CITY OF OAKLAND



Sewer System Hydraulic Modeling and Capacity Analysis Report

NOVEMBER 2012

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SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT

NOVEMBER 2012

11/26/12 **11/26/12**

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City of Oakland

SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT

TABLE OF CONTENTS

Page No.

CHAPTER 4 - COLLECTION SYSTEM FACILITIES AND HYDRAULIC MODEL

CHAPTER 5 - COLLECTION SYSTEM REHABILITATION AND REPLACEMENT PLAN

CHAPTER 6 - DESIGN FLOW ANALYSIS AND CAPACITY EVALUATION

CHAPTER 7 - CAPITAL IMPROVEMENT PLAN

LIST OF TABLES

LIST OF FIGURES

BACKGROUND

This chapter presents a brief summary of the sewer service area, the need for this Sewer System Hydraulic Modeling and Capacity Analysis Study (study), and the objectives of the study.

1.1 BACKGROUND

The City of Oakland (City) is located in the heart of the San Francisco Bay Area on the eastern mainland side of San Francisco Bay (commonly referred to as the East Bay). Figure 1.1 presents a location map of the City. The City owns, maintains, and operates gravity sewer pipelines, as well as sewage pump stations and associated force mains collecting wastewater flow from residential, commercial, industrial, and institutional customers within the City service area.

The City operates one of seven wastewater collection satellite agencies (Satellites) in the East Bay that route sewage to the East Bay Municipal Utility District (EBMUD) wastewater treatment facilities. The other collection systems include the Cities of Alameda, Albany, Berkeley, Emeryville, Piedmont, and the Stege Sanitary District. The locations of the various Satellite agency service areas are shown on Figure 1.2. All wastewater flows from the Satellite collection systems flow to an interceptor system, which is owned and operated by EBMUD.

The interceptor system conveys flows from the Satellites to the EBMUD Main Wastewater Treatment Plant (MWWTP). During wet weather flow conditions, the wastewater flows from the interceptor are also stored and disinfected, and at times discharged to San Francisco Bay, from three EBMUD owned and operated wet weather facilities. The locations of these facilities are shown on Figure 1.2.

1.1.1 Regulatory Background

On November 28, 2009, the Environmental Protection Agency (EPA) issued an Administrative Order Docket No. CWA 309(a)-10-009 requiring the City to take specific actions regarding its sewer collection system. The goal of the Administrative Order, which has since become a Stipulated Order (SO), is focused on eliminating discharges from the EBMUD wet weather facilities as part of a regional solution involving EBMUD and its Satellite dischargers. Amongst other administrative requirements, the SO requires the development of the following:

- An asset management program
- Private lateral sewer inspection and repair program
- Sub basin flow monitoring program

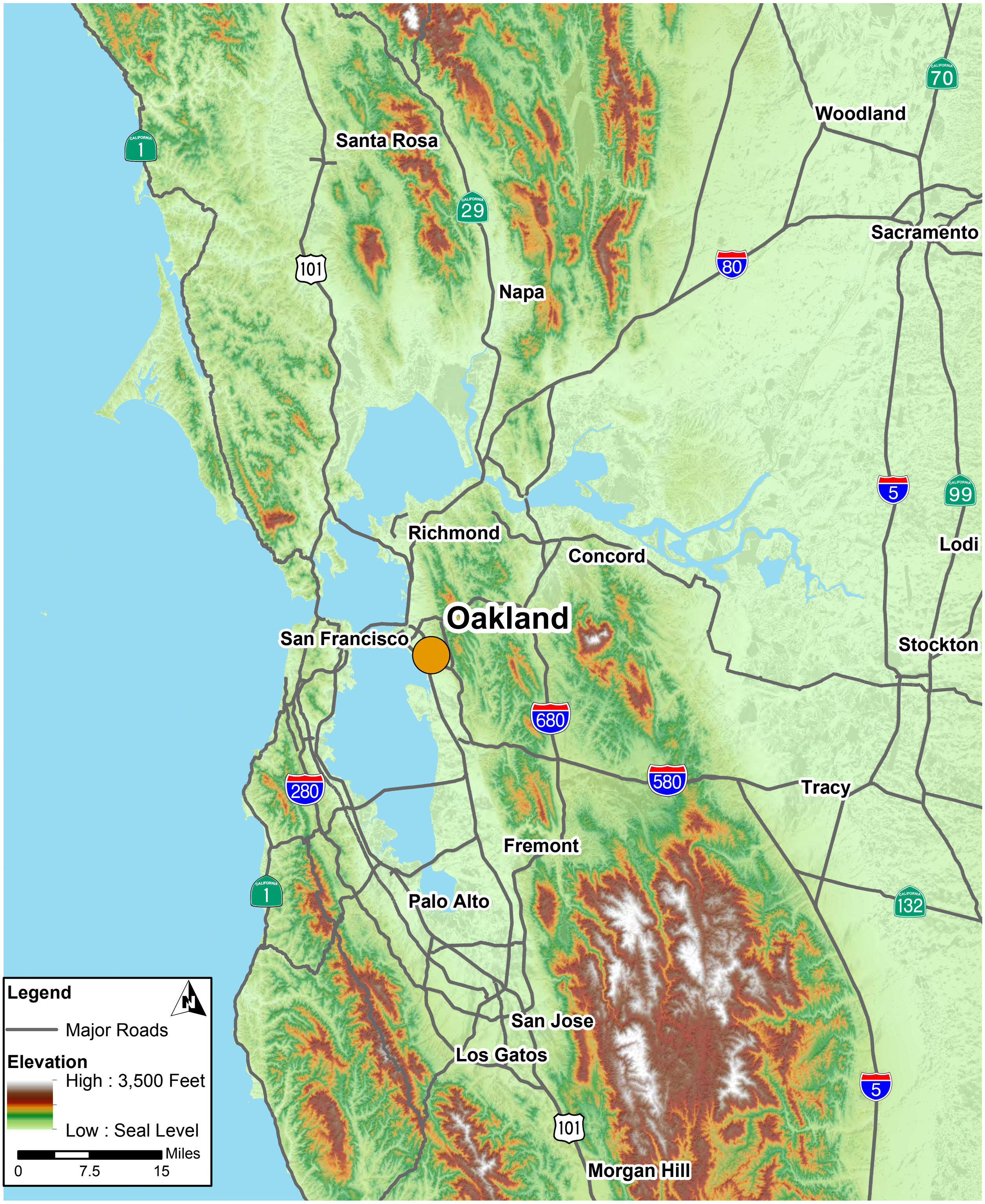


Figure 1.1
LOCATION MAP
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 1.1 Location Map.mxd

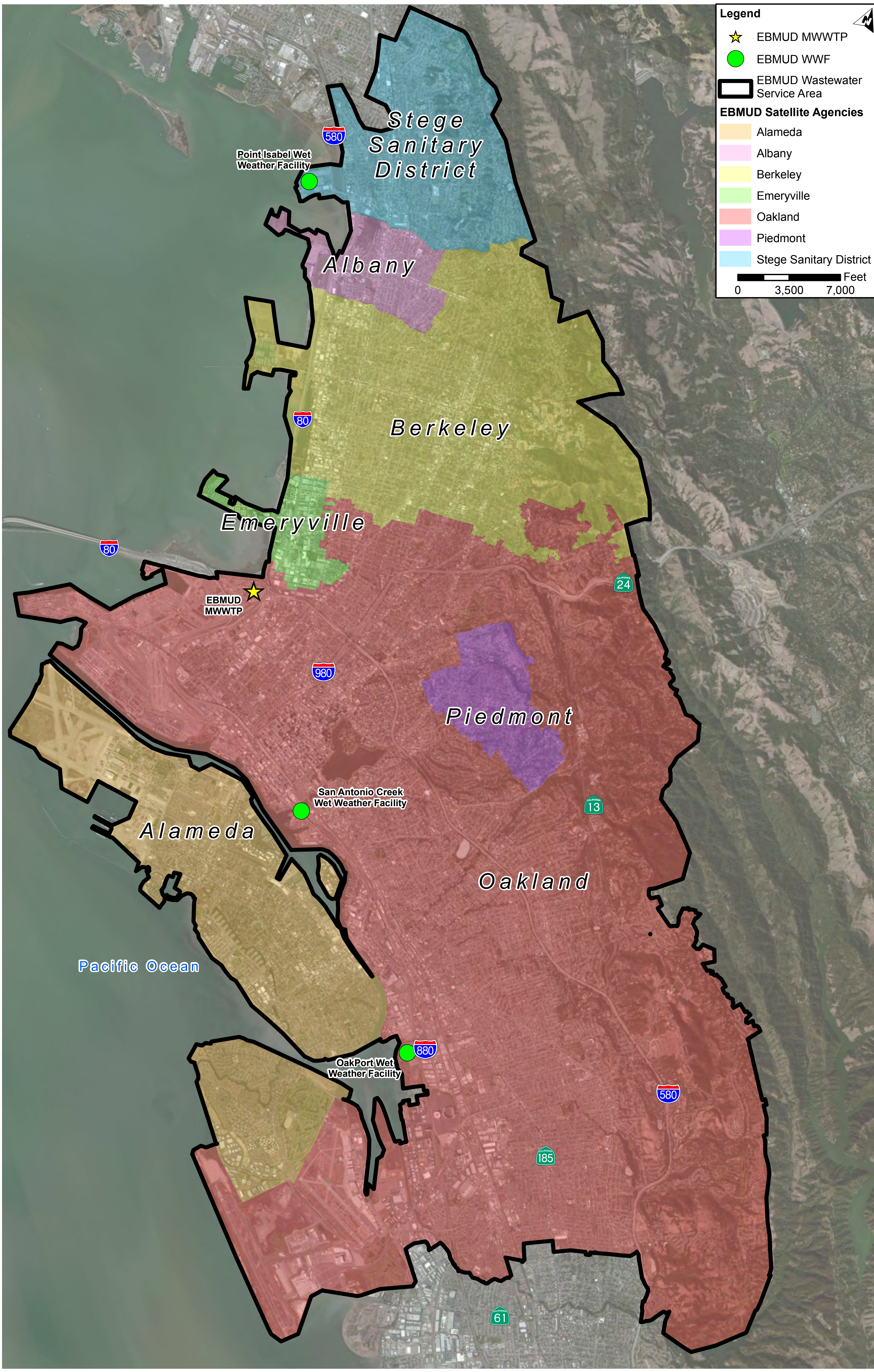


Figure 1.2
EBMUD SATELLITE AGENCY MAP
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure1.2 EBMUD Satellite Agency Map.mxd

- Inflow identification and elimination plan
- Sanitary sewer overflow response plan
- Sewer cleaning and inspection program

A copy of the City's Stipulated Order (SO) is included in Appendix A for reference.

1.1.2 Purpose

This Sewer System Hydraulic Modeling and Capacity Analysis Report has been developed to meet the requirements of the EPA SO, which states, in part, the following:

> *By December 1, 2012, the City of Oakland shall submit a report to the EPA on sub basin flows and hydraulic capacity within the sub basins. The assessments shall include the results of flow measurements, visual observations of flow levels and predictive flow modeling as needed to complete a report that:*
>
> 1. *Identifies areas, sources and quantities of significant inflow to the sewage collection system;*
> 2. *Identifies areas, sources and quantities of significant infiltration to the sewage collection system;*
> 3. *Identifies any bottlenecks in the collection system which lack sufficient capacity to convey sewage flows through the collection system and to the EBMUD interceptor during wet weather; and*
> 4. *Provide a plan for using these results to identify and target high priority areas for repair and rehabilitation work.*

The purpose of this study is to meet the requirements of the SO by identifying areas of the collection system that contribute significant amounts of inflow and infiltration (Chapter 3), This study also identifies capacity deficiencies (bottlenecks) within the City collection system. The evaluation of the collection system, identification of capacity bottlenecks, and the development of feasible alternatives to correct the deficiencies can be found in Chapter 6. The City also used the results of the flow monitoring program to identify the highest priority areas for repair and rehabilitation work. The areas of the system targeted for rehabilitation can be found in Chapter 5.

Additionally, this report meets the requirements for a System Evaluation and Capacity Assurance Plan (SECAP), as defined by the State Water Resources Control Board (SWRCB) Order No. 2006-0003-DWQ (Appendix B).

1.1.3 Previous Studies

The City has conducted certain studies in the past to evaluate the capacity of the City's wastewater collection system facilities, as summarized in this section.

1.1.3.1 1986 East Bay Infiltration and Inflow Study

The City conducted a Sewer System Evaluation Study (SSES) in the mid 1980's to identify collection system deficiencies and recommend capacity correction and rehabilitation programs in order to reduce the frequency of wet-weather related sanitary sewer overflows. The SSES recommended a 25-year system rehabilitation and capacity correction program known as the Infiltration and Inflow (I/I) Correction Program. The City is currently in the twenty-second year of its implementation.

As part of the SSES, the Collection System's trunk lines were evaluated for capacity deficiencies using a computerized hydraulic model. It included calculated amounts of infiltration and inflow. The hydraulic capacity of each pipe reach in the trunk system was calculated and compared to the total design flow for that trunk system.

Source detection methods for I/I included smoke testing, rainfall simulation, physical inspection, flow isolation, and closed circuit television (CCTV) inspection. The study presented the most cost-effective approach to reduce infiltration/inflow (I/I). The methodology for developing these recommendations incorporated site-specific characteristics for the comparison of the cost for I/I mitigation by rehabilitation versus the cost of capital projects that increased the systems conveyance, storage, and treatment capacity.

1.1.3.2 2007 Pump Station Master Plan

In 2007, the City contracted with RBF Consulting to prepare a Pump Station Master Plan to provide guidance to the City for scheduling, cost estimating, and planning for anticipated improvements needed for the City's seven sewage lift stations and three stormwater pump stations. The Pump Station Master Plan analyzed each pump/lift station's service area, land uses, influent and effluent piping, design flows, and pump size and capacity, and concluded that all existing pump stations are adequately sized for current design flows. The scope of work for all future pump station upgrades will include replacing pumps, mechanical piping, electrical components, providing stand-by power for portable back up generators, and a remote auto-dialer alarm system.

The City owns approximately 500 linear feet of force mains. The force mains will be inspected as the pump stations are constructed. As these pipelines are inspected, future pipeline rehabilitation projects may be identified. At this time, no force main improvement projects are scheduled.

1.1.3.3 2007 Report on Community Progress

In 2007, RMC, through a subcontract with MWH, issued a technical memorandum that summarizes the I/I reduction progress made by the EBMUD communities since the inception of the East Bay I/I Correction Program to the time at which the technical memorandum was issued.

For the study, data collected as part of a comprehensive flow monitoring program conducted in 2006 were analyzed and used to estimate the design storm peak wet weather flows for the 2006 metered areas. To assess the peak rainfall dependent infiltration and inflow (RDI/I) reductions that were achieved as a result of the I/I Correction Program, the basin peak flows determined through analysis of the 2006 flow monitoring data were compared to the original peak flows determined during the SSES period.

The results of the analyses of flow data presented in the technical memorandum indicate that the target I/I reductions established in the SSES have largely been met by the EBMUD communities.

As of the end of 2006, the technical memorandum states that Oakland had completed approximately 67 percent of its mandated rehabilitation projects, totaling approximately 3,400 acres, and had rehabilitated approximately 80 percent of the sewers in the cost-effective subbasins (estimated at one-third of the system). This equated to about 273 miles of sewers, or approximately 26 percent of the total length of the Oakland collection system.

1.1.3.4 Asset Management Implementation Plan

The City recently developed an Asset Management Implementation and Sanitary Sewer Management Plan (AMIP) to meet both the requirements of the EPA SO and the SWRCB Sewer System Management Plan (SSMP) requirements. The AMIP, dated May 4, 2012, updates and supersedes previous submittals to EPA required by Oakland's SO and previous issues of the SSMP. Once approved, it will serve as the basis for maintaining and reporting on the maintenance of Oakland's sewer collection system.

