Coast. The uplifted terrace has created a coastal bluff that is approximately 50 feet tall at Soldier Point near the existing City's wastewater treatment plant and 85 feet tall at Pomo Bluffs State Park. Site grades slope gently upwards towards the east to approximately El. 400 feet where the terrace meets the western edge of the Coastal Range Mountains. A topographic terrain map of the region is provided below.

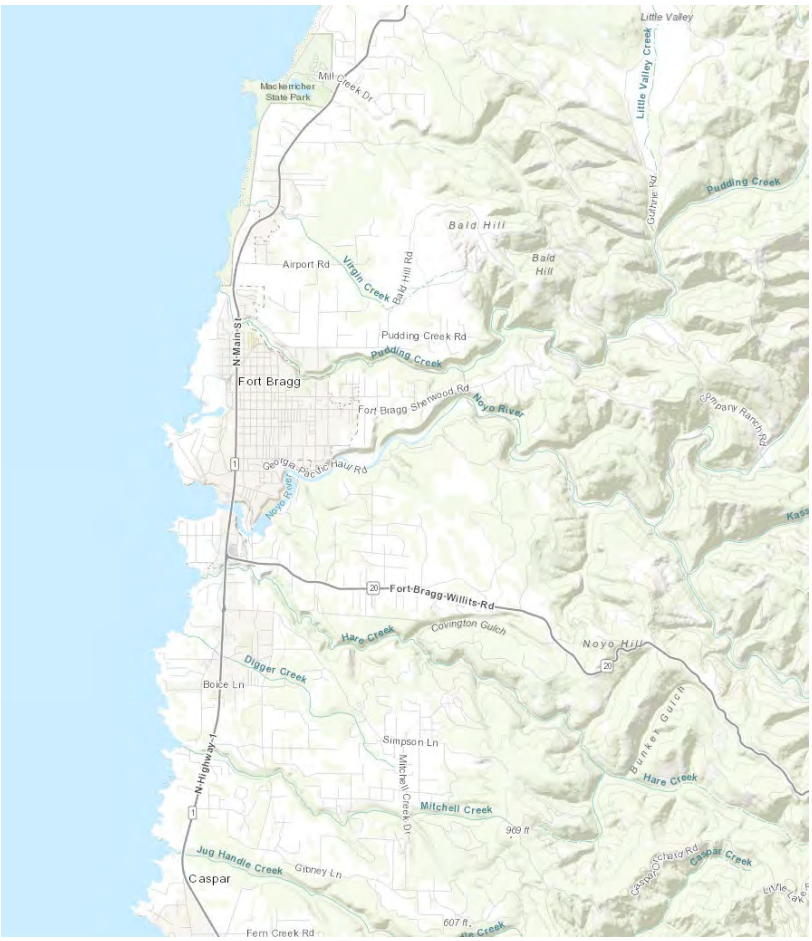


Figure 2 – Area Topography
Source: www.topozone.com

The elevations used in this study are relative to the 1929 National Geodetic Vertical Datum (NGVD 1929) which is sufficient for the general purposes of this discussion. Coastal Area elevations range on the east boundary from El. 78 feet (Main Street at Pine Street) to El 82 feet (Simpson Lane at Highway 1). Inland areas rise in elevation to about El. 200 feet (Marsben Lane at Sherwood Road). The terrace is incised by the Noyo River, Pudding Creek, and Hare Creek. Pudding Creek and the Noyo River have incised at least 160 feet into the terrace where the California Western Railroad once crossed these creeks and enters a now collapsed tunnel beneath Sherwood Road. United States Geologic Survey Benchmark at Noyo Harbor is listed as El. 11.73 feet. The mouth of Pudding Creek and Hare Creek are at or slightly above sea level where beaches have formed (El. 0 feet).

Noyo Harbor has been dredged to provide access to the Noyo Basin Marina. The most recent nautical charts should be reviewed to determine the depth of the dredged channel.

There is limited published geologic mapping of the City vicinity. The most detailed mapping was prepared as part of the Noyo River Watershed program in 2025 that includes preliminary mapping performed by Durham for the Department of Forestry in 1979. A portion of the Durham 1979 map and maps from the Noyo Watershed mapping are presented in Figure 3, Figure 4, and Figure 5. These figures are provided for illustrative purposes and are not presented to scale. The actual maps should be referenced for more specific information.

The primary units mapped by Durham are quaternary aged Terrace Deposits (Qtm) and tertiary aged Franciscan bedrock. These units are further differentiated and described by Manson as Pleistocene aged Marine Terrace Deposits Undifferentiated (Qmts) and tertiary - cretaceous aged Coastal Belt Franciscan (TKfs). Manson also maps an additional unit Older Dunes (Qods), briefly described as follows and shown in Figure 4.

5.1 Mapped Units

- Older Dunes (Qods) – Well-sorted, semi-consolidated, fine- to medium grained overlying various marine terrace deposits (Qtmts)
- Marine Terrace Deposits Undifferentiated (Qmts) Deposits generally consist of well sorted sand with minor gravel and have courser textures near major drainages, may include some dune sand.
- Coastal Belt Franciscan (TKfs) – Broken formation consisting of light colors, well-cemented to deeply weathered and sheared, clastic sedimentary rock (sandstone, conglomerate, shale).

Durham mapped a number of active landslides along the incised slopes of Pudding Creek, Hare Creek, and the Noyo River identified with the letter “A” and an arrow showing the direction of movement. Mapping by Mason et. al for the Noyo River (Figure 5) also includes shading depicting the relative risk of landslide in areas that were also mapped by Durham and show a correlation between the risk of landslide and slope inclination. Review of current Map SF-1 Geologic Hazards contained in both the Coastal and Inland General Plans include identification of landslide hazards in the City’s sphere of influence and references mapping by the State of California dated 1983.

These figures are in general agreement with the Manson landslide mapping. As the data for the General Plan maps is approximately 40 years old, a site reconnaissance by a registered engineering geologist should be considered to update the general plan Map SF-1. The State of California has prepared a map of deep landslide susceptibility originally published in 2011 as California Geologic Service Map Sheet 58 (CGS 2011). This map ranks landslide susceptibility to underlying bedrock strength and slope inclination. This map does not present the location of mapped/identified landslide and is discussed in more detail in the Geologic Hazard Section.

Mapped instability identified in Figure 5 are areas of surficial instability in the immediate City limits as points and the actual mapping of large deep-seated sliding are shown a distance approximately 2.5 miles east of the Noyo River Bridge along the Noyo river south Bank. Deep-seated landslides are more abundant within the State of California Jackson Demonstration Forest located to the east and southeast of the City with the closest slides located about 3.5 miles east of the Noyo River Bridge.

Additional insight into the surficial geology is provided from the review of mapped conditions within the City north of the Noyo River as depicted by the NCRS Soil Survey and review of the geotechnical report performed for the Aquatic Center near the intersection of Maple Street and South Lincoln Street. The 2003 geotechnical study (see Table 1) did not include a location plan for their borings; however, NCRS Soil Survey reports the material to the east of this site as fluvial marine derived deposits.

The 2003 SHN report identified the presence of soft soils and a layer of peat at a depth of 15.5 to 22 feet in Boring B-3. Boring B-2 found a gravel strata at a deeper depth. The study found the site contained fill to a depth of 4.5 feet along the north side of the site, underlain by dense sandy deposits to a depth of 18.5 feet. Boring B-3 depicts slightly different conditions suggesting that the terrace deposits mantled the bedrock and state that "the data indicates potentially variable or erratic soil conditions."

However, an alternate interpretation may be that the boring data suggests that the Noyo River or Pudding Creek may once have crossed the site and later shifted as the underlying bedrock was tectonically uplifted. The former drainage may have connected to the Soldier Bay cove at the coast, located to the west of Fort Bragg – Sherwood Road (Sherwood Road) shown in Figure 6. Studies performed for the restoration of the former mill pond document that Alder and Maple Creeks do cross the City and discharge into Soldier Bay that was dammed to form the mill pond (Arcadis 2011). The creeks were later placed in culverts and buried. The drainage could indicate more variable subsurface conditions and effect groundwater conditions beneath the main portion of the City (see https://www.fortbragghistory.org/?page_id=1071 for the 1873 map). The location of the postulated drainage roughly corresponds to the west end of the Noyo Anticline (geologic ridge formed by tectonic movement) shown on the geologic map in Figure 3. The anticline is an extension of the anticline mapped on the adjacent geologic map, the Geologic Map of the Comptche Quadrangle prepared by the State of California Department of Forestry also by Durham, 1979. If present, the drainage feature may follow a less resistant bedrock zone along the north side of the mapped anticline.

Figure 3 – Excerpt Geologic Mapping by Durham, 1979

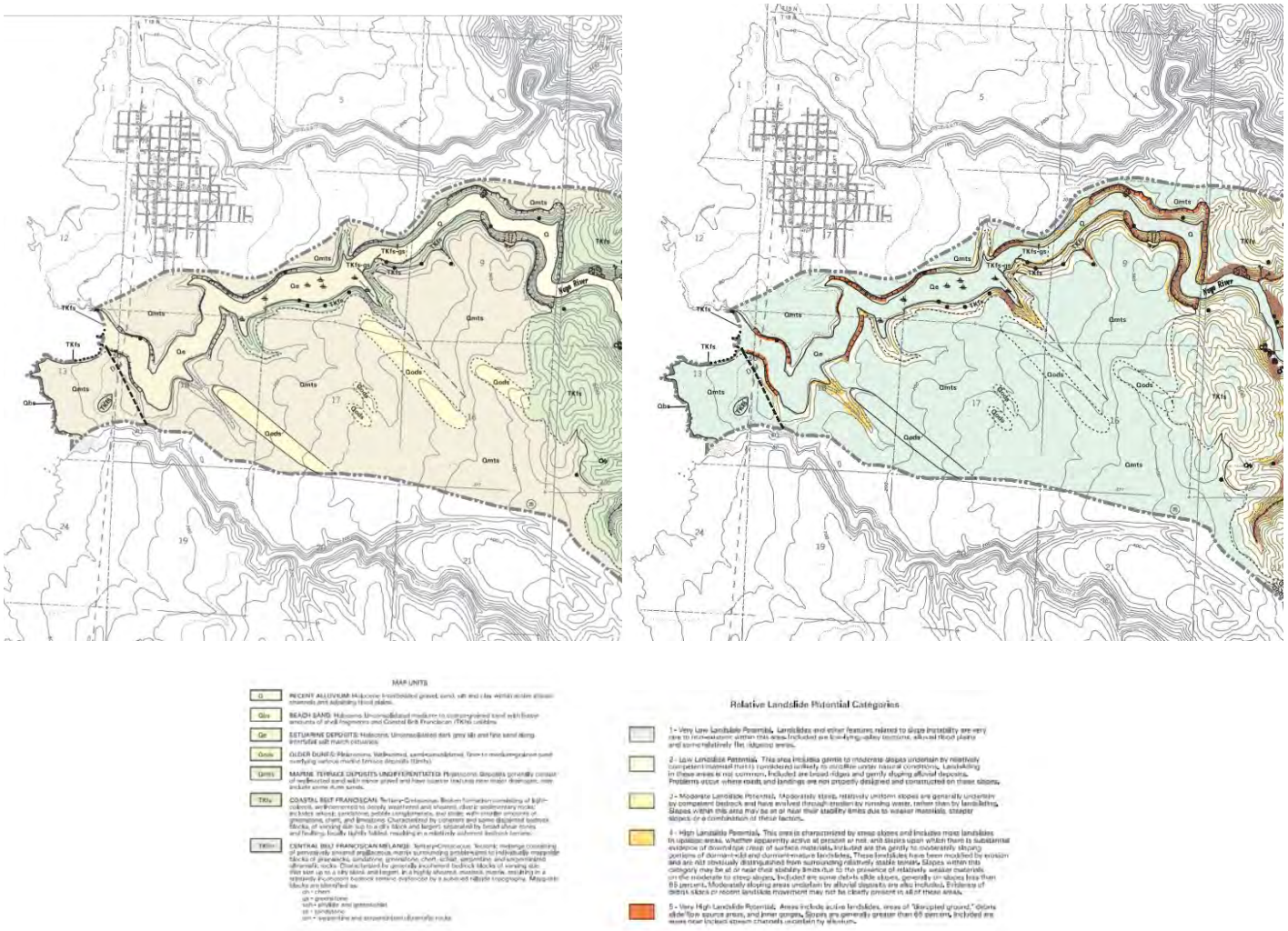


Figure 4 and Figure 5 – Excerpt from Noyo Watershed Mapping Relative Landslide Potential with Geology and Geomorphic Features (Manson et Al. 2001)

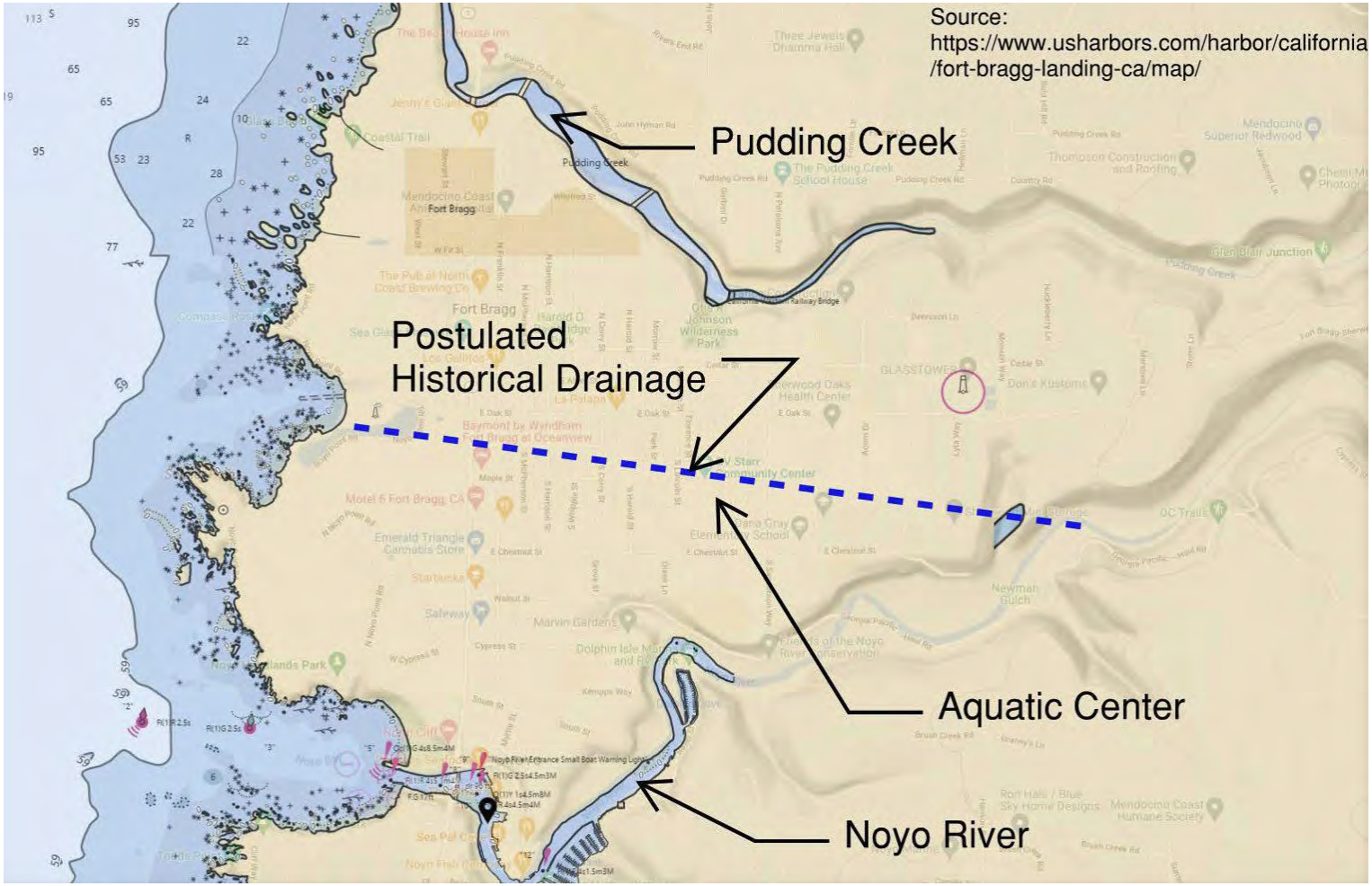


Figure 6 – Postulates Path of Historical Drained Beneath the City (No Scale)

6 Emergency Access

Subsurface conditions can impact City features such as vehicle access. The main vehicle access (and emergency evacuation/access routes) into and out of the City is Highway 1, which includes bridges that cross Hare Creek, Noyo River and Pudding Creek (from north to south). If these bridges were damaged during a seismic event or a large storm event, such as an intense storm washing out the bridge approaches or a tsunami damaging the bridge foundations, access would be limited.

The conditions of the logging roads that would be traveled to reach these points have not been evaluated as part of this study and do cross areas with high landslide susceptibility. Pedestrian access to the north from central Fort Bragg could be provided over the train trestle that crosses Pudding Creek west of the Highway 1 Bridge. The bridges are under the jurisdiction of the California Department of Transportation (Caltrans). The Noyo River Bridge replacement was completed in 2005. The previous bridge was replaced due to the seismic vulnerability. Pudding Creek Bridge was seismically retrofitted in 1998 and is currently being widened by Caltrans (2023). The Hare Creek Bridge is to be widened and retrofitted by Caltrans in the future.

It should be noted that Caltrans has its own design standards for bridges that is different than other codes such as the California Amendments to the International building Code (IBC) that govern design of occupied structures and American Water Works Association (AWWA) that govern design of water treatment, storage, and distribution systems.

7 Water Supply and Distribution

The following description of the water supply and distribution system is taken from Section 3 Public Facility Element included in the Inland General Plan.

> *The City's current water supply system consists of the Newman Reservoir, the Simpson (Waterfall Gulch) diversion, and a direct diversion in the Noyo River (which includes a wet well in the Noyo River, a pump station at the Noyo River, and various conveyances to the water treatment plant.*
>
> *The City currently obtains about 50 percent of its water from the Noyo River. Under its existing temporary license, the City is entitled to draw up to 1,500 acre feet of water per year from the Noyo River so long as withdrawals do not exceed 3.0 cubic feet per second and specified amounts are maintained in the river to meet the needs of the fish population. The City's Water Permit limits how much water can be pumped from the Noyo River during drought conditions. These limits were established by the State Department of Health Services because it concluded that the City must ensure sufficient flows within the river necessary to support the fish population. To comply with these Permit conditions, the City requires that new development implement measures that limit new water demand. Additionally, the City is developing new water storage facilities to ensure adequate water during severe drought years and to meet the needs of future development in both the Inland Area and the Coastal Zone.*

Since the Inland General Plan was last updated, the City constructed a new 45-acre-foot lined water storage reservoir and then purchased 580 acres of land south and east of the city limits on Summer Lane for future reservoirs. The City is also in the process of designing and replacing raw water pipelines connecting to the water treatment facility on Cedar Street that includes two older above-grade welded steel storage reservoirs (tanks) and one above-grade welded steel reservoir. The city also has a tall above grade welded steel reservoir at the corner of Highway 20 and Babcock Lane.

As the treated water steel reservoirs will be subject to strong ground shaking during an earthquake the design and maintenance of the reservoirs are governed by AWWA D-100 for welded steel tanks and D103 for bolted steel tanks, including requirements for having retrained foundations. Steel structures require inspection and maintenance and may require seismic upgrades as design codes evolve. Geotechnical reports related to these tanks have not been provided for review and comments regarding the design of the reservoirs is beyond the scope of this report.

Pipeline connections to these reservoirs present a seismic vulnerability as the structure and the pipe connection movement can cause localized stresses and cause failures. Flexible/articulating connections are usually provided to connect the reservoir to pumping to accommodate differential movement.