The AMIP describes how the City evaluates and maintains its collection system to achieve efficient and cost-effective collection and transport of sewage generated by City residents and businesses. The AMIP is based on asset management principles, which recommend inventorying existing assets, assessing their condition, and planning ahead to help preserve and maintain these systems.

1.2 SEWER SERVICE AREA DESCRIPTION

The current Oakland City Limits is the study area (service area) for this Sewer System Hydraulic Modeling and Capacity Analysis Study. The City limits and study area are synonymous and will be used interchangeably throughout this report. The study area encompasses an area of approximately 32,770 acres (51.2 square miles). Figure 1.3 shows the study area boundary.

1.2.1 Sewer Service Area Overview

Figure 1.3 illustrates the City's current sewer service area. The City owns and operates a sanitary sewage collection system (collection system) that serves approximately

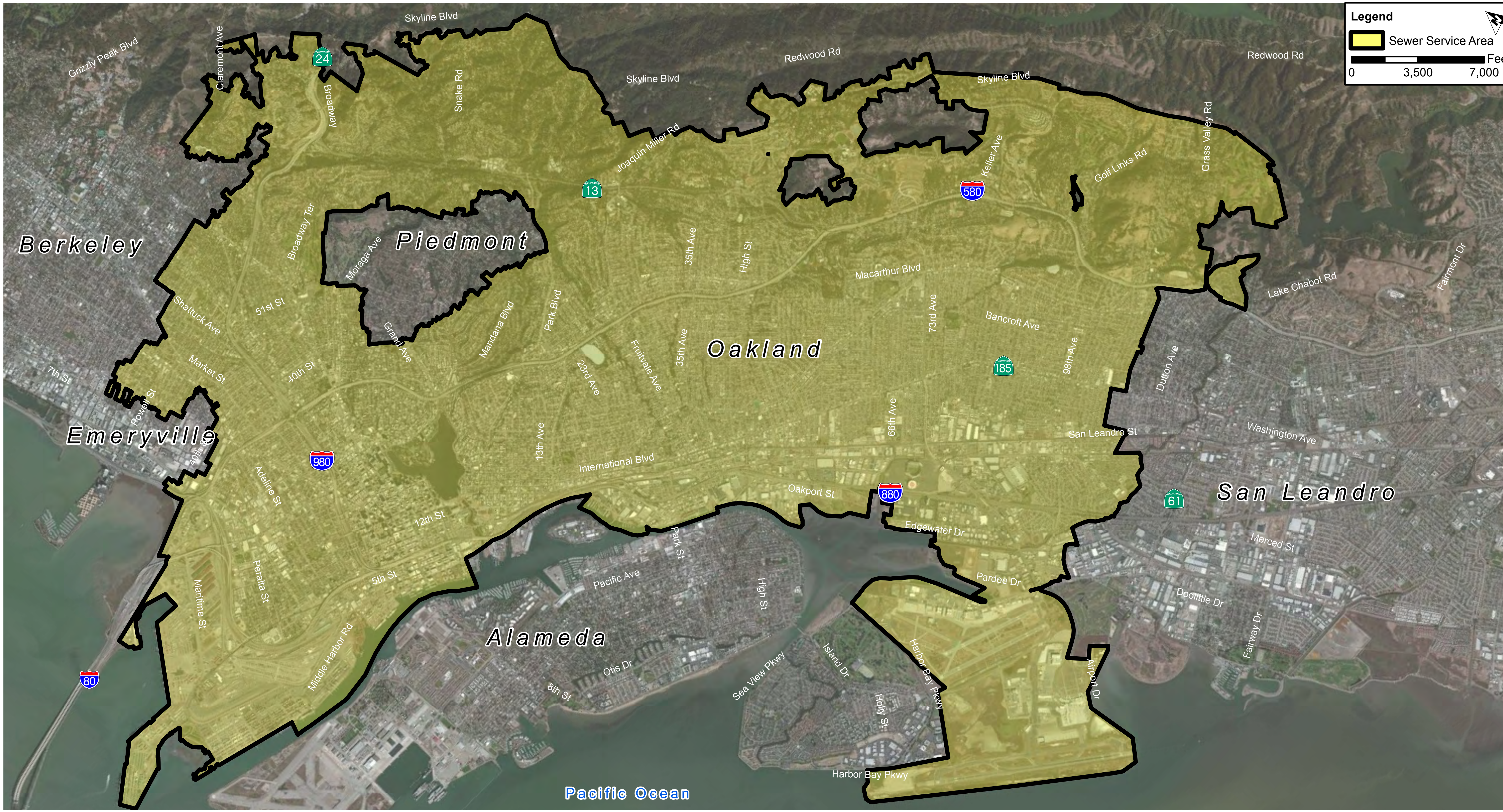


Figure 1.3
SEWER COLLECTION SYSTEM SERVICE AREA
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 1.3 Sewer Collection System Service Area.mxd

400,000 people in the City. The collection system includes approximately 919 miles of gravity main, less than one mile of force main, and seven sewage pump stations.

There are approximately 103,000 private lateral sewer connections to the collection system, which are comprised of approximately 92,900 residential units, 8,600 commercial units, 600 industrial units, and 900 public authorities. Additionally, all sanitary sewer flows from the City of Piedmont are collected and transported through Oakland's collection system. Two basins flow from Oakland into the City of Emeryville's sewers and one flows into the City of Berkeley's sewers.

The City's service area includes the Port of Oakland (Port), which owns and maintains the wastewater collection system within its boundaries. The Port's wastewater collection system discharges to the City's collection system and/or the EBMUD interceptor system and consists of nine miles of gravity sewer and approximately twelve miles of laterals.

As previously noted, the City does not own or operate wastewater treatment facilities. The City's collection system conveys the City's wastewater to the EBMUD interceptor system. That wastewater interceptor system transports wastewater to EBMUD's WWFS and ultimately the MWWTP for treatment. The treated water is discharged to San Francisco Bay.

1.2.2 Service Area History

Following a rapid increase in development associated with the California Gold Rush, the Town of Oakland was incorporated in 1852[1]. Oakland grew at a more or less steady rate through the turn of the century. In the aftermath of the 1906 San Francisco earthquake, over 150,000 people fled to Oakland. Many of the displaced residents and businesses from San Francisco chose to stay. Between 1900 and 1910, the City's population rose from 66,960 to 150,174.

The City continued to grow rapidly until the Great Depression of the 1930's, which slowed the rate of growth of the City. Business activity and population boomed during World War II; the City added nearly 100,000 residents between 1940 and 1945[2]. Following a brief post-war boom, the City's manufacturing activity and population declined. From 1950 to 1980, the City's population decreased from 384,575 to 339,337. In the 1980's, the City's population began to rebound, and in the year 2000 the City's population increased to 399,484. From 2000 to 2010, however, the City's population fell to 390,724.

1.2.3 Climate and Topography

The City's study area is characterized by a Mediterranean-type climate with wet, cool winters, and warm, dry summers. Temperatures range from the fifties and sixties during the

[1] Source: City of Oakland 1998 General Plan.
[2] Ibid.

winter months to the seventies during the summer. Most of the rainfall within the City occurs from October to April, with an average annual rainfall of approximately 23.2-inches[3]. Table 1.1 summarizes the City's average monthly rainfall and temperature.

The study area elevations ranges from about 17 feet below mean sea level (msl) near the bay to 1,500 feet above msl in the Oakland hills.

Table 1.1 Study Area Climate
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Month	Average Maximum Temperature (ºF)	Average Minimum Temperature (ºF)	Average Temperature (ºF)	Average Monthly Rainfall (in)
January	57.2	44.4	50.8	4.78
February	61.6	47.9	54.8	4.19
March	63.3	49.1	56.2	3.60
April	66.5	50.5	58.5	1.36
May	69.0	53.5	61.2	0.56
June	71.7	55.7	63.7	0.12
July	72.6	57.0	64.8	0.07
August	73.6	58.3	66.5	0.32
September	74.6	58.3	66.0	0.10
October	72.0	55.3	63.6	1.31
November	63.9	49.6	56.8	3.45
December	57.4	44.5	51.0	3.33

Notes:
1. Source: www.oaklandnet.com.

1.3 SCOPE AND AUTHORIZATION

On July 23, 2010, the City approved a professional services agreement with V&A Consulting Engineers (V&A) to provide Engineering Services for the City of Oakland Sewer System in response to the EPA SO. Carollo Engineers, Inc. (Carollo) was hired as a subconsultant to V&A under the professional services agreement with the City. This study has been prepared in accordance with Work Task D (Hydraulic Modeling, Cost-Analysis Study, and Multi-Year Sewer Rehabilitation Study), which includes the following main tasks:

- Planning Criteria
- Data Input

[3] Source: www.oaklandnet.com.

- Model Construction
- Wastewater Load Allocation
- Model Calibration
- Capacity Analysis and Proposed Capital Projects
- Coordination with EBMUD and Other Agencies

1.4 REPORT ORGANIZATION

This report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. Each chapter is briefly discussed below:

Chapter 1 - Introduction. This chapter presents the needs and objectives of this study. A general description of the sewer service areas as well as a list of references is also provided.

Chapter 2 - Planning Criteria. This chapter presents the planning criteria used for evaluating the sewer collection system. The planning criteria address the collection system capacity, gravity sewer slopes, maximum depth of flow within a sewer, and sewage lift station and force main evaluation criteria.

Chapter 3 - Sewer Design Flows. This chapter summarizes the flow monitoring program and presents the calculation of the design flows used to model the collection system. This Chapter also identifies the areas of the system that contribute the highest rates of inflow and infiltration.

Chapter 4 - Collection System Facilities and Hydraulic Model. This chapter describes the development and calibration of City's sewer collection system hydraulic model.

Chapter 5 - Collection System Rehabilitation and Replacement Plan. This chapter summarizes the collection system rehabilitation and replacement (R&R) that has been performed by the City, provides a description of future R&R work within the City collection system, and documents I/I reduction assumptions for the City's planned future R&R work. This Chapter also summarizes the prioritized areas of the system that have been targeted for rehabilitation over the next five years.

Chapter 6 - Capacity Evaluation and Proposed Improvements. This chapter discusses the hydraulic evaluation of the collection system, identifies capacity bottlenecks, and the proposed projects that correct capacity deficiencies within the City.

Chapter 7 - Capital Improvement Plan. This chapter presents the capital improvement projects, a summary of the capital costs, and a basic assessment of the possible financial impacts on the City.

1.5 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve readability, the following abbreviations are used in this report.

AACE	Association for the Advancement of Cost Engineering
AAF	Average Annual Flow
AMIP	Asset Management Implementation Plan
ADWF	Average Dry Weather Flow
BWF	Base Wastewater Flow
Carollo	Carollo Engineers, Inc.
CCTV	Closed-Circuit Television
CDO	Cease and Desist Order
CIP	Capital Improvement Plan
City	City of Oakland
d/D	Flow Depth to Pipe Diameter Ratio
DWF	Dry Weather Flow
EBMUD	East Bay Municipal Utility District
ENR CCI	Engineering News Record Construction Cost Index
EPA	Environmental Protection Agency
ft	Feet
ft/s	Feet Per Second
GARR	Gauge Adjusted Radar Rainfall
GIS	Geographic Information System
GUI	Graphical User Interface
GWI	Groundwater Infiltration
HGL	Hydraulic Grade Line
I/I	Infiltration and Inflow

mgd	Million Gallons Per Day
msl	Mean Sea Level
MWWTP	Main Wastewater Treatment Plan
Port	Port of Oakland
PSL	Private Sewer Lateral
PWWF	Peak Wet Weather Flow
R&R	Rehabilitation and Replacement
RDI/I	Rainfall Derived Infiltration and Inflow
Satellite	EBMUD Satellite Collection System Agency
SECAP	System Evaluation and Capacity Assurance Plan
SO	Stipulated Order
SSES	Sewer System Evaluation Study
SSMP	Sewer System Management Plan
SSO	Sanitary Sewer Overflow
SWMM	Stormwater Management Model
V&A	V&A Consulting Engineers
WaPUG	Wastewater Planning Users Group
WWF	Wet Weather Flow

1.6 REFERENCE MATERIAL

The following documents were referenced as part of this study and during the preparation of this report:

- *City of Oakland Asset Management Implementation Plan and Sewer System Management Plan*, Carollo Engineers, May 2012
- *City of Oakland Pump Station Master Plan, Final, RBF Consulting*, September 2007
- *City of Oakland Sanitary Sewer Flow Monitoring and Inflow/Infiltration Study*, Draft, V&A Consulting Engineers, October 2012

- *East Bay Infiltration/Inflow Study: South Oakland: Sewer System Evaluation Survey*, CDM/Jordan/Montgomery, 1986
- *East Bay Municipal Utility District Collection System Asset Management Template*, Draft, December 2010
- *East Bay Municipal Utility District Flow Monitoring Limits Report*, Draft, September 2011
- *East Bay Municipal Utility District Wet Weather Improvement Studies, Technical Memorandum, Subtasks 4.3& 4.4 – Analysis of Community I/I Rates and I/I Reduction Progress*, Final Draft, RMC, November 2007
- *Port of Oakland Port-Wide Sewer System Management Plan*, Carollo Engineers, May 2010 (Revised August 2011)

PLANNING CRITERIA

The capacity of the City of Oakland's (City's) sanitary sewer collection system was evaluated based on the planning criteria defined in this chapter. The criteria include standards from the City's design standards, as well as other planning criteria developed by Carollo based on engineering judgment and past experience. The planning criteria addresses the collection system capacity, gravity sewer pipe slopes, and maximum depth of flow within a sewer.

2.1 GRAVITY SEWERS

Gravity sewer pipe capacities are dependent on many factors. These include roughness of the pipe, the chosen maximum allowable depth of flow, and limiting velocity and slope. The following sections describe the factors that account for the determination of existing and future pipeline capacities in the City's collection system.

2.1.1 Manning Coefficient (n)

The manning coefficient 'n' is a friction coefficient and varies with respect to pipe material, size of pipe, depth of flow, smoothness of joints, root intrusion, and other factors. For sewer pipes, the manning coefficient typically ranges between 0.011 and 0.017, with 0.013 being a representative value used for system planning purposes.

2.1.2 Flow Depth Criteria (d/D)

When designing sewer pipelines, it is common practice to adopt variable flow depth criteria for various pipe sizes. These criteria are expressed as a maximum depth of flow to pipe diameter ratio (d/D). Design d/D ratios typically range from 0.5 to 0.92, with the lower values typically used for smaller pipes, which may experience flow peaks greater than design flow or may experience blockages from debris, paper, or rags.

2.1.2.1 Flow Depth for Existing Sewers

Maximum flow depth criteria for existing sanitary sewers are established based on a number of factors, including the acceptable risk tolerance of the utility, local standards and codes, and other factors. Using a conservative d/D ratio when evaluating existing sewers may lead to unnecessary replacement of existing pipelines. Conversely, lenient flow depth criteria could increase the risk of sanitary sewer overflows (SSOs). Ultimately, the maximum allowable flow depth criteria should be established to be as cost effective as possible while at the same time reducing the risk of SSOs to the greatest extent possible.

For Oakland, during peak wet weather flow (PWWF) (this is typically the maximum hourly flow in the collection system) water levels (hydraulic grade line) were allowed to rise to within five feet of the manhole rim (i.e., sewers were allowed to surcharge under these maximum flow conditions). If the flow depth is greater than the maximum allowed, then the sewer was deemed deficient and a capital project was proposed to provide greater flow capacity.

2.1.2.2 Flow Depth for New Sewers

The City's Design Standards recommend that main sewers and local collectors be designed to flow a maximum of 2/3 full, d/D ≤ 2/3. Trunk sewers shall be designed to flow full without surcharge, d/D ≤ 1. These flow depth parameters will be used to evaluate both existing and future sewer pipe. The City's standard do not define the specific pipeline diameters that constitute local collectors and trunk sewers. Based on past experience, Carollo defines sewer mains and local collectors as pipelines 12-inches in diameter and smaller and trunks as sewers with pipeline diameters greater than 15-inches in diameter. Table 2.1 summarizes the criteria for the evaluation of existing sewers and for sizing new trunk lines.

Table 2.1 Maximum Flow Depth Criteria
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Maximum Flow Depth Criteria for Existing Sewers	
Dry Weather Flows	Max d/D ≤ 1
Peak Wet Weather Flow	Surcharge to 5 feet Below Manhole Rim
Maximum d/D for Future Sewers	
Pipe Diameter (inches)	**Maximum d/D Ratio (during Peak Flows)**
< 12 inches	≤ 2/3
>12 inches	≤ 1

2.1.3 Design Velocities and Minimum Slopes

In order to minimize the settlement of sewage solids, it is standard practice in the design of gravity sewers to specify that a minimum velocity of 2 feet per second (ft/s) be maintained when the pipeline is half-full. At this velocity, the sewer flow will typically provide self cleaning for the pipe. Due to hydraulics of a circular conduit, velocity of half-full flow in pipes approaches the velocity of nearly full flow in pipes. The design flow velocity shall not exceed 10 ft/s unless warranted by special conditions (City standards).

Table 2.2 lists the recommended minimum slopes and their corresponding maximum flows for maintaining self-cleaning velocities (equal to or greater than 2 ft/s) when the pipe is flowing at its maximum depth.

Table 2.2 Maximum Flow Depth Criteria Sewer System Hydraulic Modeling and Capacity Evaluation Report City of Oakland			
Pipe Diameter (inches)	**Minimum Slop(1)(2) (feet/feet)**	**Calculated Flow at Maximum d/D(2)(3)**	
		d/D	**Maximum Flow (mgd)**
8	0.0027	0.67	0.32
10	0.0020	0.67	0.50
12	0.0016	0.67	0.73
15	0.0011	1.0	1.38
18	0.0011	1.0	2.25
21	0.0009	1.0	3.07
24	0.0008	1.0	4.14
27	0.0007	1.0	5.29
30	0.0006	1.0	6.49
36	0.0006	1.0	10.56
42	0.0006	1.0	15.93
48	0.0006	1.0	22.74

Notes:

1. Recommended minimum slope for flows at a velocity greater than or equal to 2 feet/second.
2. Manning's n = 0.013
3. Calculated flow is determined using the minimum slope and the maximum allowable d/D presented in Table 2.1.

2.1.4 Changes in Pipe Size

When a smaller sewer joins a large one, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation. For planning purposes and designing new pipes, and in the absence of field data, sewer crowns were matched at the manholes.

2.2 LIFT STATIONS AND FORCE MAINS

Pump stations were evaluated and designed for peak flow with one standby pump having a capacity equal to the largest operating unit. For the design of force mains, the minimum and maximum recommended velocities are 2.0 and 10 ft/s (City standards allow this velocity), respectively. The Hazen-Williams formula is commonly used for the design of force mains. The Velocity Equation is:

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

Where: V = mean velocity, ft/s

C = roughness coefficient

R = hydraulic radius, ft

S = slope of the energy grade line, ft/ft

The value of the Hazen-Williams 'C' varies with the type of pipe material. The value is influenced by the type of construction and age of the pipe. A 'C' value of 120 was used for evaluating the City’s system.

FLOW MONITORING PROGRAM

This chapter describes the typical components of wastewater in the collection system and the flow-monitoring program. The data and results from the flow monitoring program are also summarized and discussed.

3.1 WASTEWATER FLOW COMPONENTS

As a way to help the reader understand the wastewater flow components, this section describes and provides definitions of commonly used terminology in the wastewater collection system analysis and evaluations conducted as part of this project. In general, Wastewater consists of dry weather flow (DWF) and wet weather flow (WWF). DWF (or base flow) is flow generated by routine water usage in the residential, commercial, business and industrial sectors of the collection system. The other component of DWF is the contribution of dry weather groundwater infiltration (GWI) into the collection system. Dry weather GWI will enter the sewer system when the relative depth of the groundwater table is higher than the depth of the pipeline and when the susceptibility of the sanitary sewer pipe allows infiltration through defects such as cracks, misaligned joints, and broken pipelines.

WWF includes storm water inflow, trench infiltration, and GWI. The storm water inflow and trench infiltration comprise the WWF component termed infiltration/inflow (I/I). The response in the sewer system to rainfall is seen immediately (as with inflow) or within hours after the storm (as with infiltration).

The third element of WWF is GWI, which is not specific to a single rainfall event, but rather to the effects on the sewer system over the entire wet weather season. The depth of the groundwater table rising above the pipe invert elevation causes GWI. Sewer pipes within close proximity to a body of water can be greatly influenced by groundwater effects. As the groundwater table fluctuates over the wet weather season, this fluctuation is seen as a mounding effect in flow monitoring data.

Figure 3.1 illustrates the various flow components, which are described in detail in the following sections.

3.1.1 Base Wastewater Flow

The base wastewater flow (BWF) is the flow generated by the City's customers. The flow has a diurnal pattern that varies depending on the type of use. Commercial and industrial patterns, though they vary depending on the type of use, typically have more consistent higher flows during business hours and lower flows at night. Furthermore, the diurnal flow pattern experienced during a weekend may vary from the diurnal flow experienced during a weekday.

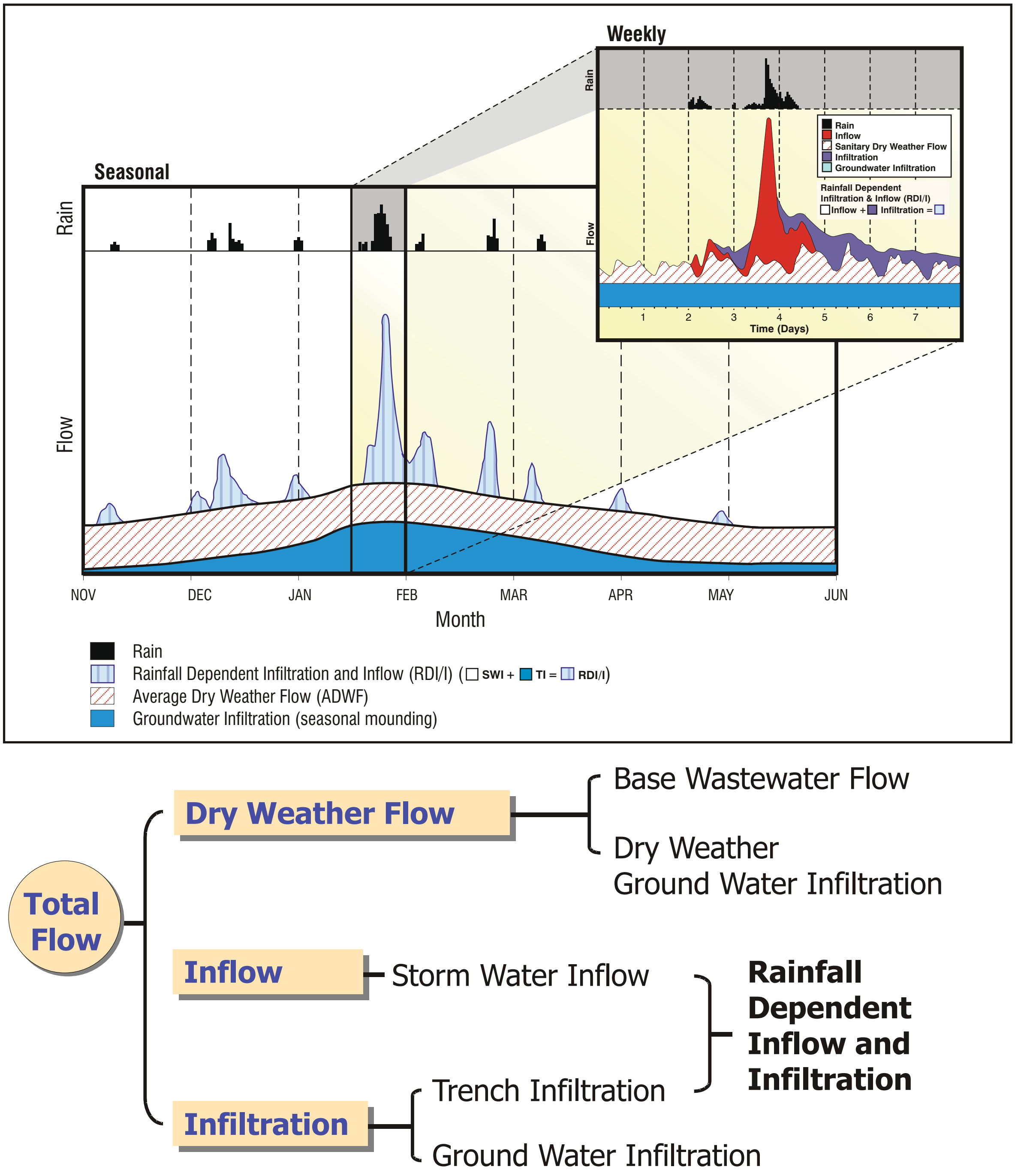


Figure 3.1
TYPICAL WASTEWATER FLOW COMPONENTS
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT

Note: This figure is not based on flow data specific to the City or this study.

3.1.2 Average Annual Flow

The average annual flow (AAF) is the average flow that occurs on a daily basis throughout the year, including both periods of dry and wet weather conditions.

3.1.3 Average Dry Weather Flow

The Average Dry Weather Flow (ADWF) is the average flow that occurs on a daily basis during the dry weather season. The ADWF includes the BWF generated by the City's residential, commercial, and industrial users, plus the dry weather GWI component. For the City, the ADWF was estimated based throughout the service area based on the data obtained from the 2010-2012 flow-monitoring program.

3.1.4 Groundwater Infiltration

GWI, one of the components of I/I, is associated with extraneous water entering the sewer system through defects in pipes and manholes. GWI is related to the condition of the sewer pipes, manholes, and groundwater levels. GWI may occur throughout the year, although rates are typically higher in the late winter and early spring. Dry weather GWI (or base infiltration) cannot easily be separated from BWF by flow measurement techniques. Therefore, dry weather GWI is typically grouped with BWF.

3.1.5 Infiltration and Inflow

All wastewater collection systems have some I/I, although the characteristics and severity vary by region and individual collection system. Some of the most common sources of I/I are shown on Figure 3.2. Infiltration is defined as storm water flows that enter the sewer system by percolating through the soil and then through defects in pipelines, manholes, and joints. Examples of infiltration entry points are cracks in pipelines, misaligned joints, and root penetration. Inflow is defined as storm water that enters the sewer system via a storm drain cross connections, leaky manhole covers, or cleanouts. Examples of inflow entry points are roof drain and downspout connections, leaky manhole covers, and illegal storm drain connections.

The adverse effects of I/I entering the sewer system is that it increases both the flow volume and peak flows, as illustrated on Figure 3.3. If too much I/I enters the sewer system such that the sewer system is operating at or above its capacity, SSOs could occur.

3.1.6 Peak Wet Weather Flow (Design Flow)

Peak wet weather flow (PWWF) is the highest observed flow that occurs following the design storm event. Wet weather I/I cause flows in the collection system to increase. PWWF is typically used for designing sewers and lift stations. Therefore, PWWF will be referred to as the design flow in this study.

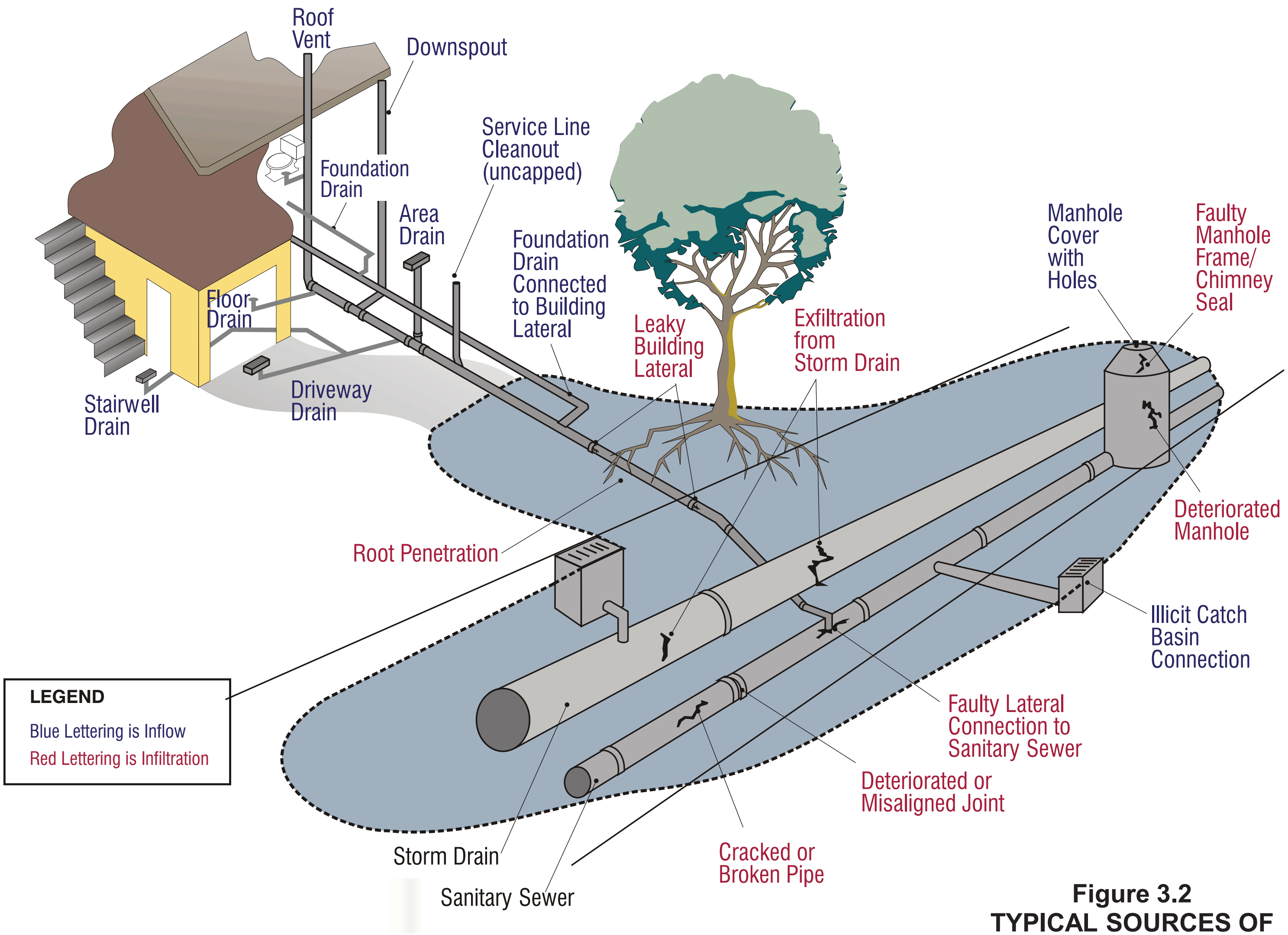
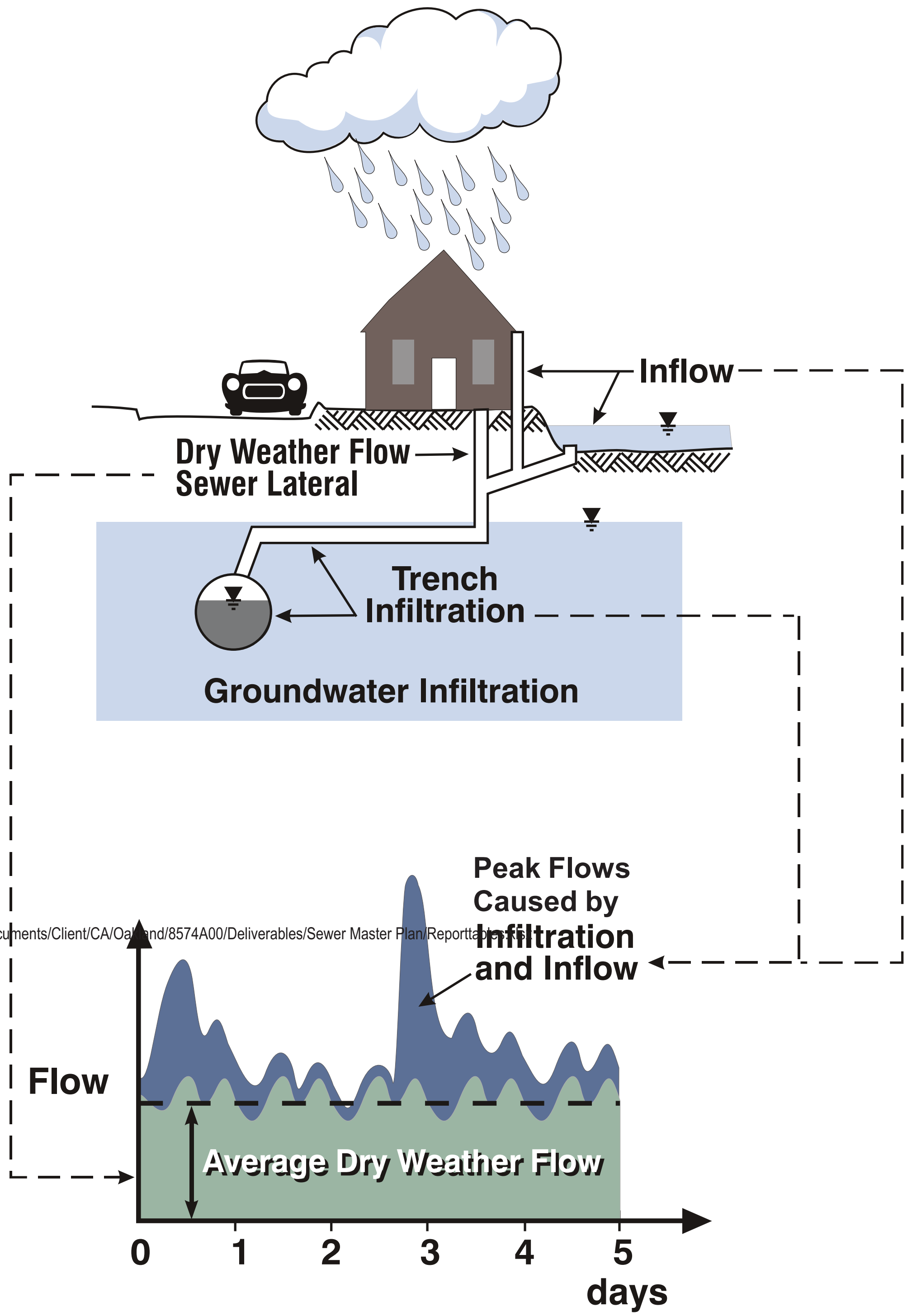