Distribution piping itself can be at risk due to many geotechnical causes, such as:

- Corrosive soils that weaken the pipe itself
- Differential settlement or pipe lengthening due to land sliding, bluff retreat, soil densification, or liquefaction resulting in large magnitude settlements or lateral spreading, static settlement due to change of overburden or imposed loads, or hydro-compression due to changes in saturation
- Differential movement during earthquake such as at service or distribution connections such as large manhole or bridge crossings

The fire hydrant network is also critical infrastructure for the City. The hydrant system needs to remain operational for small and large events such as wildfire and after a large seismic event.

The following sections discuss the different geotechnical conditions that are present within the City of Fort Bragg and its areas of influence.

8 Geotechnical Conditions Assessments

The City of Fort Bragg provided eight geotechnical reports from their files to provide a background of near surface soils conditions listed in Table 1 below and the location of the investigations are shown on Figure 7. Geotechnical information provided in these reports and in other information reviewed include the following topics, to some degree:

- Review of existing data
- Geologic setting
- Site conditions
- Site geology
- Subsurface conditions

- Groundwater
- Soil corrosivity
- Geologic hazard including:
  - Seismicity and strong ground motion
  - Soil liquefaction
  - Expansive soils
  - Bluff retreat

General geotechnical subsurface conditions within the coastal and inland areas of Fort Bragg are discussed in the following sections referencing the eight reports provided for review. Each report is identified in the specific area it is located. All the reports include a very limited review of existing data and typically limited review of available published geology and other historical investigations that were performed at the site being investigated.

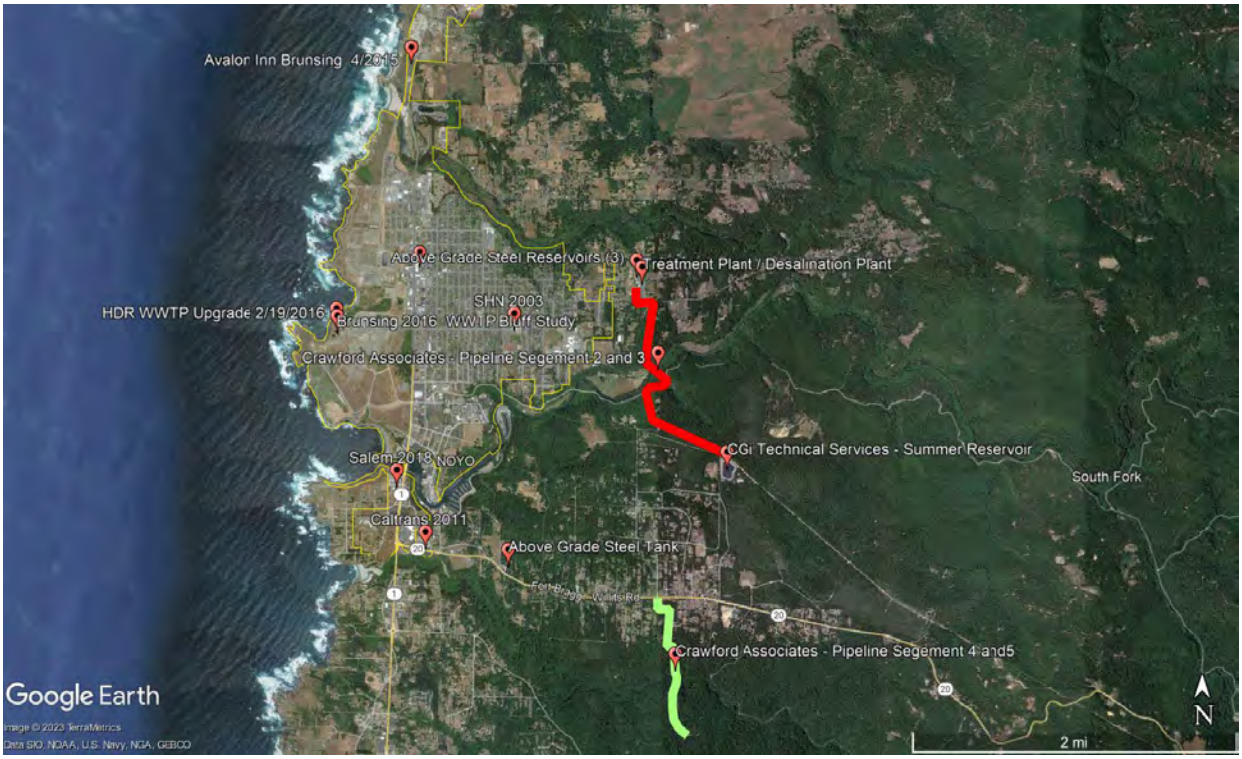


Figure 7 – Location Map – Reference Geotechnical Investigations

Other sources of data that were reviewed for this evaluation and may be of interest are cited below to provide additional insight in the geotechnical conditions and geologic hazards within the City's area of influence.

- California Department of Conservation, Mendocino County Tsunami Hazard Areas https://www.conservation.ca.gov/cgs/tsunami/maps/mendocino
- California Department of Conservation - Alquist-Priolo Earthquake Fault Zones (ca.gov)
- California Geological Survey (CGS) 2011, Sheet 58, Deep Seated Landslide Susceptibility
- California Office of Emergency Services online MyHazard Maps myhazards.caloes.gov

- Geotracker - Environmental Clean-up Areas within and in the Vicinity of Fort Bragg https://geotracker.waterboards.ca.gov/map/?CMD=runreport&myaddress=Fort+Bragg+Ca
- Coastal Conservancy – Projects and Land Acquisitions the Coastal Conservancy is s supporting along the coastline in Fort Bragg - http://websites.greeninfo.org/mapcollaborator/sccpv/prod/#
- Mendocino County Hazard Management Plan (2020) https://mitigatehazards.com/mendocino-county/final-mjhmp/
- Office of the State Fire Marshal – Fire Hazard Severity Zones Pacific Institute – California Flood Risk: Sea Level Rise, For Bragg Quadrangle https://pacinst.org/reports/sea_level_rise/hazmaps/Fort_Bragg.pdf (Link not active in 2025)
- TRC, 2004, Phase II Environmental Site Report, Georgia-Pacific California Wood Product Manufacturing Division, 90 Fort Bragg Avenue, Fort Bragg, California, May (EnviroStor. ca.gov))
- United Stated Department of Agriculture Web Soil Survey https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
- United States Geological Survey Quaternary fault map - USGS.maps.arcgis.com/apps

8.1 Geologic Hazards

8.1.1 Seismicity

The City of Fort Bragg is located in an area that is known for seismic activity; however, the City is not within a currently established State of California Earthquake Fault Zone for surface fault rupture hazards and there are no known active fault traces in the immediate project vicinity. The nearest Alquist-Priolo Earthquake Fault Zone to the project site is associated with the North San Andreas Fault system and located approximately 6.5 miles west of the site, which is the most likely source of earth shaking. The Maacama Fault zone is approximately 21 miles to the east of the City; the Mendocino Fracture Zone is approximately 60 miles to the northwest (Figure 8). The recently identified, potentially active, Pacific Star Fault is located to the northeast between the towns of Fort Bragg and Westport. All the faults could potentially cause earth shaking activity. Potential hazards associated with earthquakes includes rupture of the ground surface by displacement along faults, shaking of the ground caused by the passage of seismic waves through the earth, ground failure induced by shaking, such as landslides, liquefaction and subsidence of unstable ground, and tsunamis. The Pacific Star and Pudding Creek Faults were identified in 2006 and are reported as connecting to the San Andreas fault paralleling the Pacific Coast though they are not located within a special fault study zone.

The 1977 5.2 magnitude earthquake near Willits is the largest magnitude earthquake in the vicinity of the City, approximately 28 miles east of the City. Fort Bragg reported severe losses after the 1906 earthquake due to structure damage and fire. A 7.0 magnitude earthquake offshore Cape Mendocino occurred on December 12, 2024, approximately 90 miles northwest of Fort Bragg, with little damage report in the City as a result. Strong ground shaking is likely for a large earthquake event along the North California Coast region on the Maacama fault zone east of the city, the San Andreas Fault west of the City, and the Mendocino Fracture Zone/Cascadia Thrust Zone off the Pacific Coast near Eureka, California. USGS estimates that there is a 64.92% chance of an earthquake with a magnitude greater than 5 to occur in the next 50 years.

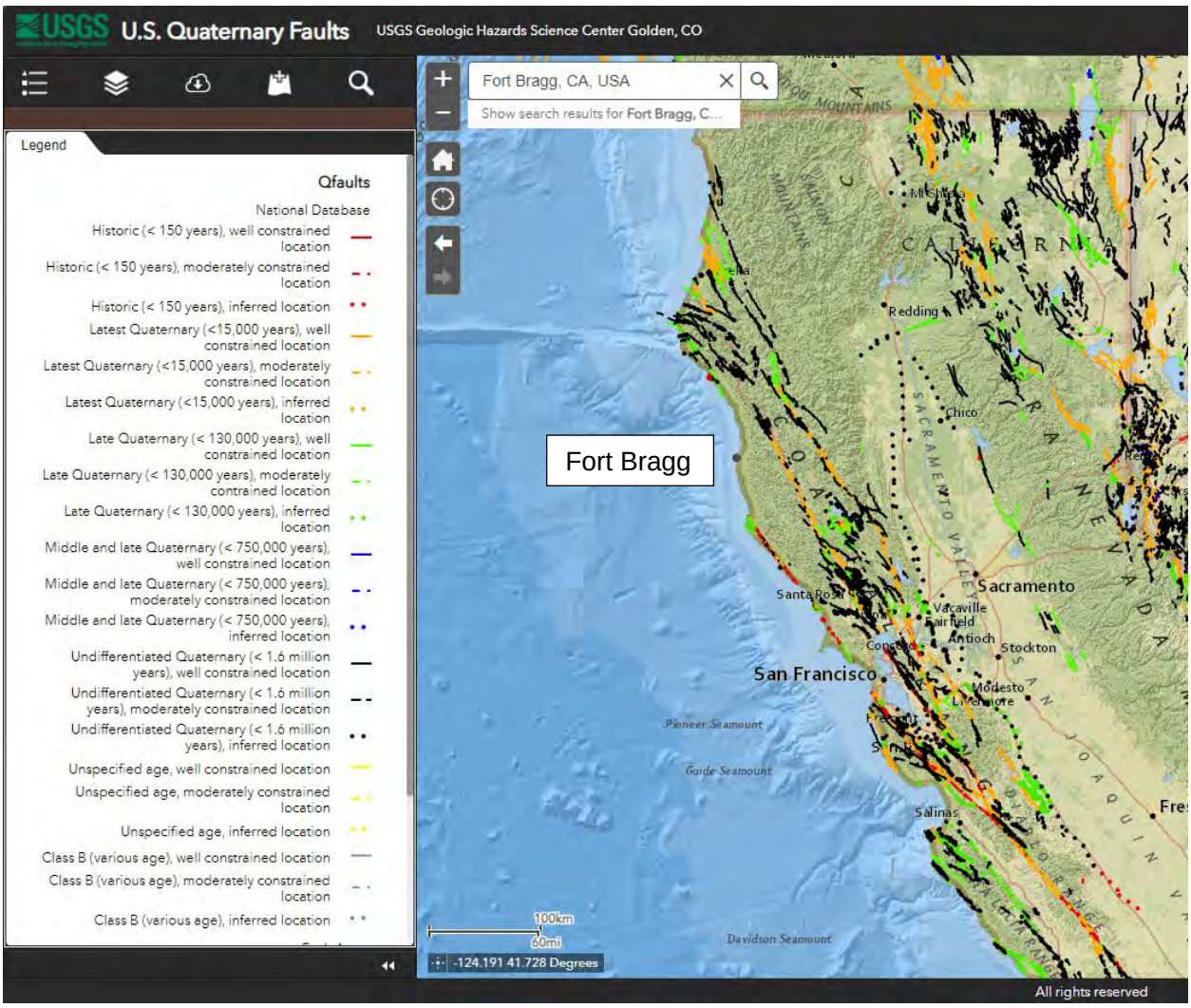


Figure 8 – Quaternary Fault Map (Source USGS.maps.arcgis.com/apps)

8.1.2 Fault Offset, Strong Ground Shaking, Liquefaction and Tsunami Impacts

The fault offset hazard in the City is very low. There are no Alquist Priolo Hazards Zones identified within or near the City (www.conservation.ca.gov). The City will be subject to strong ground shaking that could induce densification of loose to medium dense terrace deposits and slope movement within the steeply incised river and creek channels and along the coastal bluff. Loose, saturated cohesionless soils are susceptible to liquefaction, including sediments that have accumulated within and at the mouth of the coastal, river, and creek channels and potentially in eolian (windblown) derived terrace deposits that become saturated due to groundwater.

The State of California Office of Emergency Services online MyHazard maps (myhazards.caloes.gov) does not identify Fort Bragg as having a mapped liquefaction zone; however, the risk of liquefaction is judged to be moderate in the terraces and high in the river and creek channels and could occur in the event of strong ground shaking.

Tsunamis would impact the coastal areas, the Noyo Harbor and upstream areas of Noyo River Pudding Creek and Hare Creek (Figure 9). The Pacific Institute presents the effect of 55 inches of sea level rise on their Sea Level Rise Map of the Fort Bragg Quadrangle referenced above. The map shows that sea level rise will exceed the 100-year flood level within the Noyo River and Pudding Creek. The occurrence of tsunami(s) combined with sea level rise would impact the areas shown effected by sea level rise within the limits of Pudding Creek, Hare Creek, and the Noyo River including impacting existing raw water intakes along the Noyo River with salt water. The intakes have been impacted in the past with saltwater intrusion from high tides, and beginning in 2021 the City began using a desalination system to treat high salinity raw water from the Noyo River (Water Boards Media Release October 12, 2021).

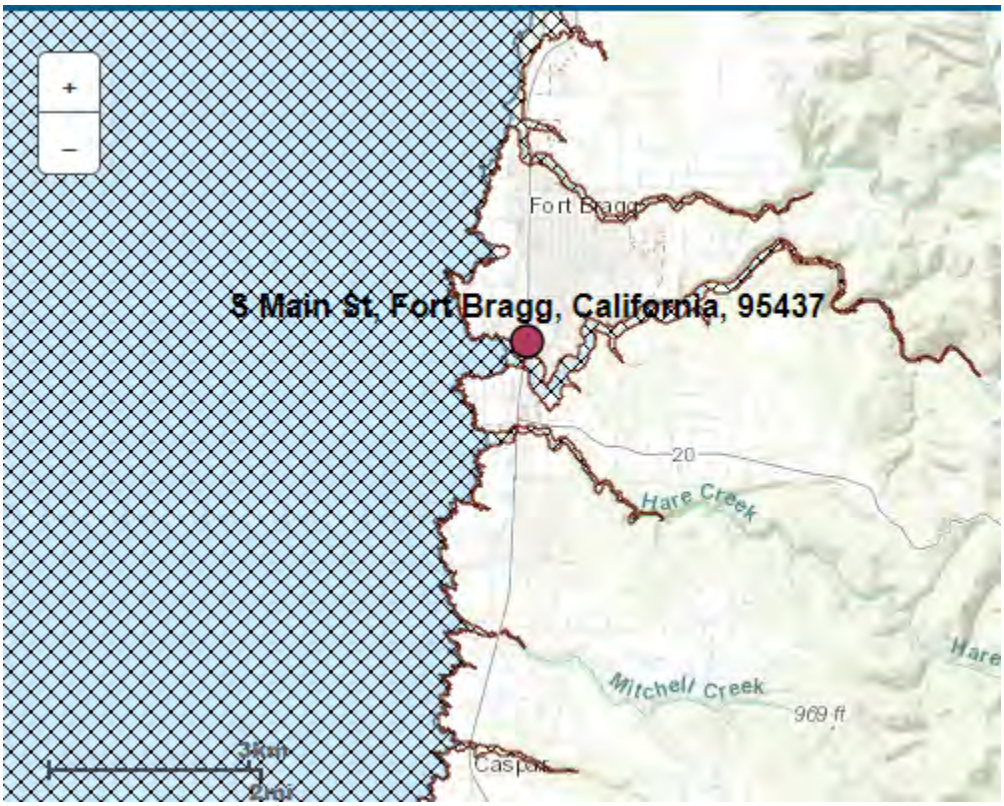


Figure 9 – Tsunami Hazard Area - Shaded (source Cal OES MyHazard)

Table 1 – Geotechnical Reference Provided by City of Fort Bragg by Area

Date	Area	Author	Address	Rock Depth	Bluff Erosion Estimated	Dynamic Densification	Liquefaction	Lateral Spreading	Tsunami Risk
2022	Inland	Crawford	Segment 2	NE	NA	Low	Low	ND	ND
	Inland *		Segment 3	NE	NA	low	Low	ND	ND
	Inland *		Segment 4	NE	NA	Low	Low	ND	ND
	Inland *		Segment 5	NE	NA	Low	Low	ND	ND
2018	South Coastal	Salem	1151 South Main Street	>20 ft	NA	Yes	Low	Low	Low
2016	Central Coastal	HDR	101 Cypress Street	11.5 to 18	No	Yes	No	No	NA
2016	Central Coastal	Brunsing	101 Cypress Street	ND	Yes (14.75 ft/75 years)	NA	NA	NA	NA
2015	North Coastal	Brunsing	1201 North Main Street	10 to16 ft	Yes (31.25 ft /75 yrs)	Yes	Yes (0.4g shallow GW)	Yes	Low
2011	South Coastal	Caltrans	Highway 1 (ADA Project)	10 to 11 ft	NA	ND	ND	ND	ND
2007	Inland (outside City Limits)	Curry Group	Summers Lane	NE	NA	Yes	Yes (0.65g and GW at ground surface)	Yes	NA
2003	Inland	SHN	Green Memorial Field/Starr State Park	11.5 to 38.5 ft	NA	Low	Low	ND	ND

Note: * - Outside of City Limits
ND – Not Determined
NA – Not Analyzed
NE – Not Encountered
Low, No, Yes – Individual Report Author's Opinion

8.1.3 Non-Seismic Hazard

Non-seismic geologic hazards include the presence of unstable soils on steep slopes and expansive soils which, in the presence of moisture, will swell and shrink when returning to a dry condition, and compressible soils. Map SF-1: Geologic Hazards identifies areas of potential landslides and is discussed in more detail in the Section of Topography and Geology earlier in this evaluation.

Bluff retreat (erosion) is estimated for two locations in the provided reports, and is discussed in more detail in the following sections. The Pacific Institute has provided graphical estimates of bluff retreat by the year 2100 on their Sea Level Rise Map of the Fort Bragg Quadrangle referenced above. It is

unlikely that bluff retreat will impact the City's water distribution system unless there are existing distribution pipelines or connections within that zone.

The presence of loose and/or weak compressible soils has been noted in the reference geotechnical reports. The presence and mitigation, if required, would be determined on a project-specific investigation/basis. It would be beneficial to document the past performance of the water distribution system (Geographic Information System [GIS], mapping and tabular format) including areas of past pipe repairs/leak/breaks and areas of known surface (street pavement and hardscape) distress to identify areas that may be underlain by weaker soils.

8.1.4 Regional Geology

The bedrock of this part of the Mendocino coast is comprised of well-consolidated sedimentary rocks of the Cretaceous-Tertiary Period coastal belt Franciscan Complex, such as sandstone and shale. The bluff-top property occupies a near-level marine terrace underlain by the Franciscan Complex bedrock. The terrace was formed during the Pleistocene Epoch, when periods of glaciation caused sea level fluctuations, which created a series of steps, or terraces, cut into the coastal bedrock by wave erosion. Shallow marine sediments (Pleistocene terrace deposits) were deposited on the wave-cut, bedrock platforms while they were submerged beneath the ocean during interglacial sea-level high stands. Some of these marine deposits have been locally eroded as the terraces began to emerge from the ocean due to uplift associated with the San Andreas Fault Zone during the middle and late Pleistocene. Present sea levels are believed to have been achieved about 5,000 to 7,000 years ago.