Figure 3.2
TYPICAL SOURCES OF INFILTRATION AND INFLOW
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT



pw://Carollo/Documents/Client/CA/Oakland/8574A00/Deliverables/Sewer Master Plan/Reporttables.xlsx

Figure 3.3
TYPICAL EFFECTS OF INFILTRATION AND INFLOW
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

3.2 FLOW MONITORING PROGRAM

In response to the requirements of the stipulated order (SO) and for use in calibrating the City's hydraulic model, a temporary flow monitoring was conducted. The data collected during the flow monitoring program also aides in the development of design flow criteria.

Temporary flow monitoring was performed by both East Bay Municipal District (EBMUD) and the City during the 2010/2011 wet weather season. These flow monitoring programs, which began in November of 2010 and continued through the end of March 2011, were used in this study to characterize both dry weather and wet weather flows in the City service area, and serve as a benchmark for calibration of the City's collection system hydraulic model.

Figure 3.4 shows the location of the flow meters, and Figure 3.5 shows the basins associated with each of those sites. Table 3.1 summarizes the number of flow monitors installed by basin. Figure 3.6 provides a schematic illustration of the flow monitoring locations. Table 3.2 describes the flow monitoring locations and the diameters for the sewers where the meters were installed.

In addition, as part of the requirements of the City's Stipulated Order (SO), the City conducted an additional round of flow monitoring during the 2011/2012 wet weather season in order to further define peak infiltration and inflow (I/I) characteristics of certain micro-basin areas within the collection system. However, the data from the second round of flow monitoring are summarized in detail in the City's Draft Sanitary Sewer Flow Monitoring and Inflow/Infiltration Study, dated October 2012, which is included in Appendix C.

3.2.1 2010/2011 EBMUD Flow Monitoring Program

As part of the EBMUD flow monitoring program, 71 flow meters were installed in the City's collection system, generally located at most of the City's connections to the EBMUD interceptor system. EBMUD also installed flow meters where wastewater is conveyed from one EBMUD member agency's collection system to another member agency's collection system (e.g., flow meters were installed to capture flows from the City of Piedmont sewers to the City of Oakland sewers).

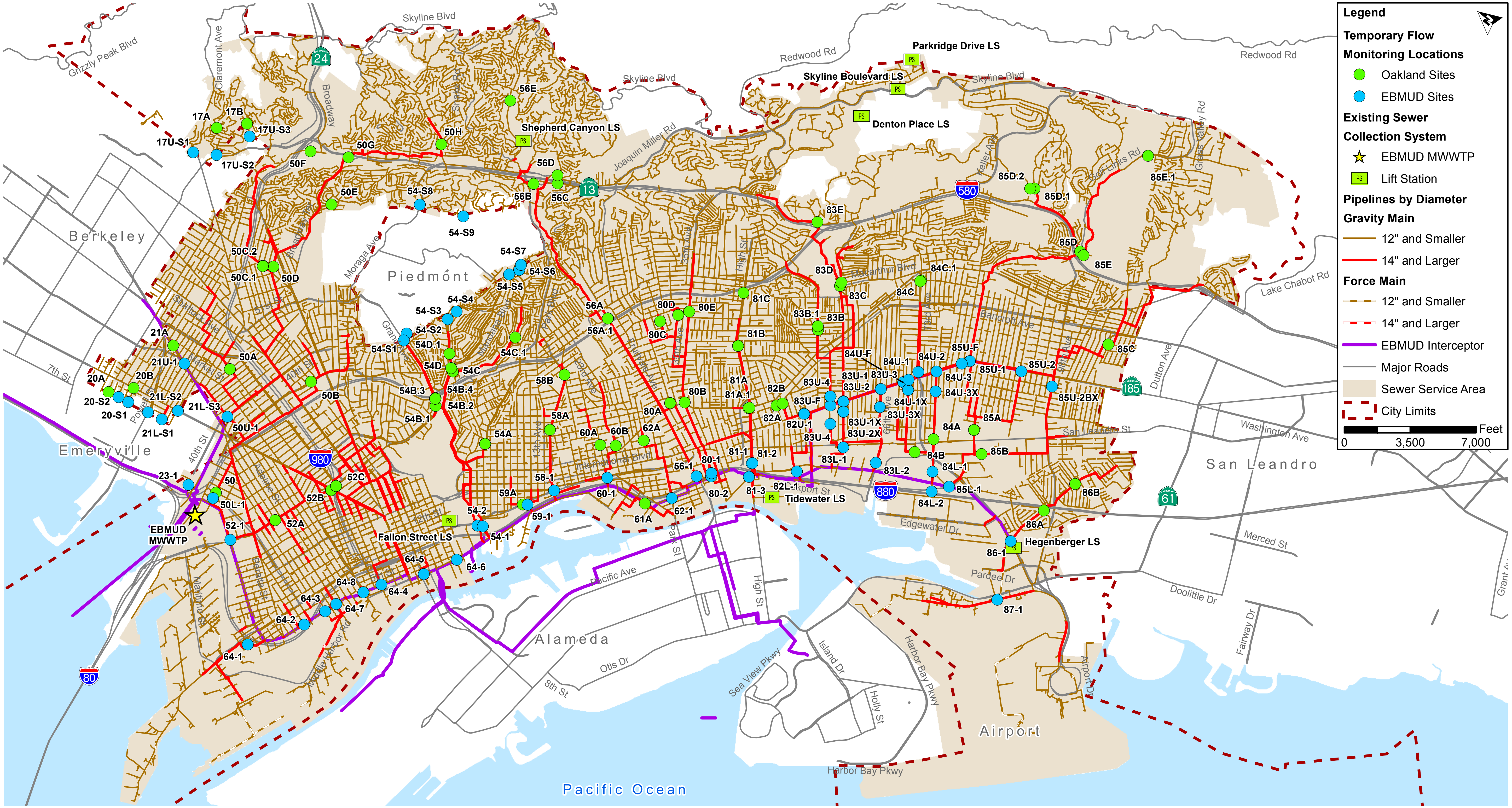


Figure 3.4
TEMPORARY FLOW MONITORING LOCATIONS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 3.4 Temporary Flow Monitoring Locations.mxd

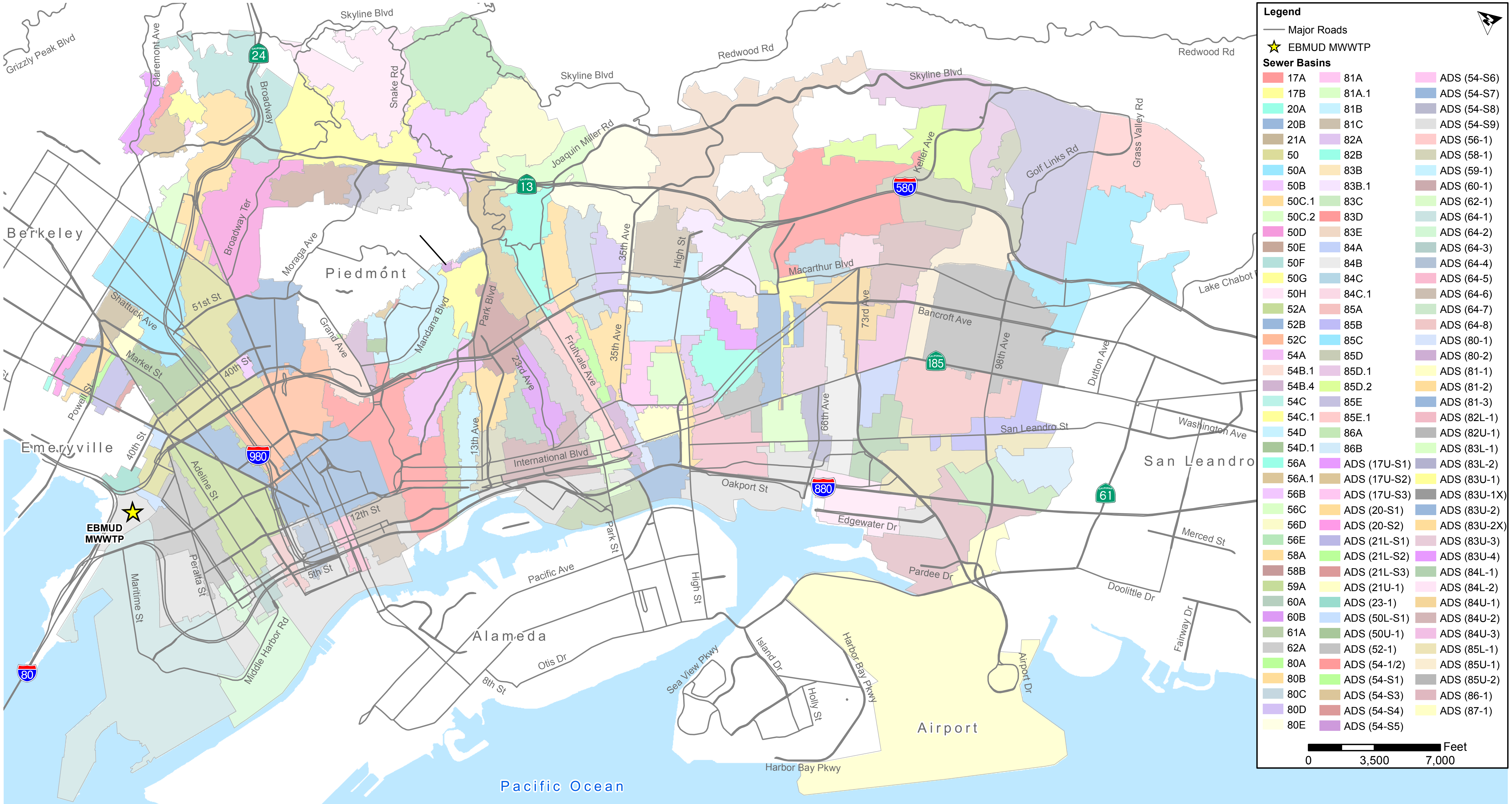


Figure 3.5
FLOW MONITORING BASINS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

Table 3.1 Number of Flow Monitors by Basin
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Basin	City Meters		EBMUD Meters		Total Meters	
	Total	Modeled[(1)]	Total	Modeled[(1)]	Total	Modeled[(1)]
17	2	0	3	2	5	2
20	2	1	2	1	4	2
21	1	1	4	3	5	4
23	0	0	1	0	1	0
50	10	10	3	3	13	13
52	3	3	1	1	4	4
54	9	9	12	9	21	18
56	6	6	1	1	7	7
58	2	2	1	1	3	3
59	1	1	1	1	2	2
60	2	2	1	1	3	3
61	1	1	0	0	1	1
62	1	1	1	1	2	2
64	0	0	8	8	8	8
80	5	5	2	2	7	7
81	4	4	3	3	7	7
82	2	2	2	2	4	4
83	5	5	10	10	15	15
84	4	4	8	8	12	12
85	8	8	5	5	13	13
86	2	2	1	1	3	3
87	0	0	1	1	1	1
Total	**70**	**67**	**71**	**64**	**141**	**131**

Notes:

1. The City and EBMUD installed flow meters on 10 sites that were not included in the City's hydraulic model. The City's hydraulic model only includes pipelines 10-inches and larger, with some smaller pipelines included for connectivity. Therefore, 10 meters that were on 8-inch lines were not modeled.