8.1.5 Near-Surface Geology and Surface Condition

The following descriptions of site near-surface geotechnical conditions are excerpted from the geotechnical reports provided by the City separated by zone, Coastal (North, Central and South) and Inland zones, and by report author to provide a basis to understand the variability of subsurface geotechnical and groundwater conditions of the terrace deposits that mantle the bedrock within the city. It should be noted that the geotechnical reports have been developed to different standards based on their age and their primary purpose. However, the reports provide insight into the variable subsurface conditions across the city, particularly the thickness of fill materials and terrace deposits.

The identification of Zones is based on the City of Fort Bragg Inland and Coast General Plans (City of Fort Bragg 2012 and 2008) The Inland Zone is identified as a generally a westward project extending from the intersection of Walnut Street and Highway 1, projecting east to the top of the Noyo River north bank and to the north from the intersection of Walnut Street and Highway 1, following Highway 1 north to beyond Virgin Creek, as shown on Map LU-1, Land Use Designation. The Coastal Zone is all areas west and south of the Inland Zone, including the intersection of Highway 1 and Highway 20, for areas within the City boundary and sphere of influence as shown on Figure LU-1 Land Use Designations. The Noyo River has been included in the Coastal Zone. For this document, Pudding Creek and the Noyo River have been selected to divide the Coastal Zone into the North, Central and Southern zones. Therefore, historical investigations that extend or are located south of the Noyo River north top of bank are included in the southern Coastal Zone.

A summary of the conditions reported at each of the eight reports are provided in attachment A. Included is a comparison to the data available from the NCRS Soil Survey data regarding the

composition of new surface soil composition. The NCRS Soil Survey Data is provided in an online map of soil conditions for depths on the order of 6 feet. A map of the units overlain on an aerial map for the City and surrounding area is provided as Attachment B as well as tabular list data of typical engineering and chemical properties contained in the NCRS database organized by soil unit number. The tabulated values are developed focused on agricultural uses but can provide insight into the soil texture and chemical nature of the soil. This data can be used for a preliminary high-level assessment of near surface site conditions in areas within a specific zone but not explicitly investigated. More detailed investigations may be warranted depending on the project under consideration.

It is particularly important to note that groundwater conditions documented in the reference reports represent conditions observed at the time of investigation and are generally poorly understood. Groundwater (at depth) and near surface perched groundwater are two different groundwater occurrences and both have been reported. Additional groundwater investigations would be required to better understand the current temporal variations in groundwater at a specific site with the City's area of influence. The assumptions related to groundwater levels have a significant impact on the occurrence of liquefaction induced by strong ground shaking and the values reported in the different documents should not be relied on for future project.

Documents related to the environmental cleanup of the Georgia-Pacific site (Central Coastal Zone) are available through the California Department of Toxic Substances (DTSC) using the Envirostor system (https://www.envirostor.dtsc.ca.gov). Groundwater in the central portion of the Coastal Zone is depicted in a series of monitoring reports that show a groundwater depression in the vicinity of Soldier Bay. The 2004 Phase 1 study described this area as a natural low spot and groundwater at the eastern edge of the zone was measured at El. 65 feet.

Fill – All Reports

Variable thickness of fill is present throughout the City due to historical grading and development. Fill is likely locally derived and can be highly variable. Fill material may contain significant organics (such as topsoil) and can have little to no compaction efforts. Suitability for reuse of fill will need to be determined on a case-by-case basis.

Marine Terrace Deposit – Coastal (five report sources)

The Coastal Zone generally consists of sand with variable amounts of gravel, silt and in some instance s clay. It is listed as being eolian (windblown) origin by NCRS, is under consolidated and can be susceptible to liquefaction due to strong ground shaking depending on the level of groundwater. Where estimated, the liquefaction hazard is generally low and liquefaction induced settlement has been calculated based on conservative (elevated) groundwater levels. The liquefiable soils are also susceptible to lateral spreading.

The depth of bedrock is variable. Bedrock was not encountered in the southern coastal zone. In the Coastal Central Zone, depth to bedrock varies from to within 2 feet of the ground surface to a depth of 9.5 feet at the City WWTP and 20 to 30 feet at the Georgia-Pacific facility in the topographic low point at Soldier Point. In the Coastal Northern Zone the depth of bedrock varied from 7 to 15 feet.

The depth to groundwater has been reported to occur at a depth of 7 to 8 feet in Georgia-Pacific monitoring wells. Groundwater encountered at the time of drilling in the north and south area was reported between 2 and 7 feet and are expected to vary seasonally.

Marine Terrace Deposits – Inland (two report sources)

The Inland Zone is likely comprised of both eolian and fluvial terrace deposits depending on the distance east from Highway 1. The terrace deposits transition to fluvial derived deposits that have higher clay and silt contents up to materials being classified as clay. These have been identified at the Aquatic Center and along the raw water pipeline alignment. The transition between the two types of terrace deposits are not defined but, for a first estimate, may be located along the El. 160-foot contour.

A potential buried drainage (bedrock depression) may be located beneath the Aquatic Center and may extend to the west towards the bay north of Soldier Point. The buried drainage would have thicker terrace deposits than the adjacent areas that could increase the risk of differential settlements due to seismic densification liquefaction. Bedrock was only encountered by the 2003 Aquatic Center investigation at depths of 5 to 10 feet but was below a depth of 22 feet at one location. A compressible peat layer was found at depths of 22 feet.

Shallow groundwater was encountered during the 2003 investigation.

Colluvium – Incised River and Creeks Slopes

Colluvium is mapped as being along slopes that have moderate to high risk for landslides. The thickness of the colluvium is not defined but is estimated in one report as being on the order of 5 feet.

Alluvium and Beach Deposits

Alluvium and beach deposits have accumulated along the river and creek channels. The Noyo River is maintained by the United Stated Corps of Engineers that periodically dredge the channel. Beach deposits are located at the mouth of Hare and Pudding creeks. Alluvium derived from erosion of adjacent areas has accumulated in the stream bottoms and likely varies from sand bars to siltation within the channel that are likely saturated and loose (granular deposits) and soft and weak (cohesive deposits). Targeted geotechnical studies would need to be performed to assess the conditions that existing for projects that are located across these deposits.

8.2 Other Geologic Related Concerns

8.2.1 Mineral Resources

According to a 2019 Initial Study and Mitigated Negative Declaration, the City does not have any identified locally important mineral resources recovery sites delineated in the general plan, specific plan, or other land use. The City has also not been utilized for Surface Mining and Reclamation Act (SMARA) activities, as noted in the City of Fort Bragg General Plan Amendment 1-19 (GPA 1-19), Inland General Plan Amendment – Housing Element Update (2019).

8.2.2 Corrosivity (Chemical Analysis)

As stated in the previous sections, the near-surface soil blanketing the site is acidic and has a low cation exchange capacity being more acidic closer to the ocean. Corrosivity analyses were only available from two of the eight studies reviewed, reported as follows.

South Coastal Zone (Salem 2018)

Soluble Sulfate - 100 mg/kg

Soluble Chloride - 36 to 37 mg/kg

pH – 7.1

The water-soluble chloride concentration detected in saturation extract from the soil samples was 37 mg/kg.

The reports states that this level of chloride concentration is considered slightly corrosive.

Inland – (Crawford 2022)

Pipeline Segment 4 – two samples depths 2.0 to 3.0 feet.

Minimum Resistivity (Ohm-CM) - 4,290 and 10,990

Sulfate Content (ppm) - 3.1 and 15.1

pH - 3.99 and 4.26

The report states that in accordance with Caltrans Standards, the soil tests indicate corrosive to structural steel materials and non-corrosive to structural concrete materials. The Crawford results correlate with NCRS data for pH.

The terrace deposits soils should be considered corrosive to steel and slightly corrosive to concrete unless specific testing is performed or the performance of buried structures can be determined from visual inspection. A testing standard should be developed for all corrosion testing so that a “Zone” database can be developed by the city to aid in their management of the water system.

8.2.3 Erosion

For the steeper slopes, Crawford (2022) stated the following for the proposed pipelines:

> *The proposed pipeline alignment meanders through steep slopes with a few areas mapped as inner gorge which are prone to landslides, erosion, and creeping. Based on our review of the project plans, the slopes are shown to range from 1H:1V to 4H:1V along the pipeline alignment. Observations along the proposed alignment showed the existing slopes are performing adequately and consist of heavily established vegetation. Following the completion of construction, overly steepened areas (such as between Station 125+00 through 126+60 and Station 130+00 through 132+00) where vegetation is being removed will be susceptible to erosion and may require periodic maintenance while the vegetation is reestablished.*

Removal of vegetation and redirection of surface water could induce erosion on any area of the City. Care must be taken to restore disturbance to reduce the risk of developing areas of concentrated surface water flow that could induce erosion. Care must be also taken to install trench dams along long lengths of pipeline in and in areas of elevation transitions so that the pipeline trench does not act as collection drawings redirecting and concentrated seepage to the trench outlet, which could lead to ground saturation and potential slope failure and erosion.

8.2.4 Non-Geotechnical Hazards

8.2.4.1 Flooding

Flooding Hazard is typically determined for a 100-year flood level for insurance purposes using maps developed by the Federal Emergency Management Agency (FEMA). As described in the Inland General Plan:

> *"FEMA … requires the City to establish development standards for construction in the 100-year floodplain. Typically the standards developed by a city or county can range from limits on the intensity of development to requirements to raise the "habitable floor" of the structure to at least one foot above the 100-year flood peak elevation. Most of the City, over 99% of the land area, is situated above both the 100-year and the 500-year floodplains. The only areas in the Inland Area located within the 100-year flood plain are along the Noyo River and Pudding Creek. The presence of riparian habitat and excessive slopes in this area prohibits development within the 100-year flood plain."*

And,

> *"Portions of the City have areas subject to potential flooding during severe storms. Because of the generally flat terrain in the Fort Bragg area, a 100-year storm could exceed the ability of the City's infrastructure to move runoff water from the City to outfalls into natural drainages and the ocean. This drainage overload may result in standing water in low areas. High tides and severe storms may also cause flooding in low-lying areas near creeks and drainages."*

The Coastal Zone Map SF-2 references flood mapping dated 1992 while the Inland Zone map references mapping stated in 2011. The FEMA updated flood maps for Fort Bragg area are dated as being published in 2017 that show larger 100-year flood hazard than shown in the Coastal General Plan Map. The Inland Zone General Plan includes Map SF-3 Tsunami Inundation Map and Map SF-4 100-year Sea Level Rise Inundation Area, which is the Pacific Institute map previously referred as an additional source document for this evaluation. The most recent FEMA flood mapping and the Pacific Institute mapping of sea level rise is recommended as references for assessing flooding impacts.

8.2.5 Fire Hazard

The City's fire hydrant system is critical infrastructure for public safety. Significant fires have occurred in Northern California in the last few years and the ability to protect the City from structure fires and wildfire is important. The fire hydrant system is also critical after a large seismic event.

In 2022, the California Department of Forestry and Fire Protection (CAL FIRE) published large-scale maps depicting Fire Hazard Severity Zones for Mendocino County as part of the Fire and Resource Assessment Program (https://osfm.fire.ca.gov/media/loqhpr10/fhsz_county_sra_e_2022_mendocino_ada.pdf).

Zones north and south of the City are zoned as having a high severity and the east is zoned as moderate severity. The City is outside the jurisdiction of CAL FIRE and the City itself is zoned as a local responsibility area (LRA). The Fire Hazard Zone Severity Viewer is located at https://egis.fire.ca.gov/FHSZ/. The viewer shows the area south and east of the Noyo River zoned as very high and the area north and east of the City as moderate. High risk zones are located east of the City on the north back of the Noyo River and east of the north Coastal Area. The south Coastal area is located in a moderate risk zone west of Highway 1 and in the lower elevations east of Highway 1.

8.2.6 Extreme Weather Events

In February 2023, the United States Department of Agriculture (USDA) declared Mendocino County a Disaster Area due to severe winter storms and flooding. The occurrence of heavy storms and storm events, characterized as atmospheric rivers, are defined by National Oceanic and Atmospheric Administration (NOAA) as long narrow regions in the atmosphere that transport most of the water vapor out of the tropics that have an equivalent flow at the mouth of the Mississippi River and exceptionally strong events can have 15 times that amount. The Pineapple Express is a strong atmospheric river bringing moisture from the tropics near Hawaii to the west coast. The rain events can induce slope instability and rapid slope movement and debris flows. One such event happened to the community of Rio Nido along the Russian River in 1998 and have also been attributed to coastal landslides in 1962.

Figure 10 presents a ranking of the potential deep-seated landslide occurrence-based on rock strength and slope inclination from CGS Map Sheet 58. The darker the color red indicates the higher potential risk. Rock strength in Mendocino County is generally ranked as moderate; therefore; the instability is a function of slope inclination ranging from 3 degrees to over 40 degrees, with rocks inclined 15 to 20 degrees or greater having the highest susceptibility (approximately equivalent to a 27 percent grade or higher). Therefore, the susceptibility of landslides impacting the City water supply and distribution system or evacuation routes directly or from debris flows should be evaluated on a case-by-case basis. It should be noted that climate change may increase the risk of slope instability.

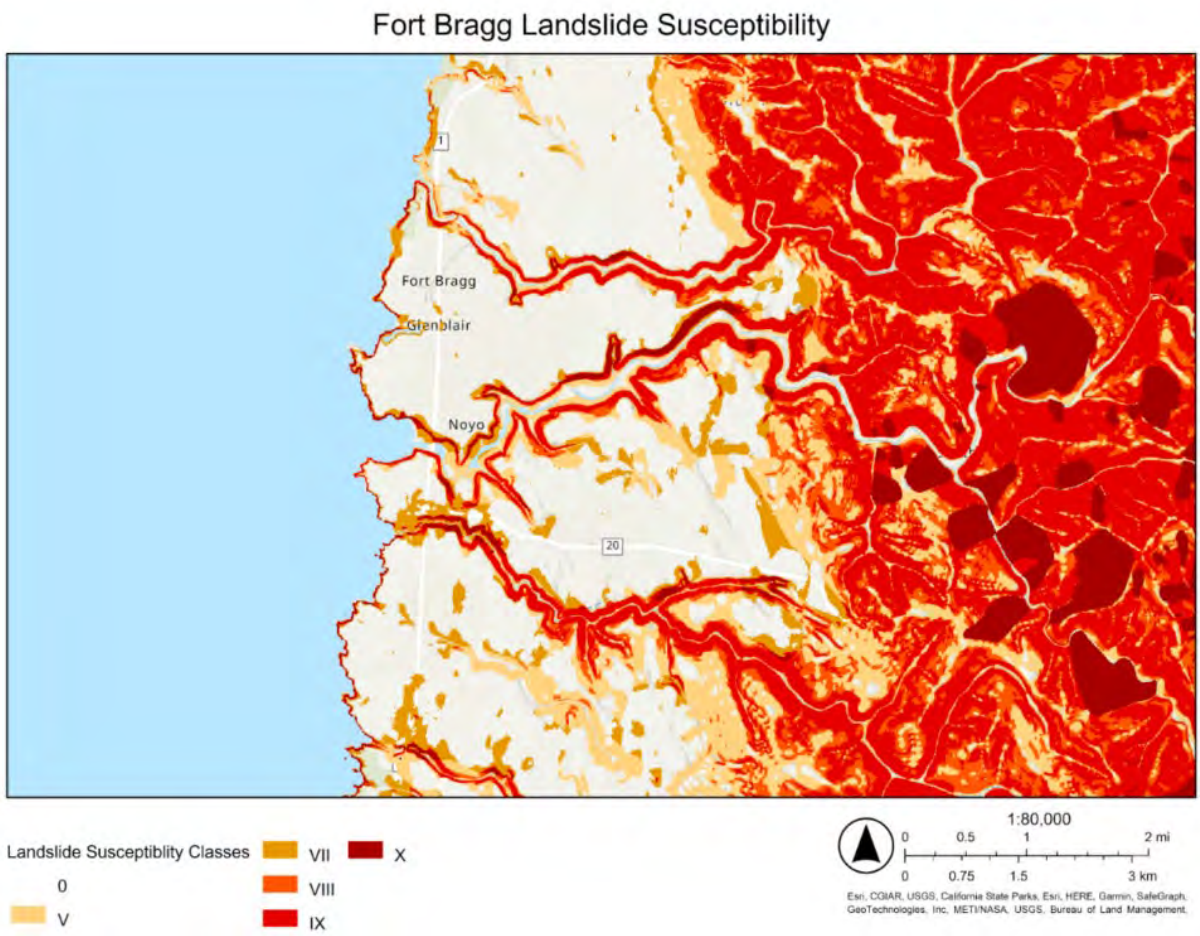


Figure 10 - Relative Slope Instability in the Fort Bragg Area (After CGS Map 58, 2011)

8.2.7 Chemically Impacted Sites

A review of the DTSC GeoTracker website provides the locations of numerous identified chemically impacted sites that range from small underground storage tanks to large facility clean-up activity. Many of the sites are identified as having closed files, meaning that the sites have been remediated to meet cleanup goals s set forward by regulatory agencies. It should be noted that there may be residual chemically impacted soils at these sites that did not require removal but, should they be excavated, may require special testing and handling to determine material reuse or disposal. The GeoTracker site and associated data should be checked as part of a future system upgrade or rehabilitation projects to be aware of potential impacted sites.

9 Areas of Concern for Rehabilitation of Water Distribution Facilities

The following geotechnical factors should be considered when addressing water distribution design or rehabilitation.

9.1 Densification and Liquefaction

The City will experience strong ground shaking that could induce seismically densification and/or liquefaction in saturated, loose granular soil. Liquefaction can also induce lateral spreading. Differential movement both vertically and laterally can damage water distribution facilities such as when connected to structures founded on rock or connected to bridges. The magnitude of movement will dictate the appropriate measures to include in a repair or rehabilitation of the system including use of articulating joints for entering rigid structures and the use Earthquake Resistant Ductile Iron Pipe (ERDIP) if the anticipated movements are significant and would damage standard pipe systems, such as those being implemented by the Los Angeles Department of Water and Power (LADWP) to provide greater resilience to their distribution system. ERDIP allows for the pipeline to extend, accommodating seismic deformations limiting failures for pipelines failing at joint. The amount of movement that can be accommodated is a function of the length of ERDIP installed. LADWP limits use of ERDIP to sites that are deemed critical to the function of the entire water system in the event of a major earthquake and are typically located in areas that are calculated to have widespread lateral spreading and large fault offset. For more information, see https://www.hdrinc.com/sites/default/files/2017-05/hdr-seismic-considerations-for-water-distribution.pdf (link not active in 2025). and

https://scag.ca.gov/sites/main/files/file-attachments/srpwebinar_orourkepresentation.pdf?1603219825)

The American Lifeline Alliance is a public/private alliance between FEMA and the National Institute of Building Sciences. In 2005, they published Seismic Guidelines for Water Pipelines that provides extensive guidance for the design of water pipelines in the seismic environment. (https://www.americanlifelinesalliance.com/pdf/SeismicGuidelines_WaterPipelines_Comm.pdf.

There are also numerous articles published in AWWA and ASCE conference proceedings, including work by O'Rourke. In the 1970s, asbestos concrete pipe (ACP) was used for water distribution systems. As these pipes age the pipes can become brittle and fail catastrophically with no warning. ACP also poses an environmental hazard. Therefore, the pipelines can be lined with a drinking water compatible resin cured-in-place pipe (CIPP) line technology that, when the resin hardens, forms a new ductile and deformation resistant pipe within the ACP. CIPP can also be applied to ductile iron pipes.

Seismic shaking itself can induce differential movement between structures and pipeline causing damage to connections, such as connections to vaults, steel reservoirs, or bridge crossings. Large, out-of-phase movement can cause damage to connections to structures. To improve resiliency flexible connections should be provided. The City will likely be subject to strong ground shaking due to earthquakes occurring on nearby faults. Existing and new connections should be evaluated by the appropriate design standards.