Table 3.2	Flow Monitoring Location Summary Sewer System Hydraulic Modeling and Capacity Evaluation Report City of Oakland		
Monitoring Site	Pipe Diameter (in)	City/ EBMUD(1)	Location
			Basin 17
17A	8	City	Intersection of Alvarado Rd and Gravatt Dr
17B	8	City	Intersection of Vicente Rd and Vicente Pl
17-S1	8	EBMUD	Near Intersection of Claremont Ave. and Avalon Ave
17-S2	8	EBMUD	Near Intersection of Tunnel Rd and Eucalyptus Path
17-S3	7.88	EBMUD	North of Vicente Rd and Tunnel Rd Intersection on Vicente Rd
			Basin 20
20A	8	City	Intersection of Ocean Ave. and Vallejo St
20B	8	City	Intersection of 61st St and San Pablo Ave
20-S1	11.63	EBMUD	Intersection of 61st St and Vallejo St
20-S2	7.5	EBMUD	Intersection of 63rd St and Vallejo St
			Basin 21
21A	9.25	City	Intersection of 59th St and Adeline St
21U-1	11	EBMUD	Intersection of Adeline St and Aileen St and Market St
21L-S1	14	EBMUD	Intersection of 55th St and Vallejo St
21L-S2	9.75	EBMUD	Intersection of Powell St and Vallejo St
21L-S3	10.25	EBMUD	Intersection of 53rd St and San Pablo Ave
			Basin 23
23-1	23.75	EBMUD	Intersection of 53rd St and San Pablo Ave
			Basin 50
50L-S1	12	EBMUD	Intersection of W. MacArthur Blvd and Access Watts St
50	36	City	Intersection of Ettie St and 34th St
50A	36	City	Intersection of 47th St and West St
50B	38x26 Egg	City	Intersection of W. MacArthur Blvd and Webster St
50U-1	36	EBMUD	Intersection of 40th St and Linden St
50L-1	35.38	EBMUD	Intersection of Mandela Pkwy and 34th St
50C.1	18	City	Intersection of Taft Ave and College Ave (On western side of College Ave)
50C.2	12	City	Intersection of Taft Ave and College Ave (On eastern side of College Ave)
50D	42x28 Egg	City	Manila Ave in between College Ave and Bryant Ave
50E	11.5	City	Intersection of Buckeye Ave and Harbord Dr
50F	12	City	SB S13 and Broadway
50G	24	City	SB S13 near SB Broadway Onramp TR
50H	15	City	Thornhill Dr between Mountain Blvd and Grisborne Ave
			Basin 52
52A	72 Thumbnail	City	Intersection of Magnolia St and W. Grand Ave
52B	54	City	Intersection of W. Grand Ave and San Pablo Ave
52C	42	City	Intersection of W. Grand Ave and Martin Luther King Jr. Wy
52-1	59.87	EBMUD	Intersection of Wood St and W. Grand Ave
			Basin 54
54-S1	20	EBMUD	Intersection of Grand Ave and Wildwood Ave
54-S2	17	EBMUD	Wildwood Ave between Grand Ave and Sylvan Wy
54B.1	21	City	Intersection of Grand Ave and El Embarcadero
54B.2	30	City	Intersection of Grand Ave and MacArthur Blvd (Western-most meter)
54B.3	30	City	Intersection of Grand Ave and MacArthur Blvd (Between Meters 54B.2 and 54B.4)
54B.4	18	City	Intersection of Grand Ave and MacArthur Blvd (East of Meter 54B.3)
54-1	48.13	EBMUD	Near Intersection of 5th Ave and E. 7th St (West of Intersection)
54-2	66	EBMUD	Near Intersection of 5th Ave and E. 7th St (Northwest of Meter 54-1)
54-S3	8.13	EBMUD	Harvard Wy Near Intersection of Winsor Ave, Harvard Wy, and Lakeshore Ave
54-S4	8.06	EBMUD	Lakeshore Ave Between Harvard Rd and Harvard Wy
54-S4A	8	EBMUD	City of Piedmont
54D	21	City	Intersection of Lakeshore Ave and Longridge Rd
54D.1	15	City	Intersection of Lakeshore Ave and Prince St
54-S5	8	EBMUD	North of Intersection of Sunnyhills Rd and Downey Pl
54-S6	9.25	EBMUD	Intersection of Valant Pl and Trestle Glen Rd
54-S7	9.31	EBMUD	Trestle Glen Rd Between Cavanagh Ct and Valant Pl
54-S8	8	EBMUD	Moraga Ave Between Maxwelton Rd and Harbord Dr
54-S9	8	EBMUD	Between Littlewood Dr and Glen Alpine Rd (Not on street)
54A	18	City	Intersection of 3rd Ave and E 20th St
54C	18	City	Intersection of Wesley Wy and Trestle Glen Rd
54C.1	16	City	West of Intersection of Grosvenor Pl and Trestle Glen Rd
			Basin 56
56A	18	City	Near Intersection of Fruitvale Ave and Montant St (Eastern-most Meter)
56A.1	27	City	Near Intersection of Fruitvale Ave and Montant St (West of Meter 56A)
56B	15	City	Between Monterey Blvd and Park Blvd near SB S13 (Not on Street)
56C	12	City	Intersection of Monterey Blvd and El Caminito

Table 3.2	Flow Monitoring Location Summary Sewer System Hydraulic Modeling and Capacity Evaluation Report City of Oakland		
Monitoring Site	Pipe Diameter (in)	City/ EBMUD[(1)]	Location
56D	12	City	Intersection of Mountain Blvd and Ascot Dr
56E	16.5	City	Southwest of Intersection of Shepherd Canyon Rd and Paso Robles Dr
56-1	30	EBMUD	Fruitvale Ave north of I880 Freeway
Basin 58			
58A	31	City	Intersection of E 22nd St and 14th Ave
58B	18	City	Intersection of 14th Ave and E 30th St
58-1	48.75	EBMUD	Intersection of 14th Ave and E. 8th St
Basin 59			
59A	24	City	Intersection of 10th Ave and E. 8th St
59-1	36.13	EBMUD	E. 8th Ave Between 10th Ave and 11th Ave (Not on Street)
Basin 60			
60A	12	City	Intersection of 22nd Ave and Commerce Wy
60B	24	City	Intersection of 23rd Ave and E. 17th St
60-1	30	EBMUD	Intersection of E. 12th St and 22nd Ave
Basin 61			
61A	15	City	Kennedy St Between Diesel St and Frederick St
Basin 62			
62A	15	City	Intersection of 27th Ave and E. 17th St
62-1	20.25	EBMUD	Intersection of E. 7th St and 29th Ave
Basin 64			
64-1	36	EBMUD	5th St West of I880 Northbound
64-2	12.19	EBMUD	Intersection of 3rd St and Center St
64-3	21	EBMUD	Intersection of Union St and 3rd St
64-4	18	EBMUD	Intersection of Martin Luther King Jr Wy and 2nd St
64-5	16.5	EBMUD	Intersection of Webster St and Embarcadero West
64-6	14.5	EBMUD	Intersection of Embarcadero West and Oak St
64-7	18	EBMUD	Intersection of 3rd St and Adeline St
64-8	12.13	EBMUD	Market St Between 3rd St and Embarcadero West
Basin 80			
80A	10	City	Intersection of E. 22nd St and Coolidge Ave
80B	27	City	Intersection of Foothill Blvd and 35th Ave
80C	14	City	Curran Ave Between Ward Ln and School St
80D	18	City	Humboldt Ave Between Pennman Ave and School St
80E	18	City	Intersection of 35th Ave and Hageman Ave
80-1	30	EBMUD	Intersection of E. 9th St and 35th Ave (NB side of I 880)
80-2	18	EBMUD	Intersection of 34th Ave and E 8th St (SB side of I 880)
Basin 81			
81A	15	City	Intersection of Foothill Blvd and High St (Northwest of Meter 81A.1)
81A.1	12	City	Intersection of Foothill Blvd and High St (Southeast of Meter 81A)
81B	18	City	Intersection of High St and Gordon St
81C	10	City	Intersection of High St and EB MacArthur Blvd
81-1	23.88	EBMUD	Northeast of Intersection of High St and NB I 880 on High St (West of Meter 81-2)
81-2	18.25	EBMUD	Northeast of Intersection of High St and NB I 880 on High St (East of Meter 81-1)
81-3	12	EBMUD	Intersection of Alameda Ave and E. 8th Street
Basin 82			
82A	10	City	Intersection of Bond St and 48th Ave
82B	21	City	Intersection of 50th Ave and Bancroft Ave
82U-1	24	EBMUD	Intersection of International Blvd and 53rd Ave
82L-1	20	EBMUD	50th Ave Between Oakport St and Coliseum Wy
Basin 83			
83B	10	City	Intersection of 55th Ave and Hillen Dr
83B.1	14	City	Intersection of 55th Ave and Fleming Ave
83C	21	City	Intersection of Seminar Ave and MacArthur Blvd
83D	15	City	Intersection of Seminar Ave and Monadnock Wy
83E	18	City	I 580 WB at Mountain Blvd
83L-1	36.5	EBMUD	Intersection of San Leandro St and Seminar Ave
83L-2	20.69	EBMUD	66th Ave Between Coliseum Wy and San Leandro St
83U-1	19.25	EBMUD	Intersection of International Blvd and Seminar Ave (Southwest of Meter 83U-2)
83U-2	17.25	EBMUD	Intersection of International Blvd and Seminar Ave (Northeast of Meter 83U-1)
83U-3	17.13	EBMUD	Intersection of 66th Ave and International Blvd
83U-4	26.75	EBMUD	57th Ave Between International Blvd and E. 15th St
83U-F	59.5	EBMUD	Intersection of International Blvd and 57th Ave
83U-1X	21	EBMUD	Intersection of Eastlawn St and Seminar Ave (Southeast of Meter 83U-2X)
83U-2X	18	EBMUD	Intersection of Eastlawn St and Seminar Ave (Northwest of Meter 83U-1X)
83U-3X	18	EBMUD	Intersection of Lucille St and 66th Ave

Table 3.2 Flow Monitoring Location Summary
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Monitoring Site	Pipe Diameter (in)	City/ EBMUD[(1)]	Location
			Basin 84
84A	19.75	City	7th Ave Between San Leandro St and Hawley St
84B	30	City	73rd Ave near Railroad Rd.
84C	12	City	Intersection of 73rd Ave and Hillside St (West of Meter 84C.1)
84C.1	12	City	Intersection of 73rd Ave and Hillside St (East of Meter 84C)
84U-1	20.13	EBMUD	International Blvd Between 71st Ave and 72nd Ave
84U-2	20	EBMUD	73rd Ave Between International Blvd and Orral St
84U-3	18	EBMUD	Intersection of International Blvd and 77th Ave
84U-1X	21	EBMUD	Intersection of 71st Ave and Herbert Guice Wy
84U-3X	18	EBMUD	Intersection of Rudsale St and 77th Ave
84L-1	29.5	EBMUD	West of Intersection of Hegenberger Rd and Baldwin St (Not on Street)
84L-2	16	EBMUD	Intersection of S. Coliseum Wy and NB I 880
84U-F	54	EBMUD	Intersection of International Blvd and 70th Ave
			Basin 85
85D	18	City	Intersection of Mountain Blvd and Golf Links Rd
85D.1	12	City	Intersection of Pool Rd and Trojakowski St (Southeast of Meter 85D.2)
85D.2	12	City	Intersection of Pool Rd and Trojakowski St (Northwest of Meter 85D.1)
85E	18	City	Intersection of Mountain Blvd and Golf Links Rd (South of Meter 85D)
85E.1	12	City	Northwest of Intersection of Golf Links Rd and Scotia Ave on Golf Links Rd
85U-1	23.62	EBMUD	Intersection of 83rd Ave and International Blvd
85A	30	City	85th Ave Between San Leandro St and Amelia St
85B	33	City	Southeast of the Intersection of Railroad Ave and 85th Ave on Railroad Ave
85C	21	City	Intersection of 105th Ave and Sunnyside St
85U-2	23.63	EBMUD	Intersection of 92nd Ave and International Blvd
85U-F	36	EBMUD	International Blvd Between 81st Ave and 82nd Ave
85L-1	39.12	EBMUD	S. Coliseum Wy West of the Hegenberger/S. Coliseum Intersection
85U-2BX	27	EBMUD	Intersection of 98th Ave and A St
			Basin 86
86A	21	City	Intersection of 98th Ave SB I 880
86B	18	City	Intersection of St Elmo Dr and Stoneford Ave
86-1	24.5	EBMUD	Intersection of Hegenberger Rd and Left Dr
			Basin 87
87-1	18	EBMUD	Intersection of Earhart Dr and Swan Wy

Notes:
(1) Meters installed for City of Oakland by V&A, or for EBMUD by ADS.

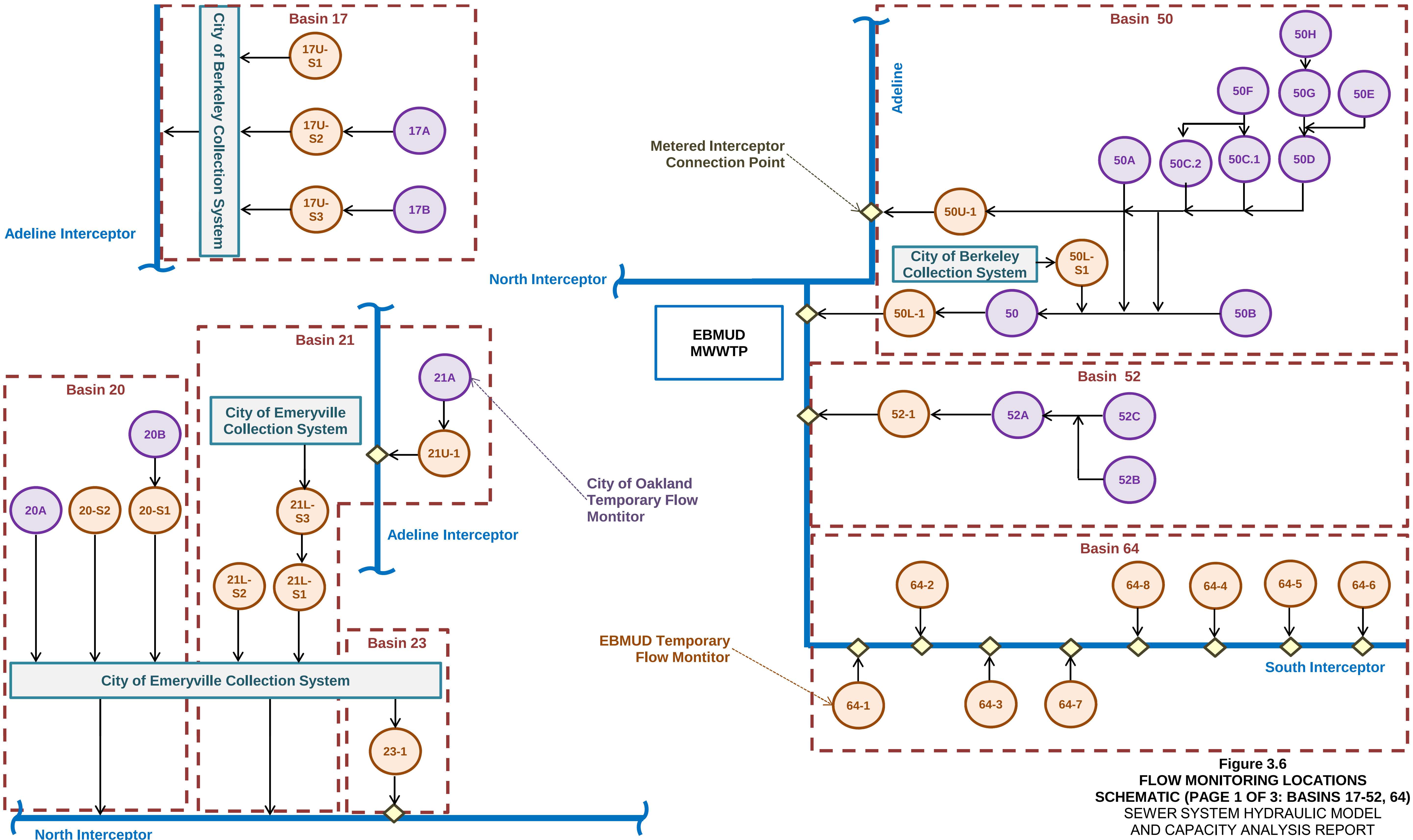


Figure 3.6
FLOW MONITORING LOCATIONS SCHEMATIC (PAGE 1 OF 3: BASINS 17-52, 64)
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