9.2 Corrosivity

Based on the limited amount of the data, the soils in and around Fort Bragg should be considered corrosive to iron and mildly corrosive to concrete. Site Specific testing should be performed and compiled to confirm the corrosivity of the soils. Testing should include:

- As-received and saturated electrical resistivity per ASTM G-187 and pH per ASTM G-51; and
- Chemical analysis for Major anions and cations per ASTM 6919, ASTM 4327 and AWWA 4110B

9.3 Groundwater

Groundwater levels are reported as varying seasonally, rising to near the ground surface in some instances. Long reaches of pipelines can interconnect areas of high groundwater and transmit water to other areas along the trench bedding or pipe zone material. This can be exacerbated by pipelines that run from higher elevations to lower elevations in the city. Trench dams should be included wherever expected or known groundwater is encountered during construction and spaced at the midpoint of each line segment, and where future construction access will be required. Trench dams consist of low permeability material (soil or Controlled Low Density Fill, manufactured materials that are slipped over the pipe at the time of installation).

9.4 Seismic Response

In addition to dynamic densification and liquefaction effects, pipe connections to structures, such as vaults, steel reservoirs or bridge crossing may experience differential movements based on the response of the ground compared to the response (shaking) of the structure. Out-of-phase movement can cause damage to connections to structures. To improve resiliency flexible connections should be provided. The City will likely be subject to strong ground shaking due to earthquakes occurring on nearby faults. Existing and new connection should be evaluated by the appropriate design standards.

9.5 Bluff Erosion

The bluffs along the coastline are actively eroding, which is referred to as bluff retreat or bluff erosion. Estimates of bluff erosion have been provided in two referenced geotechnical reports (Table 1) and from the Pacific Institute. Placement of distribution systems within the limits of future bluff retreat is not recommended.

10 Recommended Future Actions

To better understand specific geologic risk to specific portions of the water distribution system, a more detailed understanding is needed at the location of critical components of the system. Specifically, the following should be determined:

- **The peak ground acceleration based on current code requirements, typically expressed as the design earthquake return period**. Depending on the age of the facility the current design, the code may be different from what was used at the time the component was designed and constructed.
- **The thickness of fill and/or terrace deposits at the site, the depth to bedrock and an understanding of the groundwater depth and seasonal fluctuation**. Past geotechnical investigations associated with the original design of the component/facility or a report prepared for an adjacent property combined with review of the as-built grading plans would

typically provide data regarding the site soil stratigraphy and depth to bedrock. Understanding groundwater conditions below the site would likely require additional study, as discussed below. This information is required as input into a seismic vulnerability assessment for understanding the potential for seismic densification or vertical or lateral deformation as a result of liquefaction, if potentially liquefiable soils are present at the specific site.

- **Mapping of areas of slope instability along pipeline corridors and within 300 feet of a component or facility at a local scale** will provide the input to assess the current hazard that slope instability poses to the facility as well as allow comparison for changes in the risk, specifically after major storms/flood events or a large seismic event. Each specific area of concern should be mapped at a scale of 1”=50 feet and fixed reference points set, such as rebar hubs setback (above) the area of instability in readily accessible areas that can be used to easily identify changes visually and hand measurement. Each location will need to be assessed on a case-by-case basis to establish the limits of mapping and location and number of reference points. Use of fixed features such as a fence, fire hydrant, or street curb may not be sufficient as they can be modified or damaged over time.

The depth to bedrock could be evaluated by performing limited geophysical surveys (Seismic Refraction) that is a non-invasive and lower cost method of field investigation. The geophysical surveys in combination with other geotechnical or environmental investigation reports available from the City could provide the level of detail required without the expense of drilling soil borings.

Understanding the depth of groundwater and fluctuation over time could require installation of strategically placed monitoring well(s) to understand the source and direction of groundwater flow and the effects of rainwater and irrigation infiltration. An initial widely spaced grid of wells could be established and monitored semi-annually to quarterly to develop an understanding of groundwater behavior. The wells could be supplemented if an area’s data seems erratic or if addition detail is desired.

Planning for such a study should be preceded by a desktop study reviewing available data contained in City files and interviewing local civil/geotechnical and geological consultants familiar with the Fort Bragg’s soil and geologic conditions that may offer specific knowledge from past experience within the City. All the groundwater, soil, and bedrock depth and slope instability data can then be collected through GIS and reviewed to determine where more detailed study would be warranted. The information would need to be reviewed and updated to provide a living document that can be used by all departments of the City for planning and risk assessment. HDR understands that they City is documenting the presence of shallow groundwater as part of ongoing maintenance work (unpublished).

11 Limitations

This report was developed by HDR for the client's sole and exclusive use on this project for the purposes described in this report and within the scope of work, and in accordance with contract conditions. This report is not for the benefit of any third party and may not be distributed to, disclosed in any form to, used by, or relied upon by any third party without prior written consent of HDR. Consent may be withheld by HDR at its sole discretion. Use of this work product by others is at their own risk and the user assumes all liability for its use. This report must be read as a whole; individual sections should not be considered or interpreted on a stand-alone basis. The content included in this report is correct to the best of HDR's knowledge and has been developed in accordance with the standard of care that is customarily followed by a practitioner in this industry reviewing and reporting existing data. The scope of this project did not include collection and analysis of data and for calculations or modeling in support of this report.

The information provided in this report was developed or provided by others. Except as specifically identified in this report, HDR has not performed independent validation or verification of exploration data, modeling data, or other analysis data provided by others. HDR has used qualified and diligent staff to prepare this report and has assumed that third-party or client data are accurate, complete, reliable, and current. Depth to groundwater levels recorded on boring logs in these studies is subject to many variables and may not be indicative of long-term equilibrium conditions. These variables include water introduced during drilling operations, surface infiltration, puncture of perched horizons, build-up of mud against the walls of the boring (which can reduce infiltration), and inadequate time for equilibration of groundwater pressure.

HDR has not performed a site-specific seismic evaluation of ground shaking intensity or duration. Recommendations in this report are based on published mapping prepared by others and standard practices for the area.

12 References

American Lifeline Alliance (2005) Seismic Guidelines for Water Pipelines(https://www.americanlifelinesalliance.com/pdf/SeismicGuidelines_WaterPipelines_Comm.pdf.

Arcadis (2011) Draft Conceptual Design, Mill Pond Complex Restoration, Former Georgia Pacific Wood Products Facility (Text only) June (source savenoyoheadlands.org)

California Department of Conservation, Mendocino County Tsunami Hazard Areas https://www.conservation.ca.gov/cgs/tsunami/maps/mendocino

California Department of Conservation - Alquist-Priolo Earthquake Fault Zones (ca.gov)

California Geological Survey (CGS) 2011, Sheet 58, Deep Seated Landslide Susceptibility

California Office of Emergency Services online MyHazard Maps myhazards.caloes.gov

Coastal Conservancy – Projects and Land Acquisitions the Coastal Conservancy is s supporting along the coastline in Fort Bragg - http://websites.greeninfo.org/mapcollaborator/sccpv/prod/#

Durham, J.B., 1979, Title II Geologic Compilation Project, Ukiah and Santa Rosa Map Sheets: California Department of Forestry, unpublished 15-minute quadrangle maps, scale 1:62,500

Fort Bragg (2008) Coastal General Plan, July

Fort Bragg (2012) Inland General Plan, November

Fort Bragg Mendocino Coast Historical Society – 1873 Coastal Survey Map, 18723/2023 Slider Maphttps://www.fortbragghistory.org/?page_id=1071

Geotracker - Environmental Clean-up Areas within and in the Vicinity of Fort Bragg https://geotracker.waterboards.ca.gov/map/?CMD=runreport&myaddress=Fort+Bragg+CaHDR 2017, Seismic Considerations for Water Distribution https://www.hdrinc.com/sites/default/files/2017-05/hdr-seismic-considerations-for-water-distribution.pdf. (link no longer active as of 3/2025)Manson, M.W., Sowma-Bawcom, J.A., and Parker, T.K. (2001) Geologic and geomorphic features related to landsliding, Noyo River watershed, Mendocino County, California, California Division of Mines and Geology. Publication DMG CD 2001-03

Office of the State Fire Marshal – Fire Hazard Severity Zones https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/wildfire-preparedness/fire-hazard-severity-zones/fire-hazard-severity-zones-map/

O'Rourke, T.O. (Undated) Seismic Resilient Pipelines, Webinar Slides, Seismic Resilient Pipelines with Cornell Professor Thomas O'Rourke (ca.gov)

Pacific Institute – California Flood Risk: Sea Level Rise, For Bragg Quadrangle https://pacinst.org/reports/sea_level_rise/hazmaps/Fort_Bragg.pdf

TRC, 2004, Phase II Environmental Site Report, Georgia-Pacific California Wood Product Manufacturing Division, 90 Fort Bragg Avenue, Fort Bragg, California, May (EnviroStor.dtsc.ca.gov))

United Stated Department of Agriculture Web Soil Survey https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

United States Geological Survey Quaternary fault map - USGS.maps.arcgis.com/apps

USGS Publication Warehouse – Simon, R.B, Pampeyan, E.H. and Stover C.W. (1978) The Willits, California, magnitude-4.8 earthquake of November 22, 1977 https://pubs.usgs.gov/publication/ofr781075

USGS Earthquake Hazards Program M7.0- 2024 Offshore Cape Mendocino, California Earthquake - https://earthquake.usgs.gov/earthquakes/eventpage/nc75095651/executive

Attachment A – Summary of Geotechnical Conditions Depicted by City-Provided Geotechnical Reports

The thickness of soil layers described below will likely vary across the project site. Borings indicate the depth across the site, but these elevations (or depths) may be somewhat higher/lower/greater between the borings.

The reports state that the materials encountered in exploratory borings were continuously logged in the field by an engineering geologist/geological engineer. The unconsolidated materials (soil) were visually classified using the Unified Soils Classification System (USCS), according to ASTM D-2487. However, the quality of the observations, visual logging, and quantity supporting laboratory testing vary between the reports. HDR has not performed independent validation or verification of exploration data, modeling data, or other analysis data provided by others. HDR has used qualified and diligent staff to prepare this report and has assumed that third-party or client data are accurate, complete, reliable, and current.

The reports reviewed are:

- Brunsing and Associates (2015), Geotechnical Investigation, The Avalon Inn, 1201 North Main Street, Fort Bragg, December 4
- Brunsing and Associates (2016), Engineering Geologic and Geotechnical Reconnaissance, Blufftop Biological Treatment Facility, Fort Bragg Wastewater treatment Plan, 101 Cypress Street, Fort Bragg, California, September 12
- Caltrans (2011), Memorandum, Geotechnical Design Report, Fort Bragg ADA project October 31
- Crawford and Associates (2022), Final Geotechnical Report, City of Fort Bragg Raw Water Pipeline Replacement, Segment 2 – 5, Fort Bragg, California, March
- Curry Group (CGI, INC) (2007), Geotechnical Study, 45-acre-foot Line Reservoir, Fort Bragg California, January 9
- HDR 2016 Fort Bragg Wastewater Treatment Plan Upgrade Project, Fort Bragg, California, February 19
- Salem Engineering Group, Inc. (2018), Geotechnical Engineering Investigation, Proposed AutoZone Retail Store, 1151 South Main Street, Fort Bragg, California, March 6
- SHN Consulting Engineers & Associates (2003) Revised Geotechnical Report, Proposed Recreation Building Green Memorial Field, Fort Bragg, California, August

The identification of Zones is based on the City of Fort Bragg Inland and Coast General Plans (City of Fort Bragg 2012 and 2008) The Inland Zone is identified as a generally a westward project extending from the intersection of Walnut Street and Highway 1, projecting east to the top of the Noyo River north bank and to the north from the intersection of Walnut Street and Highway 1, following Highway 1 north to beyond Virgin Creek, as shown on Map LU-1, Land Use Designation. The Coastal Zone is all areas west and south of the Inland Zone, including the intersection of Highway 1 and Highway 20, for areas within the City boundary and sphere of influence as shown on Figure LU-1 Land Use Designations. The Noyo River has been included in the Coastal Zone. For this document, Pudding Creek and the Noyo River have been selected to divide the Coastal Zone

into the North, Central and Southern zones. Therefore, historical investigations that extend or are located south of the Noyo River north top of bank are included in the southern Coastal Zone.

North Coastal Zone

Brunsing 2015

The report by Brunsing (2015) is located in the North Coastal Area along the west side of Highway 1 just south of the intersection of Airport Road. The report states:

- Surface soils depicted by the exploratory borings generally consist of about one to 2.5 feet of brown silty sand topsoil that is very loose to medium dense and porous.
- Beneath the topsoil, the site is typically mantled by poorly-consolidated marine terrace deposits.
- The terrace deposits consist of beach or shallow marine sediments that are typically comprised of sands with some silt, gravel, and clay, along with incorporated rock fragments eroded from the underlying bedrock platform.
- The terrace materials were deposited in lenses that are generally flat, with local undulations caused by the variable-energy nature of the depositional environment and are mostly comprised of loose to medium dense, saturated sands. Clayey or silty sands were observed in some of the borings, generally just under the topsoil, but most of the terrace deposits encountered are relatively devoid of fines (silt- and clay-sized particles).
- The terrace deposits generally extend to between 7.5 and 15 feet below the ground surface (bgs), and appear to generally thicken toward the east.
- The terrace deposits we observed within the bluff face west of the property, up to about 10 feet thick, consisting of reddish brown silty sands interbedded with silty sandy gravels.
- Bedrock was encountered at depths ranging from approximately 7.5 to 15 feet. The encountered bedrock generally consists of dark gray sandstone that is moderately to intensely fractured, moderately hard to very hard, and deeply- to little-weathered.
- Practical drilling refusal was generally encountered after about one to three feet of penetration into the bedrock.

Unstabilized ground water levels were observed at the time the exploration was performed between about 2.5 and 7 feet below the ground surface. The report state states that shallow ground water can temporarily occur during, and immediately following wet weather periods.

The US Department of Agriculture provides maps of soil conditions depths on the order of 6 feet. A map of the units for the City and surrounding and typical engineering and chemical properties are provided in Attachment A. The units for this are (117, 161, and 214) are consistent with the Brunsing report's description of near surface conditions.

The results of tests evaluating the corrosion protection of the soil on steel and concrete were not performed by the Author of the report. According to the available soil survey data the marine terrace deposits are acidic (pH range of 2 to 5.5) and have a low cation exchange capacity. Discussion of corrosivity testing results presented in other geotechnical report is discussed in the section entitled Other Geologic Related Concerns.

Central Coastal Zone

HDR 2016

HDR performed a focused geotechnical investigation of the City's Waste Water Treatment Plant (WWTP) Expansion in 2016. The plant is located on Noyo Point Road to the south west of the former Georgia-Pacific Lumber southern processing mill site, on the southside of the site. Other geotechnical investigation have been performed in the historical past related to the WWTP and are included within this report. This document reports near surface geotechnical conditions consisted of:

- Pleistocene age marine terrace deposits that overlie marine sedimentary bedrock consisting of sandstone, shale, and conglomerate.
- Past borings by others and borings for the current study indicate that fill generally overlies bedrock at the WWTP site except shallow bedrock was encountered for two structures.
- Fill was reported as extending to depths of about 8 to 9½ feet, and the report states "generally consists of dark brown to black, loose to medium dense silty sand with varying amounts of gravel.
- Beneath the fill, brown-yellow loose to medium poorly-graded fine sand with silt was encountered.
- The sand deposits are consistent with descriptions of marine terrace deposits mapped by Kilbourne (1983). The sand deposits extend to depths of about 11½ feet (Elevation 38½ feet) in Boring K-2, 13 feet in Boring B-02 (Elevation 35 feet), and 18 feet in Boring B-01 (Elevation 30 feet), where bedrock was encountered suggesting that the depth to bedrock generally increases to the north and west.
- The bedrock encountered generally consists of slightly weathered to decomposed, weak to moderately strong sandstone and interbedded shale and sandstone and extended to the maximum depth explored of about 24 feet.

The units for the northern area just south of Pudding Creek are reported as the same as for the North Coast Area (117, 161, and 214). The unit for the majority of the Central Coast Zone and the Inland Zone of Fort Bragg is Unit 219 – Urban Land with little soil descriptions other that the material source is fluvial marine.

The results of tests evaluating the corrosion protection of the soil on steel and concrete were not performed by the Author of the report. According to the available soil survey data the marine terrace deposits are acidic (pH range of 2 to 5.5) and have a low cation exchange capacity. Discussion of corrosivity testing results presented in other geotechnical report is discussed in the section entitled Other Geologic Related Concerns.

Two boring (B-03 and B-04) were drilled in an area of shallow bedrock with near surface conditions reported as the upper approximately ½-foot to 1.5 foot silty sand fill and underlain by bedrock generally consisting of slightly weathered, moderately strong sandstone that extended to the depth explored of about 15 feet.

The report states that monitoring well data from studies performed in the surrounding area associated with the adjacent Georgia-Pacific operations were available online (Arcadis, 2010). "From a review of these data and what was encountered in the WWTP borings, … "true" groundwater may

exist in the bedrock at depths below the bottom elevation of the proposed structures (Elevation 28 feet)."

The report concluded that the reported groundwater in the past WWTP borings is perched water from near surface sources. Fluctuations in the groundwater level could occur due to changes in seasons, variations in rainfall, and other factors.

South Coastal Zone, Salem 2018 and Caltrans 2011

Salem (2018) - West of Highway 1

Salem performed a geotechnical investigation for a commercial development to be located at 1151 South Main Street northwest of the intersection of Highway 1 and Ocean View Street. The document reports:

- The soils encountered in the test borings drilled as part of this investigation generally consisted of silty and clayey sands with gravel underlain by interbedded layers of sandy silty clay, sand with silt, silty sands, and sandy silts to the maximum depth explored of 20.5 feet.
- The upper 5 feet were noted to be loose to medium dense. Below 5 feet the soils were generally described as dense to very dense, however one boring encountered loose soils at 15 feet.
- The borings were checked for the presence of groundwater during and after the drilling operations. Free groundwater was not encountered within the borings excavated for this investigation. However, perched groundwater was encountered in two borings at depths of about 11 feet below ground surface.

Caltrans 2011 - East of Highway 1 on the North Side of Highway 20

Caltrans performed an investigation for a sidewalk/retaining structure at the intersection of Highway 20 and Boatyard Drive. Subsurface Material Consist of Terrace Deposits underlay by decomposed sandstone. Weathering progresses from decomposed to intensely weathered between depths of 10 to 12 feet.

Groundwater was encountered at about 9 feet below ground surface in one boring and not encountered in other borings.

The NCRS units for this area lying north of Hare Creek are Units 106 and 161 and south of Hare Creek 212. These units are windblown terrace deposits (Eolian) consistent with the conditions provided in the two reports. Within Hare creek and the incised drainage, it is Units 131 and 139 alluvial sediments derived from bedrock.

The results of tests evaluating the corrosion protection of the soil on steel and concrete were not performed by the Author of the report. According to the available soil survey data the marine terrace deposits are acidic (pH range of 2 to 5.5) and have a low cation exchange capacity. Discussion of corrosivity testing results presented in other geotechnical report is discussed in the section entitled Other Geologic Related Concerns. The Caltrans report states that corrosion testing of soils was ongoing and would be provided at a later date.

Inland Zone – South (Outside City Limits)

CGI 2007 – Summer Lane Reservoir

The Summer Lane reservoir is located at the north end of Summer Lane north of Highway 20, located is outside of the City Limits and Inland of Southern Coastal Area. The report states the near surface conditions as:

The project site is located on an emergent marine terrace that is locally covered with older dune sands. According to Kilbourne (1983), the Fern Creek marine terrace deposits underlie the majority of the site and are exposed in Newman Gulch that projects north of the project. The Fern Creek marine terrace in the project area is composed predominantly of interbedded silty sand with intermittent sandy silt, clayey sand, and sandy clay. Minor fine to medium, subangular to subrounded gravels were observed in test pits and local cobbles might be encountered within these terrace deposits; however, cobbles were not observed during this study. The Fern Creek terrace is approximately 70 to 90 feet thick and is underlain by the Coastal Belt of the Franciscan Formation bedrock. Older dune sands were mapped by Kilbourne (1983) overlying the terrace deposits in the southwesterly corner of the site. The presence of these dune sands was not observed during this study.

Bedrock was not encountered within explorations made during this study. Regional geotechnical studies have encountered Franciscan Formation sandstone, siltstone, and shale at depths ranging from:

- *12 to 35 feet on the Boddy property located about 3,000 west of the project site (Wahler, 1994b);*
- *25 to 32 feet at a site downstream of the existing Newman Reservoir (Wahler, 1994b);*
- *26 to 55 feet at GP-2 and GP-3, located about 5,000 feet east if the site (Wahler, 1994a and 1994b).*

The report notes that groundwater was encountered at depths of 10 to 18 feet.

Crawford 2022

Crawford investigated near surface soil conditions for construction of a replacement pipeline that included 7 test pits excavated to a depth of 6 to 9 feet and 31 hand augers to depths of 3 to 5 feet. The pipeline segments are located along the eastern edge of the City extending from the water treatment facility located at the intersection of Sherwood Road and Monsen Way, extending about 2,500 lineal feet south to Chestnut Street (Segment 2 discussed in the previous section), then about 5,000 lineal across the Noyo River and then to the southeast to the Summer Lane Reservoir (Segment 3). Two additional segments are located from Benson Lane water storage facility and progress to the south side of Hare Creek (Segment 4) to a hilltop above and to the south of Hare Creek Segment 5. Segments 4 and 5 have a straight-line distance of 4,500 feet. Bedrock was only encountered in one exploration at a depth of 3.5 feet and not encountered in the remainder of the explorations. Refusal was encountered in 16 of the 31 hand augers between 2 to 4.5 feet. No estimates of stiffness or consistency were provided on the log of borings. The report states for Segments 3,4 and 5:

- Segment 3 and 4 – Encountered conditions: silty to clayey sand with interbedded silt and clay. Poorly graded sand was encountered along Dwyer Lane. Auger refusal ranged from 2 to 4 feet.
- Segment 5 – Encountered Conditions clayey sand, sandy silt and sandy lean clay. Auger refusal at a depth 4.0 to 5 feet along the alignment.

Groundwater was not encountered in the explorations. However, the report states that groundwater will likely fluctuate with the river and stream elevations in Hare Creek (Segment 5) and the Noyo River (Segment 3).

The units, as shown on Attachment B – NCRS Soil Survey Map, for Inland Zone are 122, 174 and 214 for the Segment 3 Noyo Creek crossing to the Summer Lane Reservoir. The soil unit for Segment 4 is primarily unit 122, and until 135 where it crosses hare Creek. Unit 5 is in Unit 157. Unit 122 is derived from salt affected marine terrace deposits with no reported depth to bedrock, Unit 214 are fluvial marine deposits with depth of bedrock in excess for 6 feet and Units 135 and 174 are colluvium derived material with bedrock at a depth of 5 feet or greater.

The units for the Inland Zone (south) is 196 and in the adjacent areas as 108, 122, 148, 149, 195, 199 and 214. These units are all described as marine terrace deposits derived from sandstone with the western units (122, 148, 149) comprised of Eolian Terrace Deposits that would be subsurface conditions similar to the Southern Coastal Area.

The results of tests evaluating the corrosion protection of the soil on steel and concrete were not performed by the Author of the report. According to the available soil survey data the marine terrace deposits are acidic (pH range of 4.5 to 5.5) and have a low cation exchange capacity. Discussion of corrosivity testing results presented in other geotechnical report is discussed in the section entitled Other Geologic Related Concerns.

Inland

SHN 2003

This report was prepared for the design and construction of the aquatic facility located at the intersection of South Lincoln Street and Maple Street. The report states that site soils include compressible upper deposits to depths of at least 6 feet, some minor layers of loose to moderately dense sandy soils below that depth and are variable (erratic), with low density Peat, or silty/clayey layers, extending as deep as 22 feet in some locations. The density of the sand layers below 155 feet was estimated as dense to very dense in one boring. Sand Heaving occurred in other borings resulting in lower density estimates and are not representative. Dense materials were encountered between 5 to 10 feet of the ground surface at the southern 2/3 building area (Location unknown). A compressible clay layer was encountered in three explorations between 11 and 15 feet. It is not clear if the dense sand below 15 feet is completely weathered sandstone.

Groundwater was monitored by what is described as installing a well screen at a depth of 20 feet then sealing the borehole. Groundwater reportedly rose to a depth of 3 feet below the ground surface. Other groundwater investigations are to be performed per the report. Log of borings report water at a depth of 6.5 to 7.5 ft at the time of drilling (October 28, 1998)

Crawford (2022)

As previously stated, Crawford investigated near surface soil conditions for construction of a replacement pipeline that included 7 test pits excavated to a depth of 6 to 9 feet and 31 hand augers to depths of 3 to 5 feet. Crawford performed a near surface geotechnical investigation for 4 segments of pipeline (Segments 2 through 5) that extends from the inland (segment 2) area to the south inlead area (Segments 3, 4 and 5). Segment 2 is located along the eastern edge of the City extending from the water treatment facility located at the intersection of Sherwood Road and Monsen Way, extending about 2,500 lineal feet south to Chestnut Street. Bedrock was only encountered in one exploration at a depth of 3.5 feet and not encountered in the remainder of the explorations. Refusal was encountered in 16 of the 31 hand augers between 2 to 4.5 feet. No estimates of stiffness or consistency were provided on the log of borings. The report states for Segment 2:

- Segment 2 – Encountered conditions: clayey sand to lean clay over slightly weathered sedimentary rock

Groundwater was not encountered in the explorations.

The units for the Inland Zone is 195 for the majority of the city (Urban Land) and 141, 199, 214 along the eastern edge of the city with and 136 and 174 along the north slope of the Noyo River incised channel. Units 199, and 214 are thick fluvial marine in origin derived from sedimentary rock and Unit 141 is comprised of Marine deposits. Units 136 and 174 are colluvial deposits.

The results of tests evaluating the corrosion protection of the soil on steel and concrete were not performed by the Author of the report. According to the available soil survey data the Unit 141 marine terrace deposits are acidic (pH range of 3.5 to 5.5) and have a low cation exchange capacity (5 to 50 meq/100g). Unit 199 upper soils are reported as having similar to Unit 141 while no data is provided for Unit 214. Colluvial units are report as being less acidic (Ph 5.6 to 6.5) and have a slightly higher cation exchange capacity. Discussion of corrosivity testing results presented in other geotechnical report is discussed in the section entitled Other Geologic Related Concerns.

Attachment B – NCRS Soil Survey Map and Select Data

Figure B-1 NCRS Map of Soil Units

NCRS Engineering Properties by Unit (See Figure B-1 for Unit Numbers)

NCRS Chemical Properties by Unit (See Figure B-1 for Unit Numbers)

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Report—Engineering Properties

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
106—Biaggi loam, 5 to 15 percent slopes														
Biaggi	80	C	0-23	Loam	ML	A-4	0- 0- 0	0- 0- 0	80-90-100	75-88-100	70-78-85	50-55-60	25-30-35	NP-5-10
			23-27	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—
107—Bigriver loamy sand, 0 to 5 percent slopes														
Bigriver	80	A	0-6	Loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	15-23-30	—	NP
			6-63	Stratified loamy sand to silt loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-68-75	25-38-50	15-20-25	NP-3 -5

Engineering Properties–Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
108—Blacklock and Aborigine soils, 0 to 5 percent slopes														
Blacklock	42	D	0-7	Loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	15-23-30	0-7 -14	NP
			7-14	Sandy loam, loamy sand	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	15-28-40	20-23-25	NP-3 -5
			14-61	Cemented	SP-SM, SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-73-85	5-18- 30	0-7 -14	NP
			61-64	Loamy sand, sand, loamy fine sand	SP-SM, SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-73-85	5-18- 30	0-7 -14	NP
Aborigine	38	D	0-6	Sandy loam	SC-SM, SM	A-2-4, A-4	0- 0- 0	0- 0- 0	95-97-100	90-93-100	65-71-80	30-35-43	18-22-25	2-4 -6
			6-13	Loam	CL	A-6	0- 0- 0	0- 0- 0	95-97-100	90-93-100	76-83-93	53-60-71	25-30-35	9-13-17
			13-61	Sandy clay, clay, clay loam	CH, CL	A-7-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	81-85-93	51-57-68	42-52-62	24-32-40

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
117—Cabrillo-Heeser complex, 0 to 5 percent slopes														
Cabrillo	50	B	0-26	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	65-73-80	35-43-50	20-25-30	NP-3 -5
			26-35	Sandy clay loam	SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-85-90	35-43-50	30-35-40	10-15-20
			35-50	Sandy clay loam, sandy clay	SC	A-6, A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-85-90	35-43-50	30-38-45	10-15-20
			50-60	Sandy loam, loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-60-70	10-23-35	20-25-30	NP-3 -5
Heeser	30	A	0-34	Sandy loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-70-80	30-35-40	20-25-30	NP-3 -5
			34-65	Sandy loam, loamy sand, sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	95-98-100	50-65-80	15-25-35	—	NP
122—Caspar sandy loam, 2 to 9 percent slopes														
Caspar	80	B	0-16	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-68-75	35-43-50	20-25-30	NP-3 -5
			16-37	Sandy loam, loam, sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	85-93-100	75-88-100	50-68-85	35-43-50	25-30-35	5-10-15
			37-48	Sandy clay loam, clay loam, sandy clay	CL, SC	A-6, A-7	0- 0- 0	0- 0- 0	85-93-100	75-88-100	65-78-90	35-48-60	30-38-45	10-15-20
			48-62	Sandy loam, loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-60-70	20-28-35	20-25-30	NP-3 -5

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
123—Caspar-Quinliven complex, 30 to 50 percent slopes														
Caspar	50	B	0-16	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-68-75	35-43-50	20-25-30	NP-3 -5
			16-37	Sandy loam, loam, sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	85-93-100	75-88-100	50-68-85	35-43-50	25-30-35	5-10-15
			37-48	Sandy clay loam, clay loam, sandy clay	CL, SC	A-6, A-7	0- 0- 0	0- 0- 0	85-93-100	75-88-100	65-78-90	35-48-60	30-38-45	10-15-20
			48-62	Sandy loam, loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-60-70	20-28-35	20-25-30	NP-3 -5
Quinliven	35	C	0-4	Sandy loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-65-70	30-38-45	20-25-30	NP-3 -5
			4-11	Sandy loam, loam	CL-ML, SC-SM, ML, SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	65-78-90	35-48-60	25-30-35	5-8 -10
			11-18	Loam, sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-88-95	45-60-75	25-33-40	10-15-20
			18-51	Clay, sandy clay	MH, ML	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	85-93-100	50-73-95	40-50-60	10-18-25
			51-60	Sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-90-100	40-60-80	30-35-40	10-15-20
			60-64	Loamy sand, sandy loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	20-30-40	20-25-30	NP-3 -5

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
124—Caspar-Quinliven-Ferncreek complex, 9 to 30 percent slopes														
Caspar	37	B	0-16	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-68-75	35-43-50	20-25-30	NP-3 -5
			16-37	Sandy loam, loam, sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	85-93-100	75-88-100	50-68-85	35-43-50	25-30-35	5-10-15
			37-48	Sandy clay loam, clay loam, sandy clay	CL, SC	A-6, A-7	0- 0- 0	0- 0- 0	85-93-100	75-88-100	65-78-90	35-48-60	30-38-45	10-15-20
			48-62	Sandy loam, loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-60-70	20-28-35	20-25-30	NP-3 -5
Quinliven	33	C	0-4	Sandy loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-65-70	30-38-45	20-25-30	NP-3 -5
			4-11	Sandy loam, loam	CL-ML, SC-SM, ML, SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	65-78-90	35-48-60	25-30-35	5-8 -10
			11-18	Loam, sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-88-95	45-60-75	25-33-40	10-15-20
			18-51	Clay, sandy clay	MH, ML	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	85-93-100	50-73-95	40-50-60	10-18-25
			51-60	Sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	80-90-100	40-60-80	30-35-40	10-15-20
			60-64	Loamy sand, sandy loam	SM	A-2, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	20-30-40	20-25-30	NP-3 -5
Ferncreek	15	D	0-7	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	80-90-100	75-88-100	65-70-75	35-43-50	20-25-30	NP-3 -5
			7-33	Clay, clay loam	MH, ML	A-7	0- 0- 0	0- 0- 0	80-90-100	75-88-100	70-80-90	50-63-75	40-50-60	10-18-25

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			33-43	Sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	80-90-100	75-88-100	65-73-80	35-43-50	25-33-40	5-10-15
			43-61	Sandy loam, sandy clay loam	SC-SM, SC	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-68-75	35-43-50	20-25-30	5-8 -10
131—Cottoneva loam, 0 to 2 percent slopes														
Cottoneva	90	C	0-12	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-90-95	50-63-75	20-25-30	NP-5-10
			12-43	Stratified sandy loam to very fine sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-73-85	35-43-50	15-20-25	NP-3 -5
			43-63	Stratified loam to clay loam	CL-ML, CL	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	80-88-95	55-65-75	25-33-40	5-10-15

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
135—Dehaven-Hotel complex, 50 to 75 percent slopes														
Dehaven	45	B	0-17	Gravelly loam	GC-GM, SC-SM, GM, SM	A-4	0- 0- 0	0- 0- 0	60-70-80	50-63-75	45-58-70	35-43-50	25-30-35	5-8 -10
			17-34	Very gravelly sandy clay loam, very gravelly clay loam	GC	A-2	0- 0- 0	0-13- 25	30-45-60	25-38-50	25-35-45	15-25-35	25-33-40	10-15-20
			34-52	Extremely gravelly sandy clay loam, extremely gravelly clay loam	GP-GC, GC	A-2	0- 0- 0	0-13- 25	25-28-30	15-20-25	10-18-25	5-13- 20	25-33-40	10-15-20
			52-56	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—
Hotel	35	C	0-8	Very gravelly loam	GC-GM, GM	A-2	0- 0- 0	0- 3- 5	40-48-55	35-43-50	30-38-45	25-30-35	25-30-35	5-8 -10
			8-35	Very gravelly clay loam, very gravelly sandy clay loam, extremely gravelly clay loam	GP-GC, GC	A-2	0- 0- 0	0- 8- 15	20-40-60	15-35-55	10-28-45	5-20- 35	30-35-40	10-15-20
			35-39	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
136—Dehaven-Hotel complex, 75 to 99 percent slopes														
Dehaven	42	B	0-17	Gravelly loam	GC-GM, SC-SM, GM, SM	A-4	0- 0- 0	0- 0- 0	60-70-80	50-63-75	45-58-70	35-43-50	25-30-35	5-8 -10
			17-34	Very gravelly sandy clay loam, very gravelly clay loam	GC	A-2	0- 0- 0	0-13- 25	30-45-60	25-38-50	25-35-45	15-25-35	25-33-40	10-15-20
			34-52	Extremely gravelly sandy clay loam, extremely gravelly clay loam	GP-GC, GC	A-2	0- 0- 0	0-13- 25	25-28-30	15-20-25	10-18-25	5-13- 20	25-33-40	10-15-20
			52-56	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—
Hotel	38	C	0-8	Very gravelly loam	GC-GM, GM	A-2	0- 0- 0	0- 3- 5	40-48-55	35-43-50	30-38-45	25-30-35	25-30-35	5-8 -10
			8-35	Very gravelly clay loam, very gravelly sandy clay loam, extremely gravelly clay loam	GP-GC, GC	A-2	0- 0- 0	0- 8- 15	20-40-60	15-35-55	10-28-45	5-20- 35	30-35-40	10-15-20
			35-39	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
141—Ferncreek sandy loam, 2 to 9 percent slopes														
Ferncreek	80	D	0-7	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	80-90-100	75-88-100	65-70-75	35-43-50	20-25-30	NP-3 -5
			7-33	Clay loam, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	80-90-100	75-88-100	70-80-90	50-63-75	40-50-60	10-18-25
			33-43	Sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	80-90-100	75-88-100	65-73-80	35-43-50	25-33-40	5-10-15
			43-61	Sandy clay loam, sandy loam	SC-SM, SC	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-68-75	35-43-50	20-25-30	5-8 -10
148—Gibwell loamy sand, 2 to 9 percent slopes														
Gibwell	75	C	0-12	Loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	15-23-30	—	NP
			12-18	Sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	80-88-95	40-55-70	30-35-40	10-13-15
			18-26	Sandy clay, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	95-98-100	90-95-100	85-90-95	50-65-80	40-50-60	10-18-25
			26-42	Sandy clay loam	SC	A-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	75-83-90	35-43-50	30-35-40	10-13-15
			42-65	Sandy loam, loamy sand, sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	10-20-30	—	NP

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
149—Gibwell loamy sand, 9 to 15 percent slopes														
Gibwell	75	C	0-12	Loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	15-23-30	—	NP
			12-18	Clay loam, sandy clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	80-88-95	40-55-70	30-35-40	10-13-15
			18-26	Sandy clay, clay	MH, ML	A-7	0- 0- 0	0- 0- 0	95-98-100	90-95-100	85-90-95	50-65-80	40-50-60	10-18-25
			26-42	Sandy clay loam	SC	A-6	0- 0- 0	0- 0- 0	95-98-100	90-95-100	75-83-90	35-43-50	30-35-40	10-13-15
			42-65	Sandy loam, loamy sand, sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-63-75	10-20-30	—	NP
157—Harecreek sandy loam, 2 to 9 percent slopes														
Harecreek	85	A	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-10	Sandy loam	SM	A-2-4, A-4	0- 0- 0	0- 0- 0	95-97-100	85-91-100	62-70-81	30-35-43	20-25-30	—
			10-18	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	95-97-100	85-91-100	62-70-81	30-36-43	20-25-30	—
			18-45	Sandy loam, sandy clay loam	SC-SM, SC, SM	A-2-4, A-4	0- 0- 0	0- 0- 0	95-97-100	85-92-100	68-79-88	34-42-48	25-30-35	5-8 -10
			45-65	Sand, loamy sand, sandy loam	—	—	0- 0- 0	0- 0- 0	95-97-100	86-92-100	66-74-84	9-13- 19	—	—

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
161—Heeser sandy loam, 2 to 15 percent slopes														
Heeser	85	A	0-34	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-97-100	69-75-82	33-38-46	20-25-30	—
			34-65	Sandy loam, loamy sand, sand	—	—	0- 0- 0	0- 0- 0	100-100-100	96-97-100	69-74-83	29-37-43	—	—