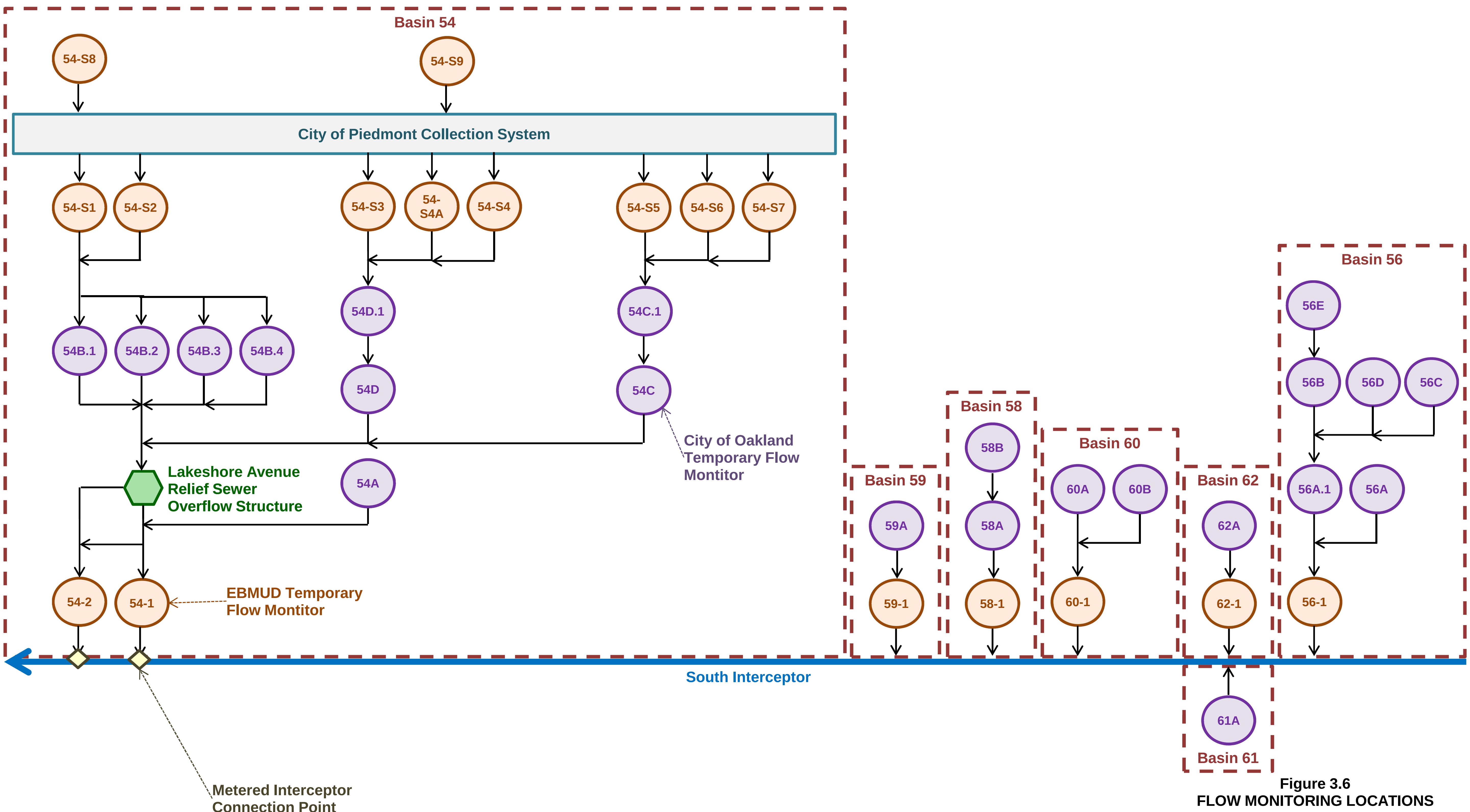


Figure 3.6
FLOW MONITORING LOCATIONS SCHEMATIC (PAGE 2 OF 3: BASINS 54-62)
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
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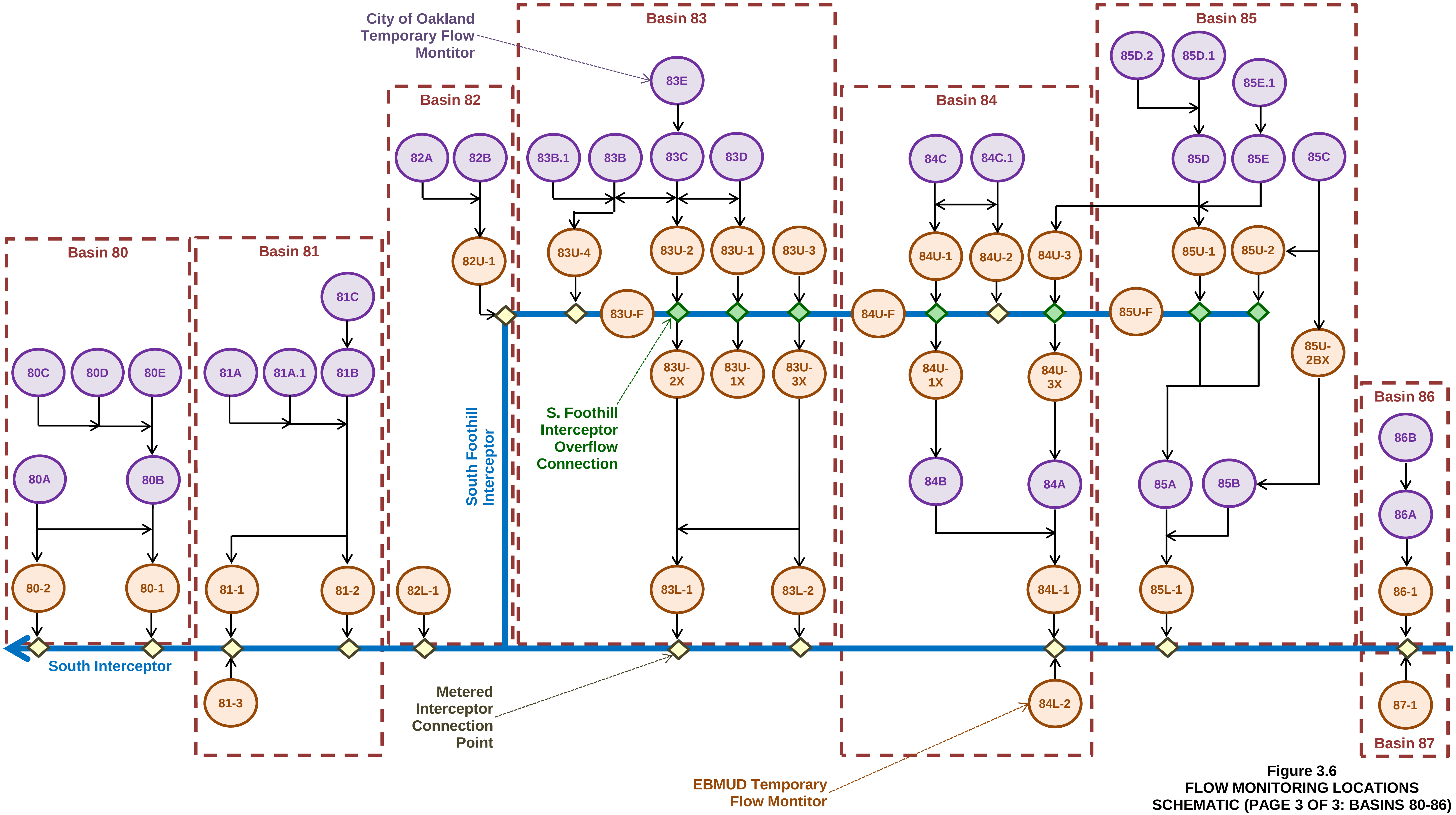

Figure 3.6
FLOW MONITORING LOCATIONS SCHEMATIC (PAGE 3 OF 3: BASINS 80-86)
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

3.2.2 2010/2011 City of Oakland Flow Monitoring Program

The City contracted with V&A Consulting Engineers (V&A) to conduct 2010-2012 flow monitoring program at 70 monitoring sites within the City collection system. The meter sites were selected to capture flow from the majority of the City's collection system and to best model the sewer areas and multiple sub-areas within the City's collection system. The sites were also selected to avoid duplication of the EBMUD flow monitoring sites.

3.3 FLOW MONITORING RESULTS

This section summarizes the results of the 2010-2012 flow monitoring program, including dry weather flow data, rainfall data, and wet weather flow data. Data collected from Meter 83E are presented throughout this and other chapters as an example of the type of data and the results from the flow monitoring program. Refer to Appendix C for additional data summaries and other information associated with the remaining meter sites.

3.3.1 Average Dry Weather Flow Data

During the flow monitoring period, depth and velocity data were provided by EBMUD and V&A at each meter for 15 minute intervals. The 15-minute data were then aggregated to hourly data for the model calibration effort. Characteristic dry weather 24 hour diurnal flow patterns for each site were developed by V&A at 15-minute intervals for both weekday and weekend flows.

The 15-minute dry weather flow data were converted to hourly flow data and then used to calibrate the hydraulic model for Average Dry Weather Flow (ADWF). For this study, both the weekday and weekend flow averages and diurnal patterns were used for calibration and analysis.

Hourly patterns for weekday and weekend flows vary and are separated to better understand dry weather flow patterns. Figure 3.7 illustrates a typical variation of weekday and weekend flow, as recorded at flow monitoring site 83E. Similar graphics associated with the remaining monitoring sites are included in Appendix C. Table 3.3 shows the ADWF for each flow meter.

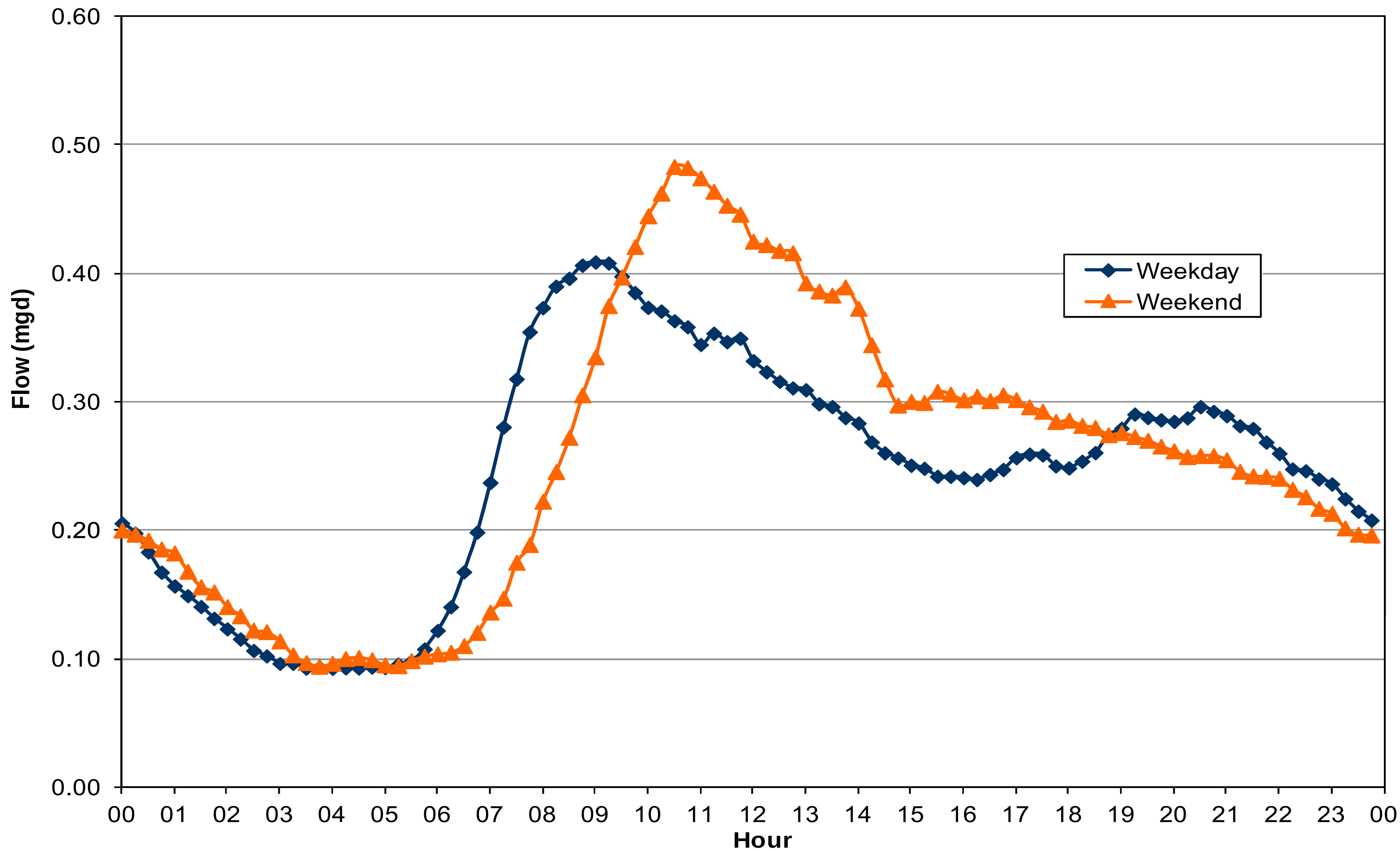

Figure 3.7
TYPICAL WEEKDAY VS. WEEKEND
DRY WEATHER FLOW VARIATION (METER 83E)
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS
CITY OF OAKLAND

November 15, 2012
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Table 3.3 Average Dry Weather Flow by Meter
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Monitoring Site	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)	Weekend/Weekday Ratio
		Basin 17		
17A	0.03	0.03	0.03	1.04
17B	0.04	0.04	0.04	0.96
17-S1	0.06	0.07	0.07	1.10
17-S2	0.07	0.07	0.07	1.03
17-S3	0.04	0.05	0.05	1.11
		Basin 20		
20A	0.01	0.01	0.01	1.04
20B	0.05	0.05	0.05	0.99
20-S1	0.17	0.17	0.17	0.98
20-S2	0.08	0.08	0.08	0.97
		Basin 21		
21A	0.04	0.05	0.04	1.08
21U-1	0.15	0.15	0.15	1.01
21L-S1	0.22	0.24	0.23	1.12
21L-S2	0.10	0.11	0.10	1.05
21L-S3	0.07	0.07	0.07	1.05
		Basin 23		
23-1	0.13	0.13	0.13	0.98
		Basin 50		
50L-S1	0.09	0.09	0.09	1.05
50	2.50	2.49	2.50	1.00
50A	0.98	1.01	0.99	1.03
50B	0.70	0.69	0.70	0.99
50U-1	2.21	2.24	2.22	1.02
50L-1	2.50	2.64	2.54	1.06
50C.1	0.46	0.48	0.47	1.04
50C.2	0.15	0.16	0.15	1.07
50D	0.85	0.88	0.86	1.04
50E	0.07	0.07	0.07	1.00
50F	0.11	0.12	0.11	1.03
50G	0.65	0.68	0.66	1.04
50H	0.28	0.30	0.28	1.05
		Basin 52		
52A	4.09	3.87	4.03	0.95
52B	1.62	1.46	1.57	0.90
52C	1.04	1.00	1.03	0.96
52-1	4.96	4.61	4.86	0.93
		Basin 54		
54-S1	0.28	0.28	0.28	1.03
54-S2	0.33	0.34	0.34	1.02
54B.1	0.11	0.11	0.11	1.01
54B.2	0.49	0.47	0.48	0.97
54B.3	0.18	0.20	0.19	1.10
54B.4	0.10	0.11	0.11	1.04
54-1	4.33	4.50	4.38	1.04
54-2	0.00	0.00	0.00	0.00
54-S3	0.07	0.08	0.07	1.04
54-S4	0.01	0.01	0.01	1.08
54-S4A	0.03	0.03	0.03	1.03
54D	0.39	0.40	0.39	1.03
54D.1	0.04	0.04	0.04	0.96
54-S5	0.10	0.10	0.10	0.98
54-S6	0.09	0.10	0.09	1.01
54-S7	0.07	0.07	0.07	0.97
54-S8	0.02	0.02	0.02	1.07
54-S9	0.07	0.07	0.07	1.08
54A	0.48	0.48	0.48	0.99
54C	0.51	0.51	0.51	1.00
54C.1	0.38	0.39	0.39	1.03
		Basin 56		
56A	0.36	0.36	0.36	1.02
56A.1	1.07	1.13	1.09	1.05
56B	0.36	0.38	0.36	1.05
56C	0.09	0.09	0.09	1.05

Table 3.3 Average Dry Weather Flow by Meter
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Monitoring Site	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)	Weekend/Weekday Ratio
56D	0.11	0.11	0.11	1.04
56E	0.23	0.25	0.24	1.09
56-1	1.70	1.76	1.72	1.03
Basin 58				
58A	0.54	0.55	0.54	1.03
58B	0.39	0.42	0.40	1.07
58-1	1.46	1.42	1.45	0.97
Basin 59				
59A	0.37	0.41	0.38	1.12
59-1	0.63	0.65	0.63	1.04
Basin 60				
60A	0.23	0.24	0.23	1.02
60B	0.28	0.30	0.29	1.05
60-1	0.73	0.74	0.73	1.01
Basin 61				
61A	0.16	0.17	0.16	1.04
Basin 62				
62A	0.28	0.28	0.28	1.00
62-1	0.32	0.33	0.32	1.01
Basin 64				
64-1	0.16	0.13	0.15	0.86
64-2	0.10	0.11	0.11	1.04
64-3	0.12	0.12	0.12	0.97
64-4	0.48	0.42	0.46	0.88
64-5	0.38	0.37	0.38	0.99
64-6	0.31	0.26	0.30	0.83
64-7	0.04	0.04	0.04	0.92
64-8	0.10	0.09	0.10	0.95
Basin 80				
80A	0.16	0.16	0.16	1.01
80B	1.38	1.43	1.40	1.03
80C	0.15	0.15	0.15	1.03
80D	0.33	0.35	0.34	1.07
80E	0.29	0.31	0.29	1.07
80-1	1.55	1.58	1.56	1.02
80-2	0.20	0.20	0.20	0.98
Basin 81				
81A	0.08	0.08	0.08	1.05
81A.1	0.25	0.26	0.25	1.05
81B	0.82	0.90	0.84	1.09
81C	0.59	0.58	0.58	0.99
81-1	0.89	0.99	0.92	1.11
81-2	0.66	0.71	0.68	1.07
81-3	0.18	0.17	0.18	0.95
Basin 82				
82A	0.06	0.06	0.06	1.00
82B	0.45	0.43	0.44	0.97
82U-1	0.55	0.57	0.55	1.04
82L-1	0.44	0.46	0.45	1.04
Basin 83				
83B	0.13	0.14	0.13	1.13
83B.1	0.22	0.23	0.22	1.04
83C	0.34	0.36	0.35	1.04
83D	0.39	0.38	0.39	0.96
83E	0.25	0.26	0.25	1.04
83L-1	1.94	2.07	1.98	1.06
83L-2	0.37	0.38	0.37	1.04
83U-1	0.51	0.52	0.51	1.02
83U-2	0.59	0.63	0.60	1.06
83U-3	0.15	0.15	0.15	1.05
83U-4	0.63	0.67	0.64	1.07
83U-F	1.15	1.27	1.19	1.11
83U-1X	0.42	0.43	0.42	1.02
83U-2X	0.58	0.62	0.59	1.07
83U-3X	0.32	0.33	0.32	1.03

Table 3.3 Average Dry Weather Flow by Meter
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Monitoring Site	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)	Weekend/Weekday Ratio
Basin 84				
84A	0.45	0.44	0.44	0.98
84B	0.71	0.75	0.72	1.06
84C	0.12	0.13	0.13	1.05
84C.1	0.06	0.07	0.06	1.16
84U-1	0.47	0.49	0.47	1.05
84U-2	0.44	0.46	0.44	1.03
84U-3	0.43	0.44	0.43	1.03
84U-1X	0.59	0.60	0.59	1.02
84U-3X	0.41	0.40	0.41	0.98
84L-1	1.13	1.17	1.14	1.03
84L-2	0.08	0.06	0.08	0.69
84U-F	1.14	1.31	1.19	1.14
Basin 85				
85D	0.32	0.34	0.32	1.06
85D.1	0.10	0.11	0.10	1.11
85D.2	0.10	0.11	0.10	1.07
85E	0.21	0.23	0.21	1.09
85E.1	0.10	0.11	0.10	1.09
85U-1	0.79	0.84	0.81	1.06
85A	1.69	1.75	1.71	1.04
85B	0.76	0.68	0.74	0.90
85C	0.30	0.35	0.32	1.15
85U-2	1.50	1.55	1.51	1.03
85U-F	0.53	0.58	0.54	1.10
85L-1	2.53	2.68	2.57	1.06
85U-2BX	0.00	0.00	0.00	0.00
Basin 86				
86A	0.52	0.56	0.53	1.07
86B	0.21	0.21	0.21	1.01
86-1	0.68	0.70	0.68	1.03
Basin 87				
87-1	0.34	0.31	0.33	0.91

Notes:
1. Source: 2010/2011 Temporary flow monitoring program data.

3.3.2 Rainfall Data

EBMUD provided gauge adjusted radar rainfall (GARR) data to Carollo and V&A for its entire service area during the 2010/2011 flow monitoring period. The GARR data is broken up into "pixels," each with an area of roughly one square kilometer. The 5-minute rainfall data was provided per pixel covering the entire City service area. Figure 3.8 shows the GARR pixels with an overlay of the flow monitoring basins that were used for this project.

The rainfall affecting a particular sanitary sewer collection system basin (e.g., each flow monitoring basin in this case) was calculated based on the proximity to the GARR pixels. For example, the rain that fell within Basin 83E is characterized by Pixels 247, 270, 271, 272, 273, 293, 294, and 295. Figure 3.9 shows the pixels associated with Flow Monitoring Basin 83E. Each pixel's influence is proportional to the area of the basin contained within that pixel. For Basin 83E, Pixel 247, 270, 271, 272, 273, 293, 294, and 295 has 1.3 percent, 13.3 percent, 13.3 percent, 21.3 percent, 17.3 percent, 12.0 percent, 14.7 percent, and 6.7 percent influence, respectively. The influence of each pixel as calculated for each flow monitoring basin is shown in Appendix C.

V&A used this methodology to develop the 15-minute rainfall depth totals for each individual flow monitoring basin during the flow monitoring period. In order to reduce hydraulic model simulation time, the 15-minute rainfall was converted to an hourly rainfall for model calibration purposes.

The flow monitoring program captured flows during several storm events. Figure 3.10 shows the hourly rainfall activity that occurred over the flow monitoring period for Meter 83E. Figure 3.11 shows the total rainfall accumulation for Meter 83E over the flow monitoring period. As shown in this figure, a total of 20.75-inches of rainfall fell over Flow Meter Basin 83E from December 1, 2010 to March 31, 2011, which equates to roughly 123 percent of normal for that time period.

V&A identified four major storm events system wide. These events occurred on December 18-19, 2010, December 28-29, 2010, February 14-20, 2011, and March 18-26, 2011. As shown on Figure 3.11, the maximum 24-hour rainfall volume of the four major storms (1.72-inches) occurred during the December 28-29, 2010 storm event for Meter 83E. The storm event that occurred between March 18-26, 2011, however, had the largest 10-day rainfall volume (5.18-inches). The 15-minute peak rainfall intensity of the four storms (0.54 inches per hour) occurred during the December 18-19, 2010 rainfall event. As shown on Figure 3.12, all four storms can be classified as less than 2-year events.

In general, the greatest infiltration and inflow (I/I) response was observed in the system during the March 2011 storm events. For this reason, the period of March 13 through March 30, 2011 was selected for the wet weather calibration, as discussed in greater detail in Chapter 4.

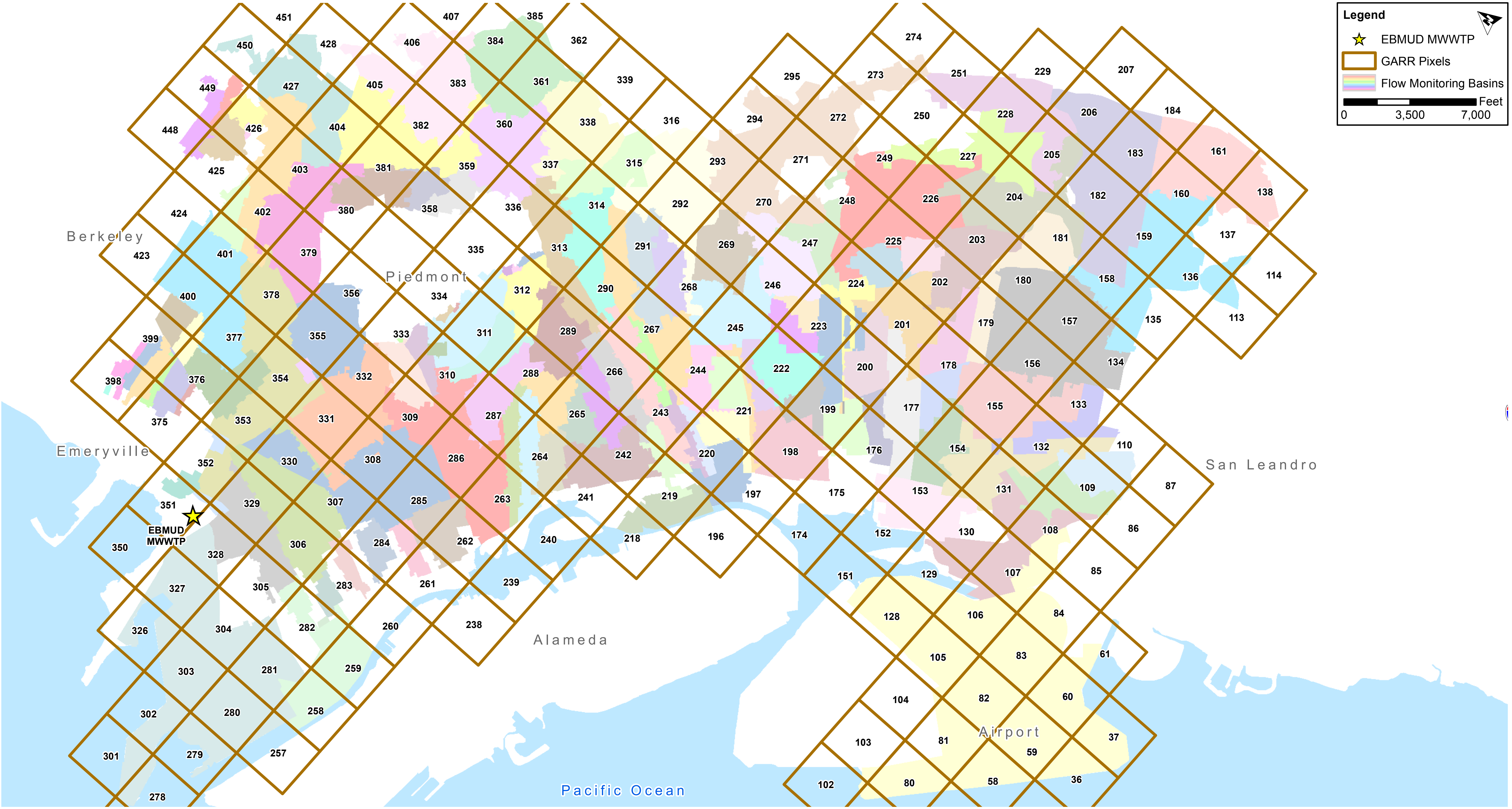


Figure 3.8
FLOW MONITORING BASINS AND GARR PIXELS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 3.8 Flow Monitoring Basins and GARR.mxd

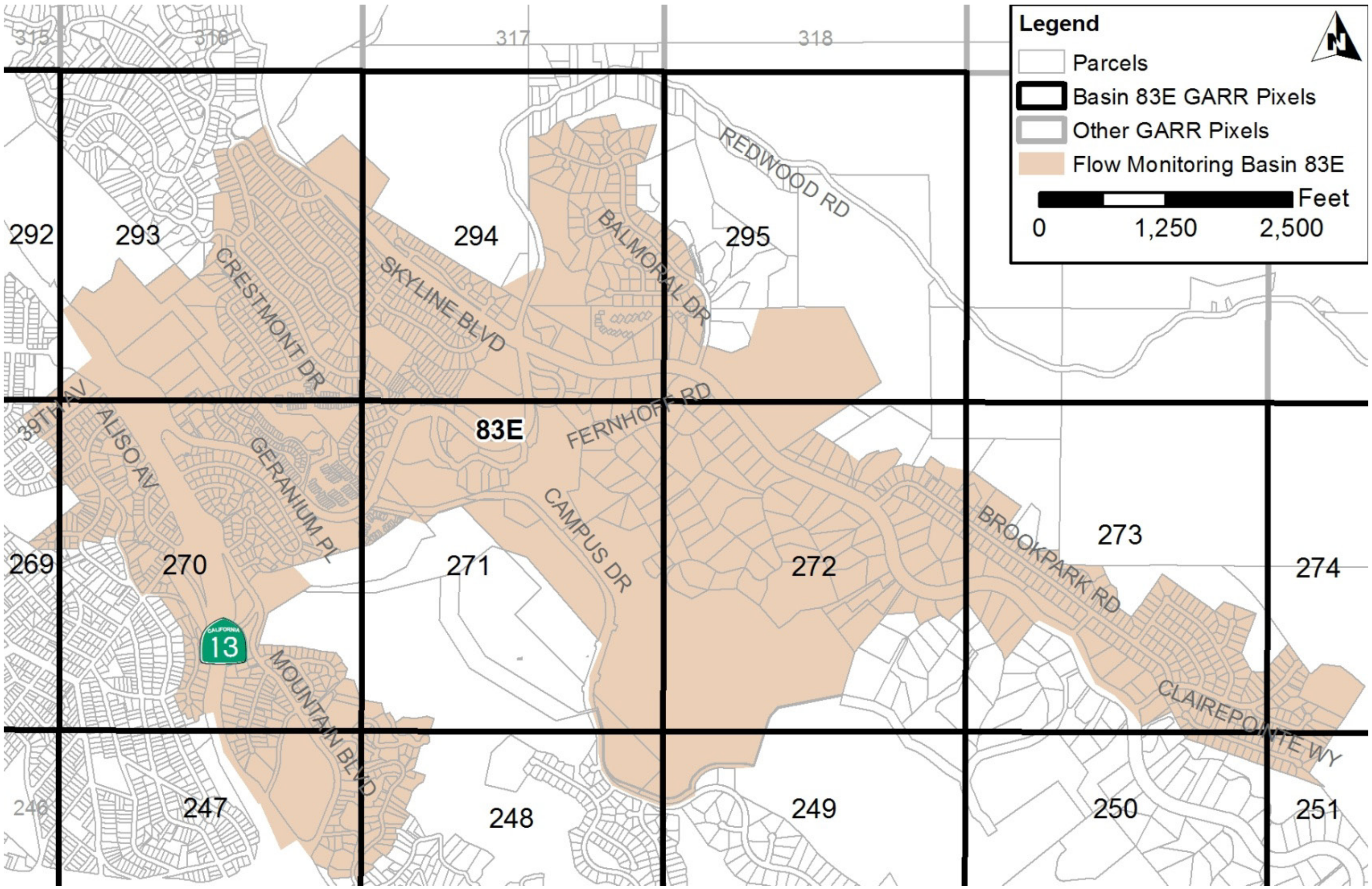


Figure 3.9
FLOW MONITORING BASIN 83E AND ASSOCIATED GARR PIXELS
SEWER SYSTEM HYDRAULIC MODEL
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