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
173—Irmulco-Tramway complex, 30 to 50 percent slopes														
Irmulco	70	B	0-1	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			1-7	Loam	SC-SM, CL, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	76-86-100	65-80-96	45-57-72	25-30-35	5-8 -10
			7-42	Loam, clay loam, gravelly loam	SC-SM, CL, SC	A-2-4, A-4, A-6	0- 0- 0	0- 0- 0	76-86-100	49-69-100	43-64-98	31-49-78	25-33-40	5-10-15
			42-62	Clay loam, gravelly clay loam	CH, SC	A-2-4, A-6, A-7-6	0- 0- 0	0- 0- 0	76-86-100	48-68-100	41-63-100	30-49-81	30-40-50	10-18-25
			62-72	Bedrock	—	—	—	—	—	—	—	—	—	—
Tramway	16	C	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-9	Loam	SC-SM, CL, ML	A-4	0- 0- 0	0- 0- 0	91-95-100	77-87-100	66-77-91	47-56-66	25-30-35	5-8 -10
			9-14	Loam	CL-ML, CL	A-4, A-6	0- 0- 0	0- 0- 0	91-95-100	78-87-100	67-78-93	50-59-71	25-33-40	5-10-15
			14-30	Clay loam, gravelly clay loam	CL, SC	A-2-4, A-6, A-7-6	0- 0- 0	0- 0- 0	76-85-100	48-68-100	40-62-98	31-48-78	30-38-45	10-15-20
			30-43	Bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
174—Irmulco-Tramway complex, 50 to 75 percent slopes														
Irmulco	45	B	0-6	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	85-93-100	75-85-95	55-63-70	25-30-35	5-8 -10
			6-61	Loam, clay loam, gravelly loam	CL-ML, GC-GM, CL, GC	A-4, A-6	0- 0- 0	0- 0- 0	65-83-100	60-80-100	50-70-90	40-58-75	25-33-40	5-10-15
			61-65	Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Tramway	35	C	0-7	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	85-93-100	65-80-95	50-63-75	25-30-35	5-8 -10
			7-12	Loam	CL-ML, CL	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	85-93-100	65-80-95	50-63-75	25-33-40	5-10-15
			12-28	Clay loam, gravelly clay loam	CL, GC, SC	A-6, A-7	0- 0- 0	0- 0- 0	65-83-100	60-80-100	55-75-95	40-60-80	30-38-45	10-15-20
			28-32	Weathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
196—Quinliven-Ferncreek complex, 2 to 15 percent slopes														
Quinliven	60	C	0-5	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			5-9	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	72-77-83	34-40-46	20-25-30	—
			9-16	Loam, sandy loam	SC-SM, ML, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	69-77-85	32-40-50	25-30-35	5-8 -10
			16-23	Loam, sandy clay loam, clay loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	83-91-96	59-69-76	25-33-40	10-15-20
			23-56	Clay, sandy clay	MH, ML	A-7-5	0- 0- 0	0- 0- 0	100-100-100	100-100-100	84-92-100	67-80-89	40-50-60	10-18-25
			56-65	Sandy clay loam, clay loam	CL, SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	79-87-95	42-51-60	30-35-40	10-15-20
			65-75	Loamy sand, sandy loam	SM	A-2-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	75-82-89	18-22-33	20-25-30	—
Ferncreek	25	C	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-9	Sandy loam	SM	A-2-4, A-4	0- 0- 0	0- 0- 0	85-91-100	67-80-100	49-61-84	24-31-48	20-25-30	—
			9-35	Clay loam, clay	MH, SM	A-7-5	0- 0- 0	0- 0- 0	85-90-100	65-78-100	57-75-100	44-61-91	40-50-60	10-18-25
			35-45	Sandy clay loam	SC-SM, CL, SC	A-2-4, A-4, A-6	0- 0- 0	0- 0- 0	85-90-100	66-79-100	54-69-92	30-39-54	25-33-40	5-10-15
			45-63	Sandy loam, sandy clay loam	SC-SM, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	71-77-84	34-40-48	20-25-30	5-8 -10

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
199—Shinglemill-Gibney complex, 2 to 9 percent slopes														
Shinglemill	45	C/D	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-10	Loam	ML, SM	A-4	0- 0- 0	0- 0- 0	84-88-95	68-78-95	55-69-89	38-49-65	25-30-35	—
			10-17	Sandy clay loam, loam	CL, SC	A-6	0- 0- 0	0- 0- 0	85-90-100	66-79-100	56-71-91	42-54-69	30-35-40	10-13-15
			17-27	Clay, clay loam	MH, ML	A-7-5	0- 0- 0	0- 0- 0	85-90-100	65-78-100	60-74-100	51-62-100	40-53-65	10-18-25
			27-65	Sandy clay, clay	MH, SM	A-2-7, A-7-5	0- 0- 0	0- 0- 0	85-90-100	65-78-100	48-66-91	30-44-63	45-55-65	15-20-25
Gibney	35	C	0-9	Loam	SC-SM, ML, SC	A-4	0- 0- 0	0- 0- 0	83-90-100	62-78-100	51-68-91	36-48-66	25-30-35	5-8 -10
			9-29	Sandy clay loam, clay loam	CL, SC	A-2-4, A-6	0- 0- 0	0- 0- 0	84-90-100	63-79-100	51-68-92	31-42-59	30-35-40	10-15-20
			29-55	Clay	MH, SM	A-7-5	0- 0- 0	0- 0- 0	83-90-100	62-78-100	51-72-100	44-63-91	40-50-60	10-18-25
			55-63	Sandy clay loam, sandy clay	CH, SC	A-2-4, A-6, A-7-6	0- 0- 0	0- 0- 0	84-90-100	63-79-100	49-69-98	30-45-67	30-40-50	10-18-25

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
212—Tregoning-Cleone complex, 0 to 5 percent slopes														
Tregoning	60	B/D	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-11	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	72-77-81	33-39-45	20-25-30	—
			11-25	Loamy sand, sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	70-76-82	30-38-46	20-25-30	—
			25-64	Sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	78-80-83	11-14-16	—	—
Cleone	20	B	0-3	Loamy sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	76-80-85	19-23-28	—	—
			3-7	Sandy loam	SM	A-2-4, A-4	0- 0- 0	0- 0- 0	87-92-100	70-83-100	52-63-79	25-31-41	20-25-30	—
			7-13	Gravelly sandy loam, gravelly loamy sand	SC-SM, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	76-81-86	57-70-86	41-54-70	19-27-37	20-25-30	—
			13-40	Sandy loam, loamy sand	SC-SM, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	95-97-100	86-92-100	61-70-82	29-35-44	20-25-30	—
			40-62	Loamy sand, sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	77-80-84	19-23-26	—	—

Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
213—Tregoning-Cleone complex, 5 to 15 percent slopes														
Tregoning	55	B/D	0-2	Slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-11	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	72-77-81	33-39-45	20-25-30	—
			11-25	Loamy sand, sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	70-76-82	30-38-46	20-25-30	—
			25-64	Sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	78-80-83	11-14-16	—	—
Cleone	25	B	0-3	Loamy sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	76-80-85	19-23-28	—	—
			3-7	Sandy loam	SM	A-2-4, A-4	0- 0- 0	0- 0- 0	87-92-100	70-83-100	52-63-79	25-31-41	20-25-30	—
			7-13	Gravelly sandy loam, gravelly loamy sand	SC-SM, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	76-81-86	57-70-86	41-54-70	19-27-37	20-25-30	—
			13-40	Loamy sand, sandy loam	SC-SM, SC	A-2-4, A-4	0- 0- 0	0- 0- 0	95-97-100	86-92-100	61-70-82	29-35-44	20-25-30	—
			40-62	Loamy sand, sand	—	—	0- 0- 0	0- 0- 0	100-100-100	100-100-100	77-80-84	19-23-26	—	—
221—Vandamme loam, 9 to 30 percent slopes														
Vandamme	85	C	0-9	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	95-98-100	85-90-95	70-78-85	55-63-70	25-30-35	5-8 -10
			9-42	Clay, clay loam	CH, MH	A-7	0- 0- 0	0- 0- 0	95-98-100	85-90-95	80-85-90	75-80-85	50-55-60	20-25-30
			42-46	Bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
222—Vandamme-Caspar complex, 2 to 15 percent slopes														
Vandamme	50	C	0-9	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	60-65-70	35-43-50	20-25-30	NP-3 -5
			9-42	Clay, clay loam	CH, MH	A-7	0- 0- 0	0- 0- 0	95-98-100	85-90-95	80-85-90	75-80-85	50-55-60	20-25-30
			42-46	Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Caspar	35	B	0-16	Sandy loam	SM	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	60-68-75	35-43-50	20-25-30	NP-3 -5
			16-37	Sandy loam, loam, sandy clay loam	SC-SM, SC	A-4, A-6	0- 0- 0	0- 0- 0	85-93-100	75-88-100	50-68-85	35-43-50	25-30-35	5-10-15
			37-48	Sandy clay loam, clay loam, sandy clay	CL, SC	A-6, A-7	0- 0- 0	0- 0- 0	85-93-100	75-88-100	65-78-90	35-48-60	30-38-45	10-15-20
			48-62	Sandy loam, loamy sand	SM	A-2	0- 0- 0	0- 0- 0	100-100-100	100-100-100	50-60-70	20-28-35	20-25-30	NP-3 -5

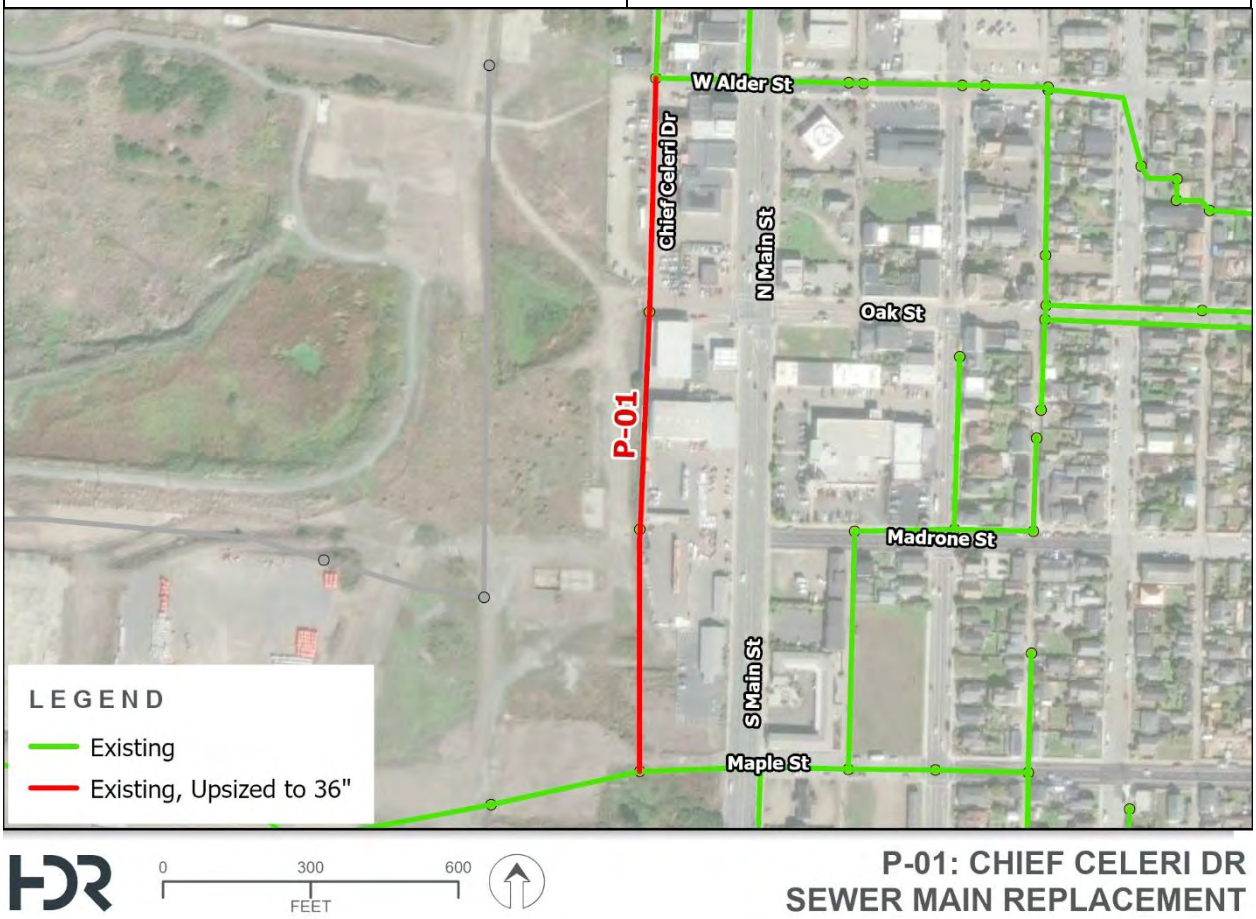
Engineering Properties--Mendocino County, Western Part, California														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
224—Vandamme-Irmulco-Tramway complex, 50 to 75 percent slopes														
Vandamme	32	C	0-9	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	95-98-100	85-90-95	70-78-85	55-63-70	25-30-35	5-8 -10
			9-42	Clay, clay loam	CH, MH	A-7	0- 0- 0	0- 0- 0	95-98-100	85-90-95	80-85-90	75-80-85	50-55-60	20-25-30
			42-46	Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Irmulco	28	B	0-6	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	85-93-100	75-85-95	55-63-70	25-30-35	5-8 -10
			6-61	Loam, clay loam, gravelly loam	CL-ML, GC-GM, CL, GC	A-4, A-6	0- 0- 0	0- 0- 0	65-83-100	60-80-100	50-70-90	40-58-75	25-33-40	5-10-15
			61-65	Weathered bedrock	—	—	—	—	—	—	—	—	—	—
Tramway	15	C	0-7	Loam	CL-ML, ML	A-4	0- 0- 0	0- 0- 0	90-95-100	85-93-100	65-80-95	50-63-75	25-30-35	5-8 -10
			7-12	Loam	CL-ML, CL	A-4, A-6	0- 0- 0	0- 0- 0	90-95-100	85-93-100	65-80-95	50-63-75	25-33-40	5-10-15
			12-28	Clay loam, gravelly clay loam	CL, GC, SC	A-6, A-7	0- 0- 0	0- 0- 0	65-83-100	60-80-100	55-75-95	40-60-80	30-38-45	10-15-20
			28-32	Weathered bedrock	—	—	—	—	—	—	—	—	—	—

Data Source Information

Soil Survey Area: Mendocino County, Western Part, California
Survey Area Data: Version 18, Sep 7, 2022

Appendix J. Preliminary Engineering Reports

Improvement Name:	Chief Celeri Dr Sewer Main Replacement
Project ID:	P-01
CIP Year:	2027



Description:	Replace approximately 1,408 LF of existing 18” main and 474 LF of existing 24” main to 36” Ductile Iron (DI) pipe. The project area extends from the terminus of the existing 18” main at W Alder Street east of N Main Street to the existing 30” main at Maple Street and S Main Street. The depth of the existing water mains is approximately 7.5’ throughout. Utility conflicts will need to be identified during pre-design.
Purpose:	The main purpose of this project is to address condition and structural deficiencies in this line and to accommodate expected increased capacity needs as needed upstream improvements are addressed.
Hydraulic Model Results	During the 10-year storm event, the existing main does not experience any capacity deficiencies. However, as capacity deficiencies upstream of the main are addressed, flows downstream increase. This

	results in capacity issues in the existing main. These resulting capacity deficiencies are eliminated with the system improvement, with max d/D reduced to 0.71.
Alternatives Analysis	Pipeline replacement projects have a limited alternative alignment and associated alternatives analysis; however, there is always a "no project" alternative that can be considered. The "no project" alternative for P-01 results in increasing risk of structural collapse and deficiencies in capacity during the 10-year storm.
Project Trigger:	The primary project triggers for P-1 are the material, condition, and location of the line. It is Corrugated Metal Pipe, which is no longer considered an appropriate material for sanitary sewer gravity mains. According to City staff, corrosion damage to the line is probable. Portions of the line also run under storage structures at the Meno Mill lumber yard, and there is a danger that damage to the line could affect ground stability near those structures. A secondary trigger is a moderately high risk score for the northern portion of the line.
Expected Environmental Compliance:	This project may qualify as categorically exempt. However, the increased size to support future growth may trigger an Initial Study (IS). If the IS identifies no significant impact, the project may adopt a Negative Declaration and proceed with implementation. If the IS identifies significant impacts, but the impacts can be reduced to a less than significant level through mitigation, then the project may adopt a Mitigated Negative Declaration (MND) and proceed. Projects with significant impacts that cannot be mitigated to less than significant levels must be evaluated in an Environmental Impact Report (EIR).
OPCC (2027 dollars):	$2,853,000
Funding Opportunities:	Funding would need to be evaluated further. WIFIA funding may be an option but requires a $5 million project minimum. However, projects can be combined to reach the minimum project size. Fort Bragg qualifies as a small and rural community based on the USDA's eligibility criteria of providing loans to populations of 10,000 or less and USDA loans may be available at a lower than market interest rate. A cost-

	benefit analysis should be used to evaluate if a USDA loan would be worth applying for when compared to water revenue bonds. To qualify, Fort Bragg must propose projects that expand services to very small, rural parts of the town. Eligible activities include legal and engineering fees, acquisitions, start-up operations and maintenance, interest incurred during construction, and the purchase of facilities to expand service.

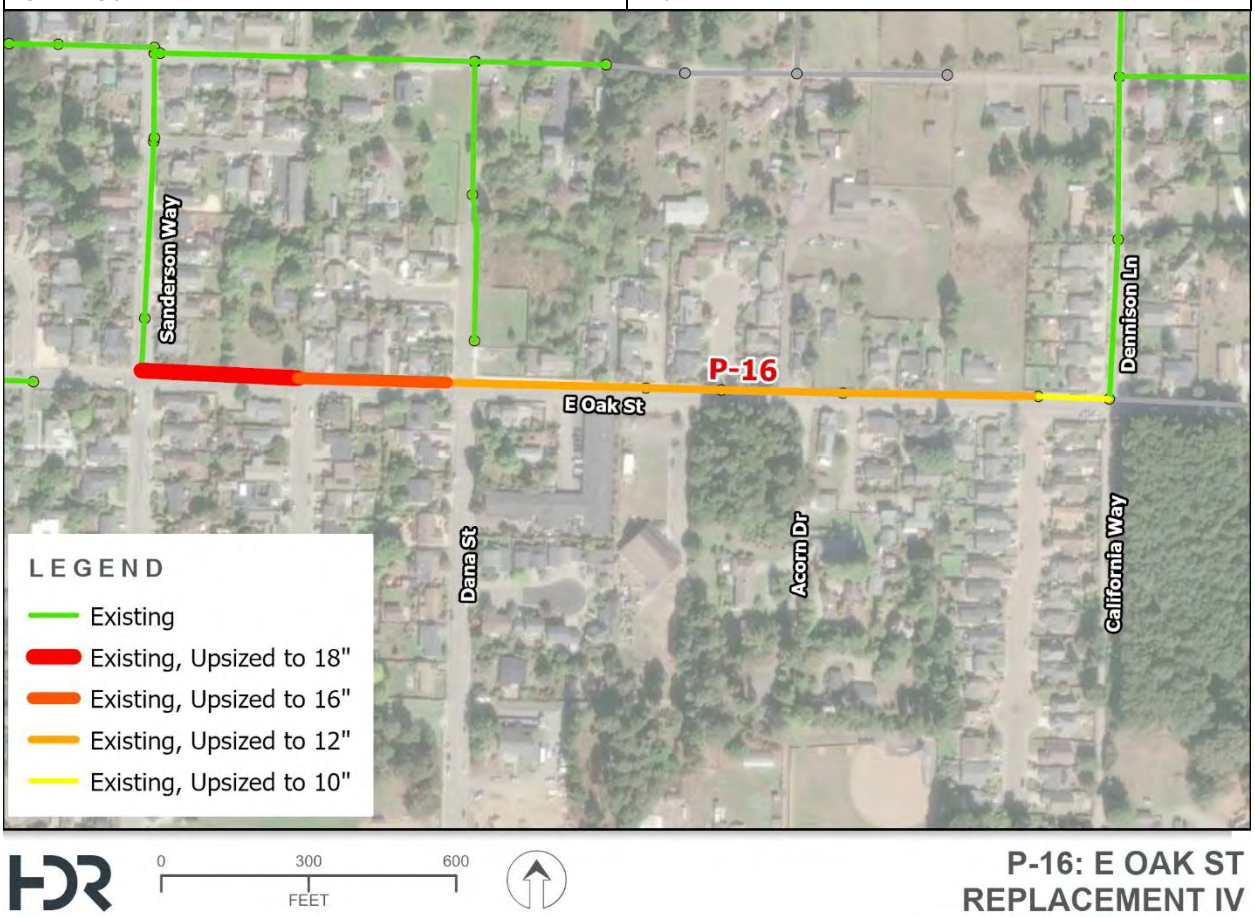
Improvement Name:	WWTP Inflow Sewer Main Replacement
Project ID:	P-02
CIP Year:	2027

Description:	Replace approximately 2,300 LF of existing 30” main to a 42” Ductile Iron (DI) pipe. The project area extends from the terminus of the existing 30” main at South Main Street and Maple Street to the Wastewater Treatment Plant (WWTP) intake. The depth of the existing water mains ~~are~~is approximately 12’ throughout. Utility conflicts will need to be identified during pre-design.
Purpose:	The main purpose of this project is to address condition and structural deficiencies in this line and to accommodate expected increased capacity needs as needed upstream improvements are addressed.
Hydraulic Model Results	During the 10-year storm event, the existing main does not see any capacity deficiencies. However, as

	capacity deficiencies upstream of the main are addressed, flows downstream increase. This results in capacity issues in the existing main. These resulting capacity deficiencies are eliminated with the system improvement, with max d/D reduced to 0.68.
Alternatives Analysis	Pipeline replacement projects have a limited alternative alignment and associated alternatives analysis; however, there is always a "no project" alternative that can be considered. The "no project" alternative for P-02 results in increasing risks of structural collapse and deficiencies in capacity during the 10-year storm.
Project Trigger:	P-1has multiple triggers. First is the known condition of the pipeline. City staff are aware of the poor condition of the line, including large voids in the bottom of the pipe in some areas, along with corrosion damage. A second trigger is a high risk score for the pipe, mainly driven by its age, material, and criticality.
Expected Environmental Compliance:	This project may qualify as categorically exempt. However, the increased size to support future growth may trigger an Initial Study (IS). If the IS identifies no significant impact, the project may adopt a Negative Declaration and proceed with implementation. If the IS identifies significant impacts, but the impacts can be reduced to a less than significant level through mitigation, then the project may adopt a Mitigated Negative Declaration (MND) and proceed. Projects with significant impacts that cannot be mitigated to less than significant levels must be evaluated in an Environmental Impact Report (EIR).
OPCC (2027 dollars):	$6,103,000
Funding Opportunities:	Funding would need to be evaluated further. WIFIA funding may be an option, but requires a $5 million project minimum. However, projects can be combined to reach the minimum project size. Fort Bragg qualifies as a small and rural community based on the USDA's eligibility criteria of providing loans to populations of 10,000 or less and USDA loans may be available at a lower than market interest rate. A cost-benefit analysis should be used to evaluate if a USDA loan would be worth applying for when compared to

	water revenue bonds. To qualify, Fort Bragg must propose projects that expand services to very small, rural parts of the town. Eligible activities include legal and engineering fees, acquisitions, start-up operations and maintenance, interest incurred during construction, and the purchase of facilities to expand service.

Improvement Name:	E Oak St Replacement IV
Project ID:	P-16
CIP Year:	2027

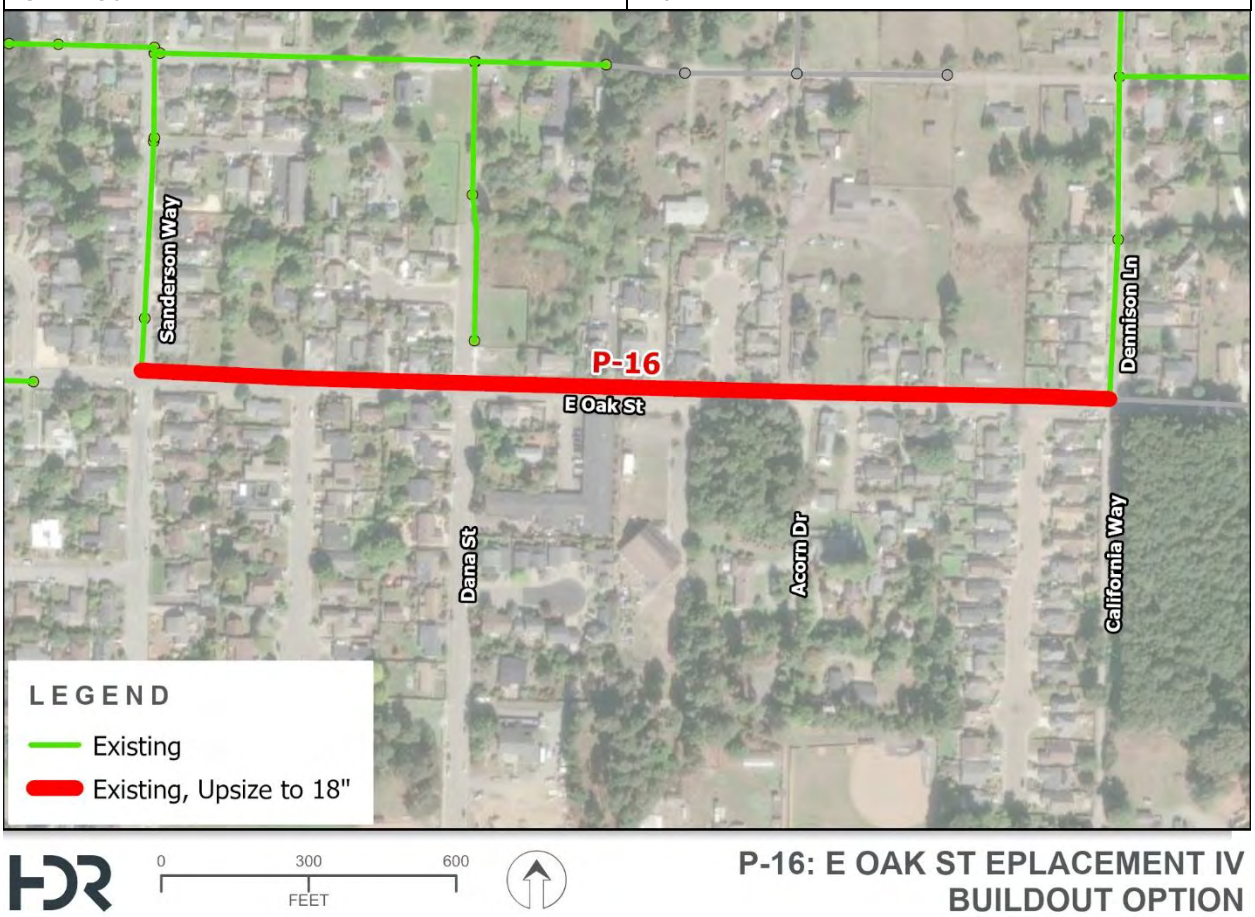


Description:	Replace 146 LF of existing 8” main to a 10” PVC SDR 35 pipe. Replace 1,203 LF of existing 8" main to a 12” PVC SDR 35 pipe. Replace 303 LF of existing 6" main to a 16” PVC SDR 35 pipe. Replace 319 LF of existing 6” main to a to 18” PVC SDR 35 pipe. The project area extends along E. Oak Street from the existing 8” main at Dennison Lane to the existing 6” at- Sanderson Way. The depth of the existing water mains is approximately 7’ throughout. Utility conflicts will need to be identified during pre-design.
Purpose:	The main purpose of this project is to address capacity issues in the existing system under existing 10-year storm conditions.

Hydraulic Model Results	During the 10-year storm event, the existing main is over capacity with a max d/D of 1, with moderate overflows expected on three manholes. This capacity deficiency is eliminated with the system improvement, with max d/D reduced to 0.74.
Alternatives Analysis	Pipeline replacement projects have a limited alternative alignment and associated alternatives analysis; however, there is always a "no project" alternative that can be considered. The "no project" alternative for P-16 results in deficiencies in capacity during the 10-year storm.
Project Trigger:	There are multiple project triggers for P-16. The primary drivers are the full pipe flow and manhole overflows of these gravity mains during the 10-year design storm, along with their moderately high risk score. A secondary driver is the pipe segments proximity to a planned paving and storm drain improvement project that is currently scheduled in the City's existing CIP program. These pipe segments can be replaced at the same time as the other CIP work eliminating the need to open the pavement again.
Expected Environmental Compliance:	This project may qualify as categorically exempt. However, the increased size to support future growth may trigger an Initial Study (IS). If the IS identifies no significant impact, the project may adopt a Negative Declaration and proceed with implementation. If the IS identifies significant impacts, but the impacts can be reduced to a less than significant level through mitigation, then the project may adopt a Mitigated Negative Declaration (MND) and proceed. Projects with significant impacts that cannot be mitigated to less than significant levels must be evaluated in an Environmental Impact Report (EIR).
OPCC (2027 dollars):	$724,000
Funding Opportunities:	Funding would need to be evaluated further. WIFIA funding may be an option, however, there is a $5 million project minimum. But projects can be combined to reach the minimum project size. Fort Bragg qualifies as a small and rural community based on the USDA's eligibility criteria of providing loans to

	populations of 10,000 or less and USDA loans may be available at a lower than market interest rate. A cost-benefit analysis should be used to evaluate if a USDA loan would be worth applying for when compared to water revenue bonds. To qualify, Fort Bragg must propose projects that expand services to very small, rural parts of the town. Eligible activities include legal and engineering fees, acquisitions, start-up operations and maintenance, interest incurred during construction, and the purchase of facilities to expand service.

Improvement Name:	E Oak St Replacement IV – Buildout Option
Project ID:	P-16
CIP Year:	2027



Description:	Replace 146 LF of existing 8” main to 18” PVC SDR 35 pipe. Replace 1,203 LF of existing 8" main to 18” PVC SDR 35 pipe. Replace 303 LF of existing 6" main to 18” PVC SDR 35 pipe. Replace 319 LF of existing 6” main to a to 18” PVC SDR 35 pipe. The project area extends along E. Oak Street from the existing 8” main at Dennison Lane to the existing 6” at Sanderson Way. The depth of the existing water mains are approximately 7’ throughout. Utility conflicts will need to be identified during pre-design.
Purpose:	The main purpose of this project is to address capacity issues in the existing system under 10-year storm conditions with anticipated future buildout.

Hydraulic Model Results	During the 10-year storm event and future buildout conditions, the main is over capacity with a max d/D of 1, with moderate overflows expected on three manholes. This capacity deficiency is eliminated with the system improvement, with max d/D reduced to 0.74.
Alternatives Analysis	Pipeline replacement projects have a limited alternative alignment and associated alternatives analysis; however, there is always a "no project" alternative that can be considered. The "no project" alternative for P-16 results in deficiencies in capacity during the 10-year storm and future buildout conditions.
Project Trigger:	There are multiple project triggers for P-16. The primary drivers are the full pipe flow and manhole overflows of these gravity mains during the 10-year design storm, along with their moderately high risk score. A secondary driver is the pipe segments proximity to a planned paving and storm drain improvement project that is currently scheduled in the City's existing CIP program. These pipe segments can be replaced at the same time as the other CIP work eliminating the need to open the pavement again.
Expected Environmental Compliance:	This project may qualify as categorically exempt. However, the increased size to support future growth may trigger an Initial Study (IS). If the IS identifies no significant impact, the project may adopt a Negative Declaration and proceed with implementation. If the IS identifies significant impacts, but the impacts can be reduced to a less than significant level through mitigation, then the project may adopt a Mitigated Negative Declaration (MND) and proceed. Projects with significant impacts that cannot be mitigated to less than significant levels must be evaluated in an Environmental Impact Report (EIR).
OPCC (2027 dollars):	$866,000
Funding Opportunities:	Funding would need to be evaluated further. WIFIA funding may be an option, however, there is a $5 million project minimum. But projects can be combined to reach the minimum project size. Fort Bragg qualifies as a small and rural community based on the USDA's eligibility criteria of providing loans to

	populations of 10,000 or less and USDA loans may be available at a lower than market interest rate. A cost-benefit analysis should be used to evaluate if a USDA loan would be worth applying for when compared to water revenue bonds. To qualify, Fort Bragg must propose projects that expand services to very small, rural parts of the town. Eligible activities include legal and engineering fees, acquisitions, start-up operations and maintenance, interest incurred during construction, and the purchase of facilities to expand service.

Appendix K. CIP Projects

Table K-1 - CIP Projects

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
0-5 yrs	1	P-01	Chief Celeri Dr Sewer Main Replacement	Capacity	3	1,408	Replace 1408 FT of 18-inch pipe with 36-inch. Replace 474 FT of 24-inch pipe with 36-inch.		P-10: Chief Celeri Dr Water Main Replacement (0-5 yrs)	$2,853,000	
0-5 yrs	2	F-01	Elm Street Force Main CIPP Lining	Renewal	2	2,293	CIPP lining of 2293 FT force main			$1,053,000	
0-5 yrs	3	P-02	WWTP Inflow Sewer Main Replacement	Capacity	9	2,305	Replace 2305 FT of 30-inch pipe with 42-inch		P-3: Noyo Center Water Line (0-5 yrs)	$6,103,000	
0-5 yrs	4	P-03	E Alder St Sewer Main Replacement	Capacity	6	797	Replace 174 FT of 18-inch pipe with 24-inch. Replace 187 FT of 18-inch pipe with 30-inch. Replace 231 FT of 18-inch pipe with 24-inch. Replace 205 FT of 18-inch pipe with 30-inch.		P-10: Chief Celeri Dr Water Main Replacement (0-5 yrs)	$892,000	
0-5 yrs	5	P-16	E Oak St Sewer Main Replacement IV	Capacity	8	1,970	Replace 303 FT of 6-inch pipe with 16-inch. Replace 319 FT of 6-inch pipe with 18-inch. Replace 146 FT of 8-inch pipe with 10-inch. Replace 1203 FT of 8-inch pipe with 12-inch.	Replace 303 FT of 6-inch pipe with 18-inch. Replace 319 FT of 6-inch pipe with 18-inch. Replace 146 FT of 8-inch pipe with 18-inch. Replace 1203 FT of 8-inch pipe with 18-inch.	Paving Plan (0-5 yrs)	$724,000	$866,000
0-5 yrs	6	P-10	S Franklin St Sewer Main Replacement	Capacity	2	633	Replace 633 FT of 8-inch pipe with 24-inch.			$351,000	
0-5 yrs	7	P-11	S Harrison St Sewer Main Replacement	Capacity	1	662	Replace 662 FT of 6-inch pipe with 18-inch.			$291,000	
0-5 yrs	8	P-06	E Oak St Sewer Main Replacement III	Capacity	6	989	Replace 167 FT of 6-inch pipe with 10-inch. Replace 822 FT of 6-inch pipe with 16-inch.		V-1: Oak St. Valves (0-5 yrs)	$377,000	
0-5 yrs	9	P-34	North Fort Bragg Sewer Main Extension	Build-out	2	1,970		Install new 1970 FT of 8 inch pipe diameter.	P-2: N Fort Bragg Water Main Extension (0-5 yrs)		$471,000
0-5 yrs	10	P-35	GP Mill Sewer Main Extension I (Noyo Center)	Build-out	1	1,074		Install new 1074 FT of 16-inch pipe diameter.	P-3: Noyo Center Water Line (0-5 yrs)		$471,000

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
0-5 yrs	11	R-01	CCTV Condition Inspection	Renewal			Placeholder for CCTV Condition Inspection of gravity mains.			$500,000	
0-5 yrs	12	R-02	Lift Station Rehabilitation	Renewal			Consolidated electrical, mechanical, and structural upgrades at multiple lift stations, coordinated as a single capital project to maintain operations and minimize outages during rehabilitation.			$442,000	
0-5 yrs	13	R-03	0-5 yr CIPP Lining Projects	Renewal			Targeted CIPP lining projects based on known pipe condition.			$500,000	
0-5 yrs	14	O-01	Capital Plan Update	Other			10-year capital plan update			$110,000	
									0-5 Yr Subtotal	*$14,196,000*	*$15,280,000*
6-10 yrs	15	P-05	E Oak St Sewer Main Replacement II	Capacity	8	2,893	Replace 715 FT of 10-inch pipe with 16-inch. Replace 1462 FT of 10-inch pipe with 18-inch. Replace 716 FT of 6-inch pipe with 16-inch.		V-1: Oak St. Valves (0-5 yrs)	$1,399,000	
6-10 yrs	16	P-13	Cedar St Replacement I	Capacity	12	2,172	Replace 919 FT of 6-inch pipe with 8-inch. Replace 11 FT of 6-inch pipe with 18-inch. Replace 1241 FT of 8-inch pipe with 18-inch.	Replace 11 FT of 6-inch pipe with 12-inch. Replace 906 FT of 6-inch pipe with 16-inch. Replace 11 FT of 6-inch pipe with 24-inch. Replace 1241 FT of 8-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$961,000	$1,224,000
6-10 yrs	17	P-18	E Laurel St Sewer Main Replacement	Capacity	2	783	Replace 783 FT of 8-inch pipe with 18-inch.	Replace 783 FT of 8-inch pipe with 24-inch.		$399,000	$504,000
6-10 yrs	18	P-26	E Chestnut St Sewer Main Replacement II	Capacity	15	3,958	Replace 176 FT of 6-inch pipe with 10-inch. Replace 1734 FT of 6-inch pipe with 12-inch. Replace 143 FT of 6-inch pipe with 8-inch. Replace 384 FT of 8-inch pipe with 10-inch. Replace 1180 FT of 8-inch pipe with 12-inch.	Replace 176 FT of 6-inch pipe with 12-inch. Replace 748 FT of 6-inch pipe with 12-inch. Replace 986 FT of 6-inch pipe diameter to 16-inch. Replace 143 FT of 6-inch pipe with 10-inch. Replace 384 FT of 8-inch pipe with 12-inch. Replace 1180 FT of 8-inch pipe with 16-inch. Replace 342 FT of 12-inch pipe with 16-inch.	P-9: East Chestnut Street Water Main Replacement (6-10 yrs)	$1,567,000	$1,725,000

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
6-10 yrs	19	P-29	Maple St Sewer Main Replacement	Capacity	1	180	Replace 180 FT of 6-inch pipe with 10-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$66,000	
6-10 yrs	20	P-31	South Harold St Sewer Main Replacement	Capacity	2	902	Replace 902 FT of 6-inch pipe with 12-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$364,000	
6-10 yrs	21	P-24	N Sanderson Way Sewer Main Replacement	Capacity	4	647	Replace 647 FT of 6-inch pipe with 18-inch.	Replace 647 FT of 6-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$330,000	$416,000
6-10 yrs	22	P-23	N McPherson St Sewer Main Replacement	Capacity	5	909	Replace 225 FT of 18-inch pipe with 24-inch. Replace 410 FT of 6-inch pipe with 10-inch. Replace 42 FT of 6-inch pipe with 12-inch. Replace 231 FT of 8-inch pipe with 18-inch.	Replace 225 FT of 18-inch pipe with 30-inch. Replace 410 FT of 6-inch pipe with 10-inch. Replace 42 FT of 6-inch pipe with 16-inch. Replace 231 FT of 8-inch pipe with 30-inch.		$429,000	$1,068,000
6-10 yrs	23	P-15	Dennison Ln Sewer Main Replacement	Capacity	3	1,151	Replace 331 FT of 6-inch pipe with 10-inch. Replace 325 FT of 8-inch pipe with 10-inch.	Replace 331 FT of 6-inch pipe with 16-inch. Replace 325 FT of 8-inch pipe with 16-inch. Replace 494 FT of 6-inch pipe with 8-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$239,000	$526,000
6-10 yrs	24	P-33	Georgia-Pacific-Haul Rd Sewer Main Replacement	Capacity	3	874	Replace 681 FT of 8-inch pipe with 10-inch. Replace 193 FT of 8-inch pipe with 12-inch.			$326,000	
6-10 yrs	25	P-28	S Sanderson Way Sewer Main Replacement	Capacity	3	613	Replace 613 FT of 6-inch pipe with 8-inch.			$216,000	
6-10 yrs	26	P-27	Minnseota Ave Sewer Main Replacement	Capacity	1	700	Replace 700 FT of 6-inch pipe with 8-inch.			$246,000	
6-10 yrs	27	P-20	E Redwood Ave Sewer Main Replacement	Capacity	2	703	Replace 703 FT of 8-inch pipe with 18-inch.	Replace 703 FT of 8-inch pipe with 24-inch.	P-1: Cedar St Water Line Replacement (0-5 yrs)	$359,000	$452,000
6-10 yrs	28	P-32	Cypress St Sewer Main Replacement	Capacity	2	674	Replace 674 FT of 8-inch pipe with 10-inch.			$245,000	
6-10 yrs	29	P-30	Park St Sewer Main Replacement	Capacity	1	250	Replace 250 FT of 6-inch pipe with 10-inch.		P-8: Maple St Water Main Loop (6-10 yrs)	$91,000	

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
6-10 yrs	30	P-04	E Oak St Sewer Main Replacement I	Capacity	1	316	Replace 316 FT of 6-inch pipe with 8-inch.		P-13: E. Alder St Water Main Replacement (6-10 yrs)	$112,000	
6-10 yrs	31	P-08	E Chestnut St Sewer Main Replacement	Capacity	2	703	Replace 363 FT of 12-inch pipe with 18-inch. Replace 340 FT of 8-inch pipe with 18-inch.		P-3: Noyo Center Water Line (0-5 yrs)	$359,000	
6-10 yrs	32	P-21	N Harold St Sewer Main Replacement	Capacity	1	433	Replace 433 FT of 8-inch pipe with 18-inch.	Replace 433 FT of 8-inch pipe with 24-inch.		$221,000	$279,000
6-10 yrs	33	P-25	N Whipple St Sewer Main Replacement	Capacity	1	439	Replace 439 FT of 10-inch pipe with 18-inch.	Replace 439 FT of 10-inch pipe with 24-inch.		$224,000	$282,000
6-10 yrs	34	P-14	Cedar St Replacement II	Capacity	1	399	Replace 399 FT of 6-inch pipe with 10-inch.		P-1: Cedar St Water Line Replacement (0-5 yrs)	$145,000	
6-10 yrs	35	P-07	N Franklin St Sewer Main Replacement	Capacity	4	472	Replace 130 FT of 12-inch pipe with 18-inch. Replace 342 FT of 12-inch pipe with 24-inch.		P-13: E. Alder St Water Main Replacement	$286,000	
6-10 yrs	36	P-19	E Pine St Sewer Main Replacement	Capacity	2	745	Replace 375 FT of 15-inch pipe with 18-inch. Replace 370 FT of 15-inch pipe with 18-inch.	Replace 375 FT of 15-inch pipe with 24-inch. Replace 370 FT of 15-inch pipe with 30-inch.		$380,000	$971,000
6-10 yrs	37	P-17	E Fir St Sewer Main Replacement	Capacity	7	1,140	Replace 196 FT of 8-inch pipe with 12-inch. Replace 944 FT of 18-inch pipe with 24-inch.	Replace 196 FT of 8-inch pipe with 16-inch. Replace 944 FT of 18-inch pipe with 30-inch.		$686,000	$1,951,000
6-10 yrs	38	P-12	S Main St Sewer Main Replacement II	Capacity	3	671	Replace 66 FT of 12-inch pipe with 24-inch.			$432,000	
6-10 yrs	39	P-22	N Main St Sewer Main Replacement	Capacity	7	1,829	Replace 1829 FT of 21-inch pipe with 24-inch.	Replace 1829 FT of 21-inch pipe with 30-inch.		$1,176,000	$3,605,000
6-10 yrs	40	P-09	Hazel St Sewer Main Replacement	Capacity	1	357	Replace 357 FT of 12-inch pipe with 24-inch.			$230,000	
	41	P-36	S Main St Sewer Main Extension	Build-Out	3	2,334		Install new 2334 FT of 8-inch pipe diameter.			$647,000
6-10 yrs	42	R-04	CCTV Condition Inspection	Renewal			Placeholder for CCTV Condition Inspection of gravity mains.			$634,000	
6-10 yrs	43	R-05	6-10 yr CIPP Lining Projects	Renewal			Placeholder for CIPP lining projects to be identified through condition assessment			$761,000	
6-10 yrs	44	O-02	Capital Plan Update	Other			10-year capital plan update			$127,000	

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
									6-10 Yr Subtotal	*$13,010,000*	*$19,689,000*
									Total	*$27,206,000*	*$34,969,000*
>10 yr	45	P-53	Basin St Sewer Main Replacement	Build-Out	10	1767.20043		Increase 235 FT of 10-inch pipe diameter to 12-inch. Increase 1160 FT of 8-inch pipe diameter to 10-inch. Increase 372 FT of 8-inch pipe diameter to 12-inch.			$728,000
>10 yr	46	P-40	Cedar St Sewer Main Extension I	Build-Out	3	694.40313		Install new 694 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$250,000
>10 yr	47	P-45	Cedar St Sewer Main Extension I	Build-Out	3	2182.4855		Install new 2182 FT of 8-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$661,000
>10 yr	48	P-46	Cedar St Sewer Main Extension III	Build-Out	4	2838.60887		Install new 2839 FT of 8-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$859,000
>10 yr	49	P-43	Dennison Ln Sewer Main Extension	Build-Out	7	3670.97975		Install new 3439 FT of 12-inch pipe diameter. Install new 232 FT of 16-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$1,332,000
>10 yr	50	P-49	E Chestnut St Sewer Main Extension	Build-Out	3	2987.56034		Install new 2988 FT of 10-inch pipe diameter.			$942,000
>10 yr	51	P-44	Fawn Ln Sewer Main Extension	Build-Out	1	1335.32525		Install new 1335 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$480,000
>10 yr	52	P-47	Fort Bragg Sherwood Rd Sewer Main Extension	Build-Out	4	3659.062		Install new 1613 FT of 12-inch pipe diameter. Install new 2046 FT of 18-inch pipe diameter.			$1,552,000
>10 yr	53	P-50	Georgia-Pacific-Haul Rd Sewer Main Extension	Build-Out	13	5385.31259		Install new 852 FT of 12-inch pipe diameter. Install new 4301 FT of 16-inch pipe diameter. Install new 232 FT of 8-inch pipe diameter. Install proposed lift station with 80 GPM capacity.			$2,786,000
>10 yr	54	P-37	GP Mill Sewer Main Extension II	Build-Out	4	2782.22572		Install new 2360 FT of 10-inch pipe diameter. Install new 422 FT of 18-inch pipe diameter.			$945,000
>10 yr	55	P-38	GP Mill Sewer Main Extension III	Build-Out	8	5954.50522		Install new 2348 FT of 10-inch pipe diameter. Install new 3606 FT of 12-inch pipe diameter.			$2,036,000
>10 yr	56	P-39	GP Mill Sewer Main Extension IV	Build-Out	8	7199.21355		Install new 3261 FT of 10-inch pipe diameter. Install new 3939 FT of 8-inch pipe diameter. Install proposed lift station with 80 GPM capacity	P-10: Chief Celeri Dr Water Main Replacement (6-10 yr)		$2,808,000
>10 yr	57	P-55	Highway 20 Sewer Main Extension	Build-Out	5	729.304155		Install new 729 FT of 12-inch pipe diameter.			$262,000

Time Frame (years)	Priority Ranking	CIP ID	Project Name	Category	Pipe Count	Total Pipe Footage (FT)	Project Description	Buildout Project Alternative Description	Associated Projects	Escalated Existing Project Cost	Escalated Buildout Project Cost
>10 yr	58	P-51	Jacobsen Ln Sewer Main Extension I	Build-Out	1	620.20626		Install new 620 FT of 4-inch pipe diameter.			$116,000
>10 yr	59	P-52	Jacobsen Ln Sewer Main Extension II	Build-Out	2	482.705068		Install new 483 FT of 8-inch pipe diameter.			$147,000
>10 yr	60	P-48	Lyta Way Sewer Main Extension	Build-Out	4	5186.15799		Install new 5186 FT of 12-inch pipe diameter.			$1,863,000
>10 yr	61	P-54	N Harbor Dr Sewer Main Replacement	Build-Out	2	280.248742		Increase 30 FT of 12-inch pipe diameter to 24-inch. Increase 251 FT of 8-inch pipe diameter to 24-inch.			$197,000
>10 yr	62	P-41	Nurnberger Ln Sewer Main Extension	Build-Out	2	3058.77951		Install new 3059 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$1,099,000
>10 yr	63	P-56	Ocean View Sewer Main Extension	Build-Out	34	23052.9975		Install new 23053 FT of 8-inch pipe diameter.			$6,974,000
>10 yr	64	P-42	Peterson Ln Sewer Main Extension	Build-Out	1	1653.71432		Install new 1654 FT of 12-inch pipe diameter.	P-1: Cedar St Water Line Replacement (0-5 yr)		$594,000
>10 yr	65	LS-1	South Noyo LS Improvement	Build-Out	N/A	N/A		Increase South Noyo LS capacity from 920 GPM to 1,500 GPM.			$7,337,000
									>10 Yr Subtotal	*$0*	*$33,968,000*
									Total	*$27,206,000*	*$68,937,000*

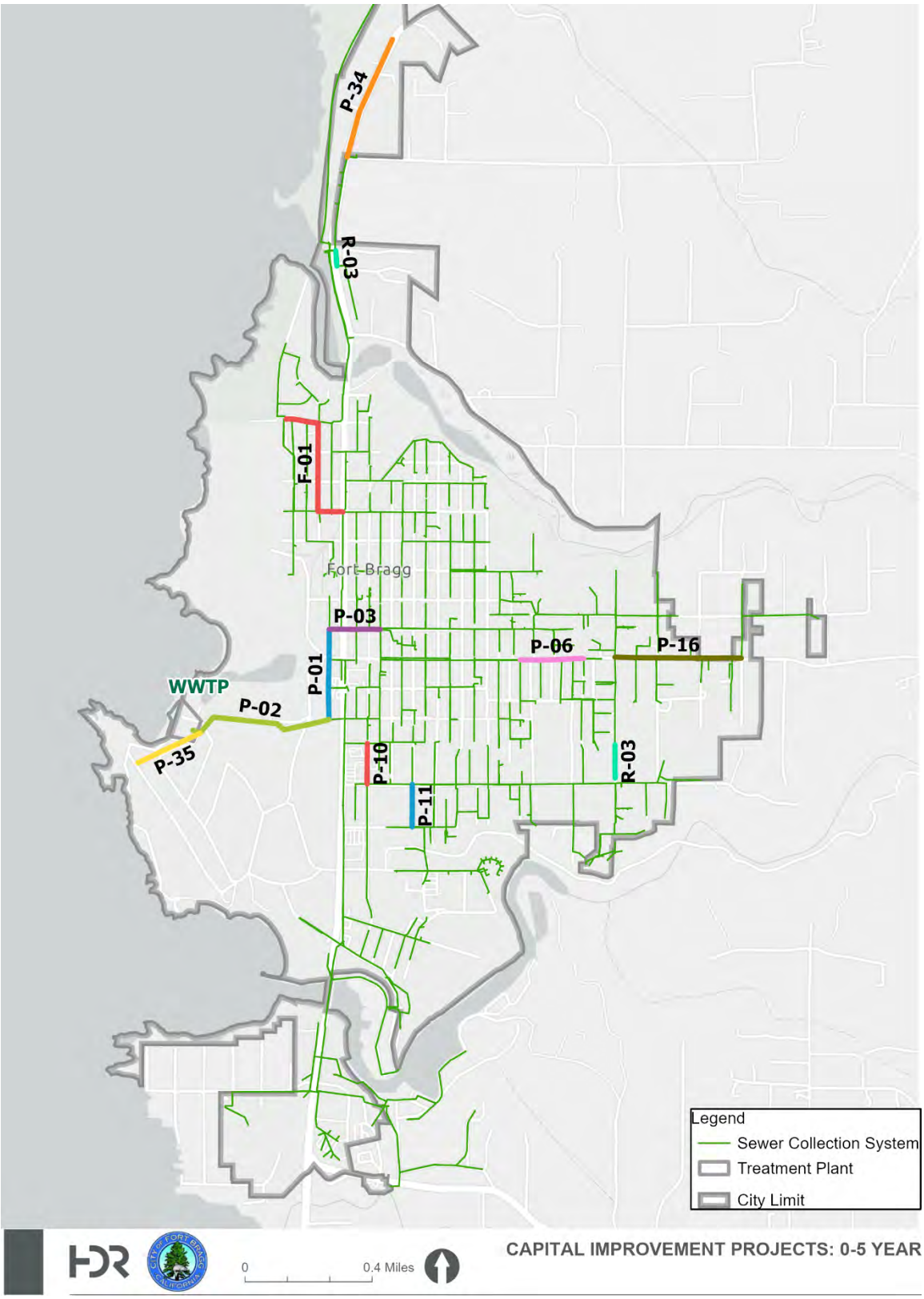


Figure K-1. - 0-5 Yr Capital Projects

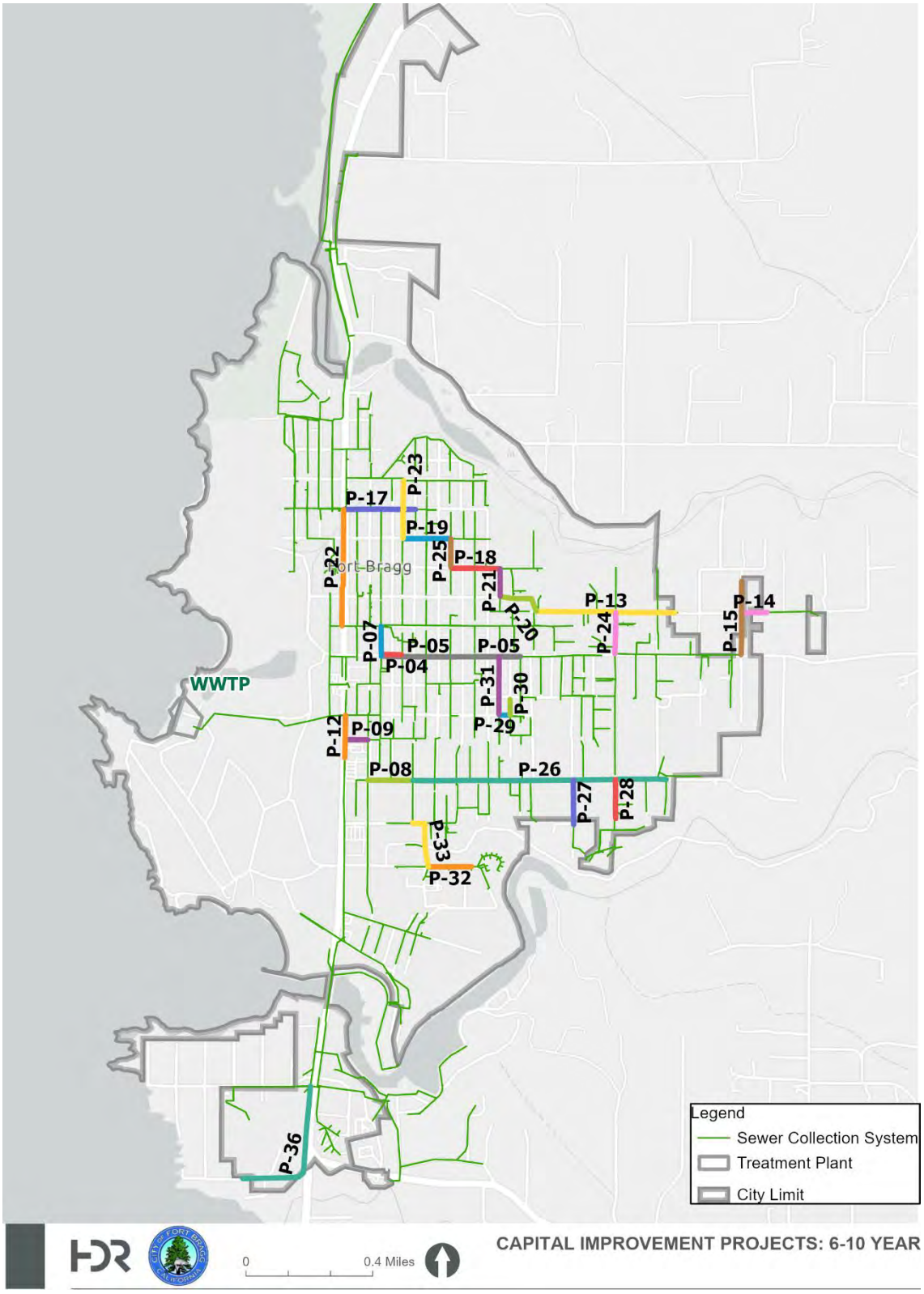


Figure K-2. 6-10 yr Capital Projects

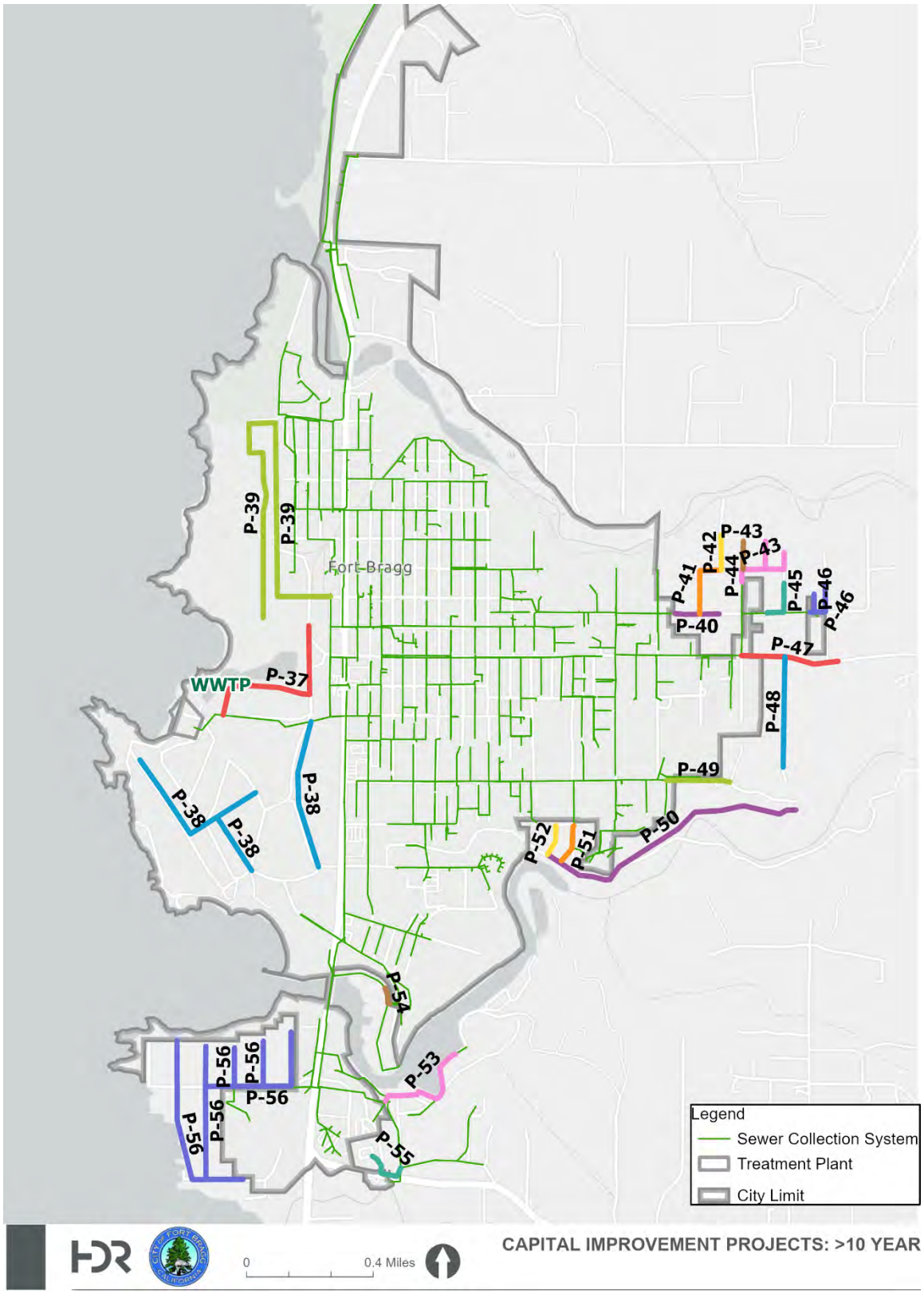


Figure K-3. >10 Yr Capital Projects