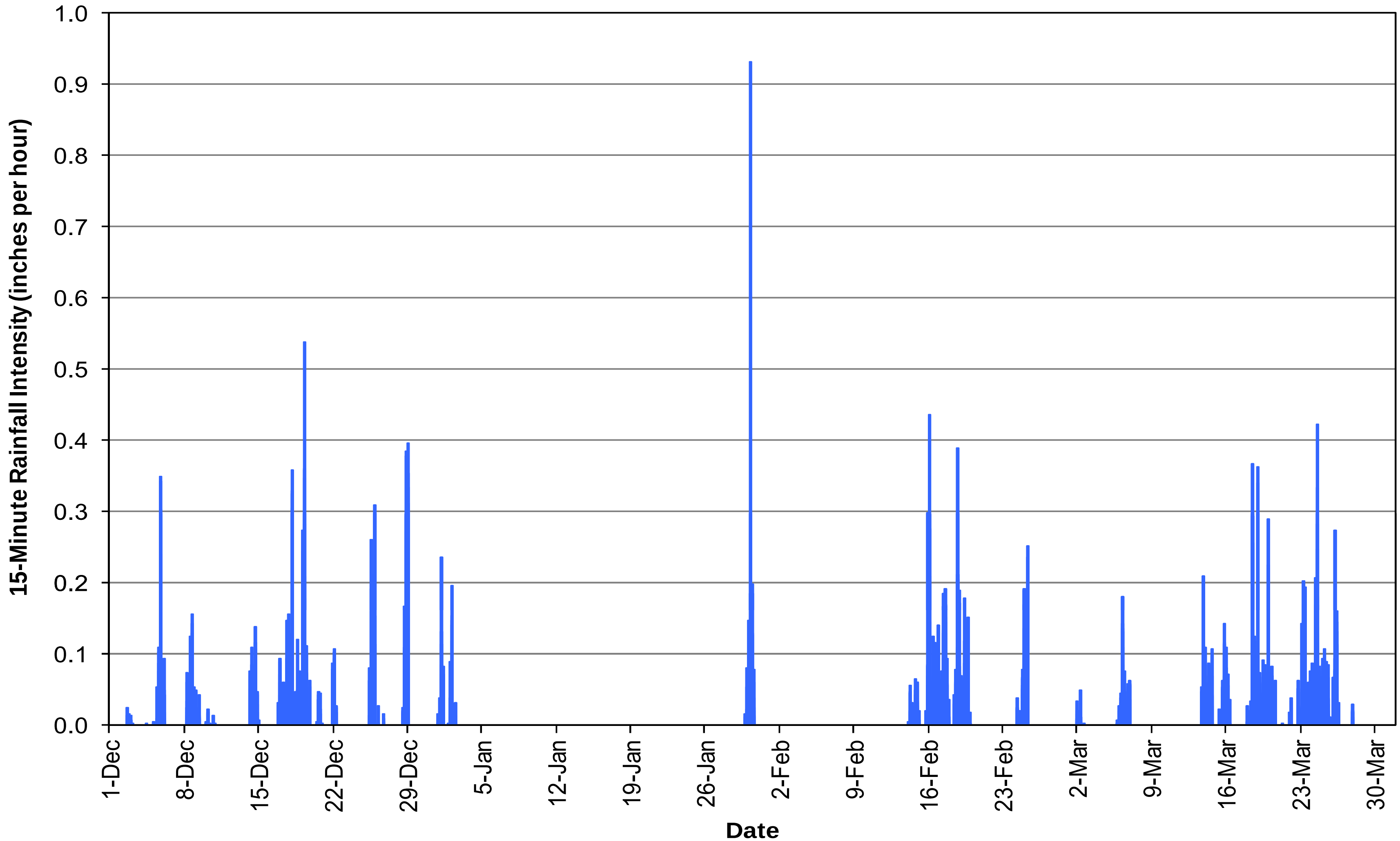
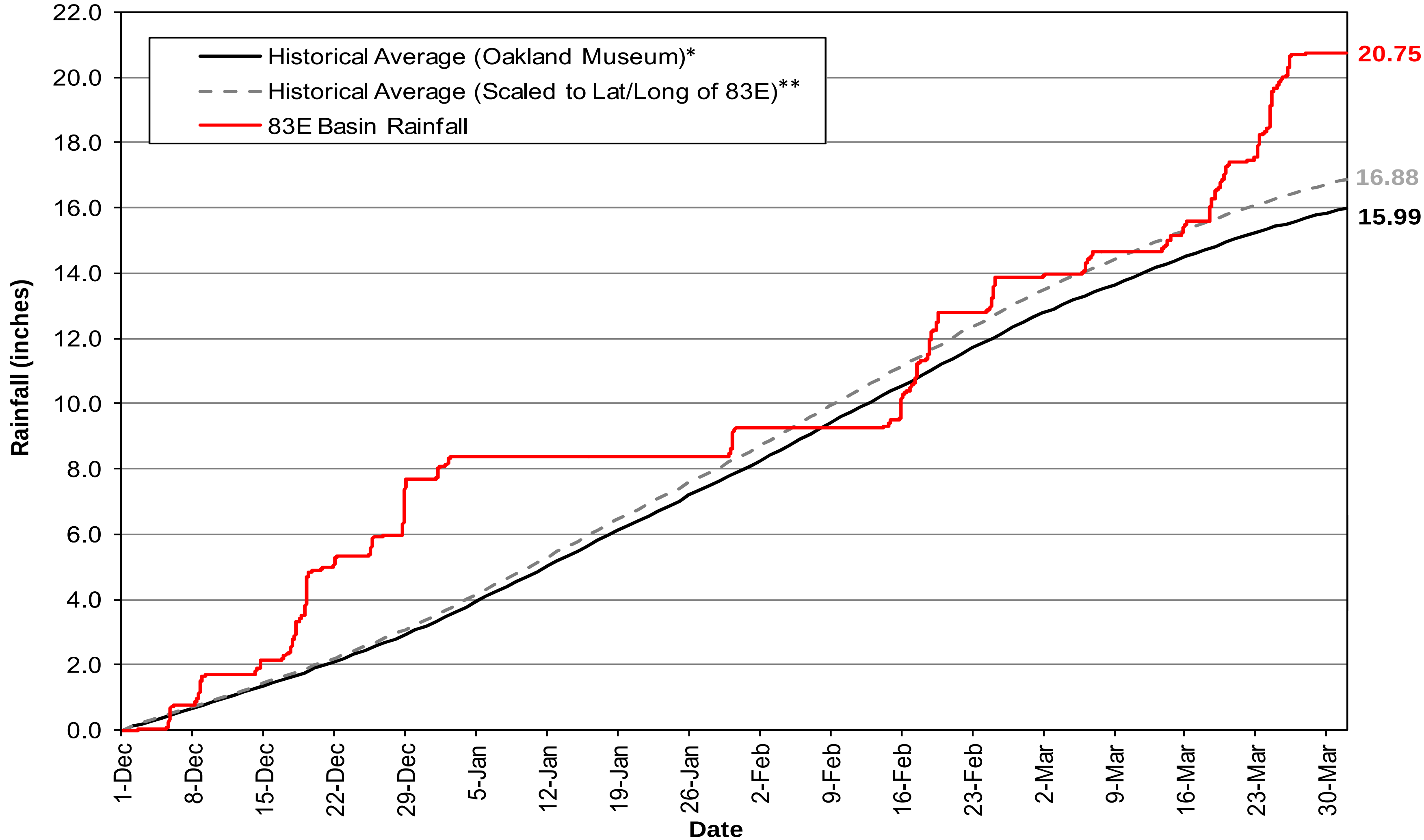
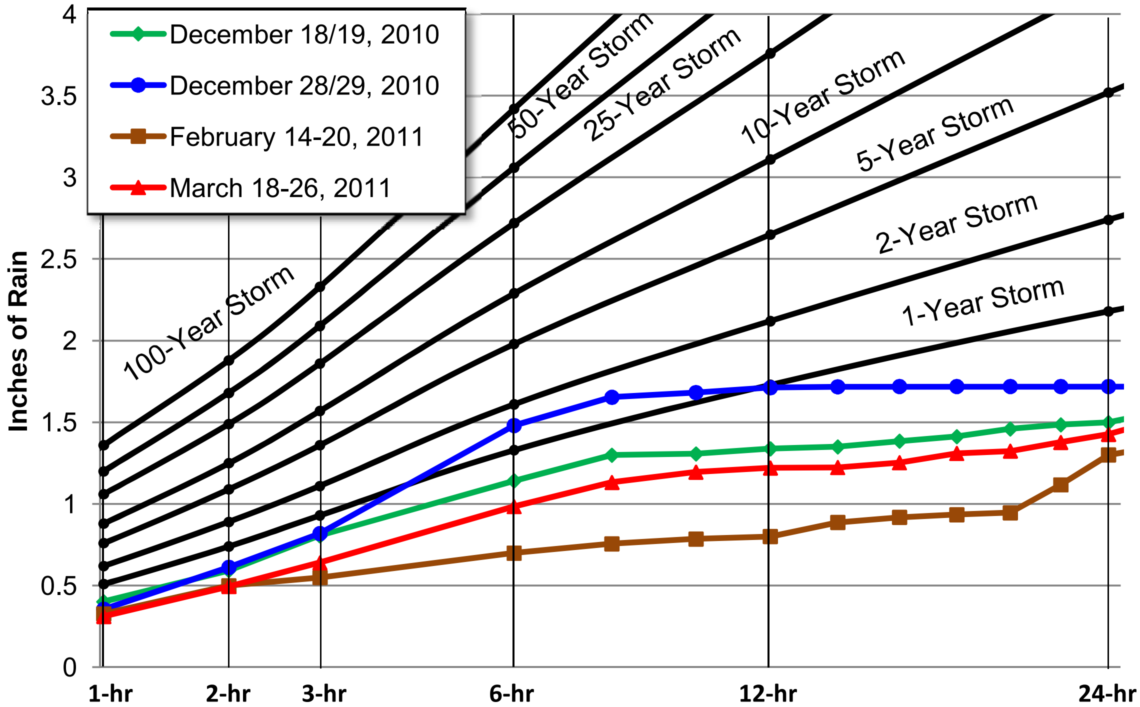


Figure 3.10
RAINFALL ACTIVITY OVER FLOW MONITORING PERIOD FOR METER 83E
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS
CITY OF OAKLAND



* Source: Western Regional Climate Center (www.wrcc.dri.edu/summary/climsmnca.html)
** Basin rainfall scaling source: hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

Figure 3.11
RAIN ACCUMULATION PLOT FOR METER 83E
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS
CITY OF OAKLAND



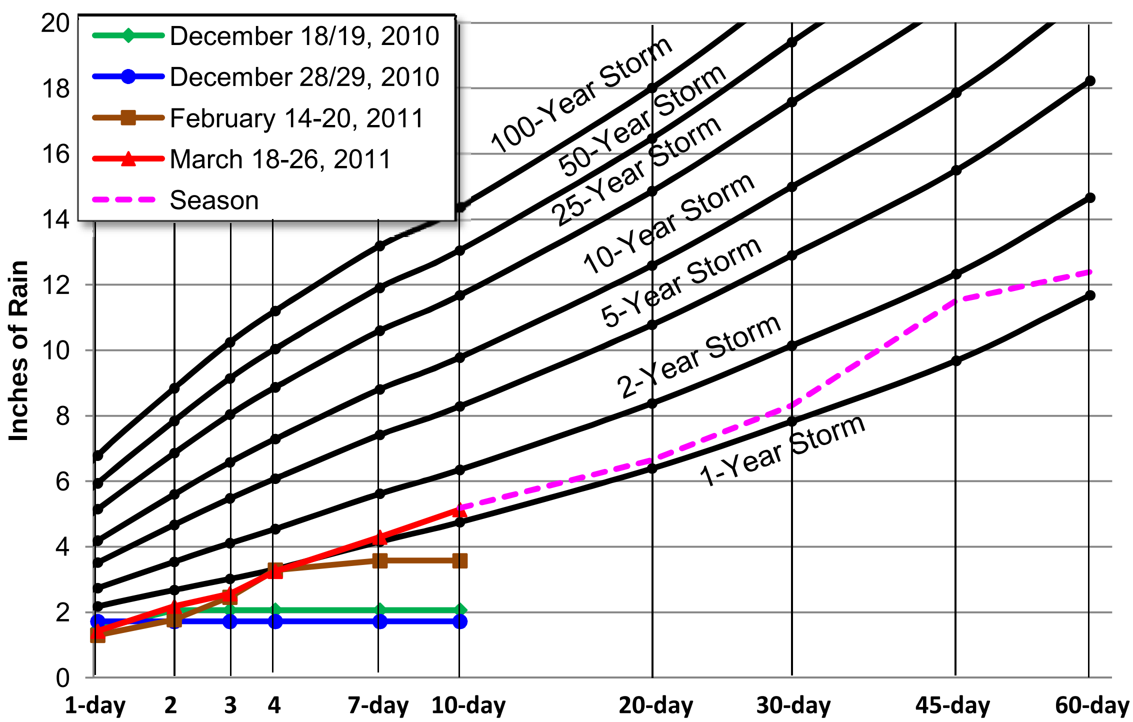


Figure 3.12
RAINFALL EVENT
CLASSIFICATION FOR METER 83E
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS
CITY OF OAKLAND

For a summary of the rainfall activity associated with the remaining flow monitoring sites, refer to Appendix C.

3.3.3 Design Storm Data

Design storms are rainfall events used to analyze the performance of a collection system under extreme wet weather events. The design storm used for this study is based on the EBMUD I/I Study Storm and is the specific rainfall event developed and used for the East Bay Sewer System Evaluation Survey and EBMUD Wet Weather Facilities Plan during the 1980's. The design storm is a historical storm with a total of 1.57 inches (Oakland Airport) that has a 5-year rainfall return period over a seven-hour duration, broken down into 15 minute increments.

The design storm rainfall was assumed to occur simultaneously over the entire City service area. However, the total volume of the design storm varied throughout the collection system to account for increasing rainfall from low-elevation areas near the Bay to high elevations. V&A performed the calculations to determine the appropriate 5-year, 7-hour design storm rainfall volume for each individual flow monitoring basin. The hydraulic model simulated the Design Storm in 15-minute intervals. An example design storm for Meter 83E is shown on Figure 3.13. As can be seen in Figure 3.13, the volume of rainfall for Meter 83E is greater than the general design storm due to the increased elevation of Basin 83E. The design storms associated with the remaining flow monitoring basins are provided in Appendix C.

3.3.4 Wet Weather Flow Data

Flow monitoring data was evaluated to determine how the collection system responds to wet weather events. As mentioned above, the flow monitoring program captured four major rainfall events. The period of March 13 through March 30, 2011 was selected for wet weather calibration because the storms that occurred during this time period produced the greatest I/I response within the system.

Figure 3.14 shows an example of the wet weather response at Site 83E during the March 13, 2010 to March 30, 2011 rainfall events. Figure 3.14 illustrates the volume of I/I that entered the system from the collection system upstream of Site 83E. The light blue area is the base sanitary flow while the gray area is the measured flow from the flow monitoring period. As can be seen in the figure, significant amounts of I/I do enter the system during wet weather events. Similar graphs were generated for the remaining monitoring sites can be found in Appendix C.

The flow monitoring data was used to conduct an analysis of the system's I/I response. The metric typically used to quantify the severity of the system's I/I is the R-value. The R-value is defined as the percentage of rainfall volume that makes it into the collection system as I/I. Table 3.4 summarizes the results.

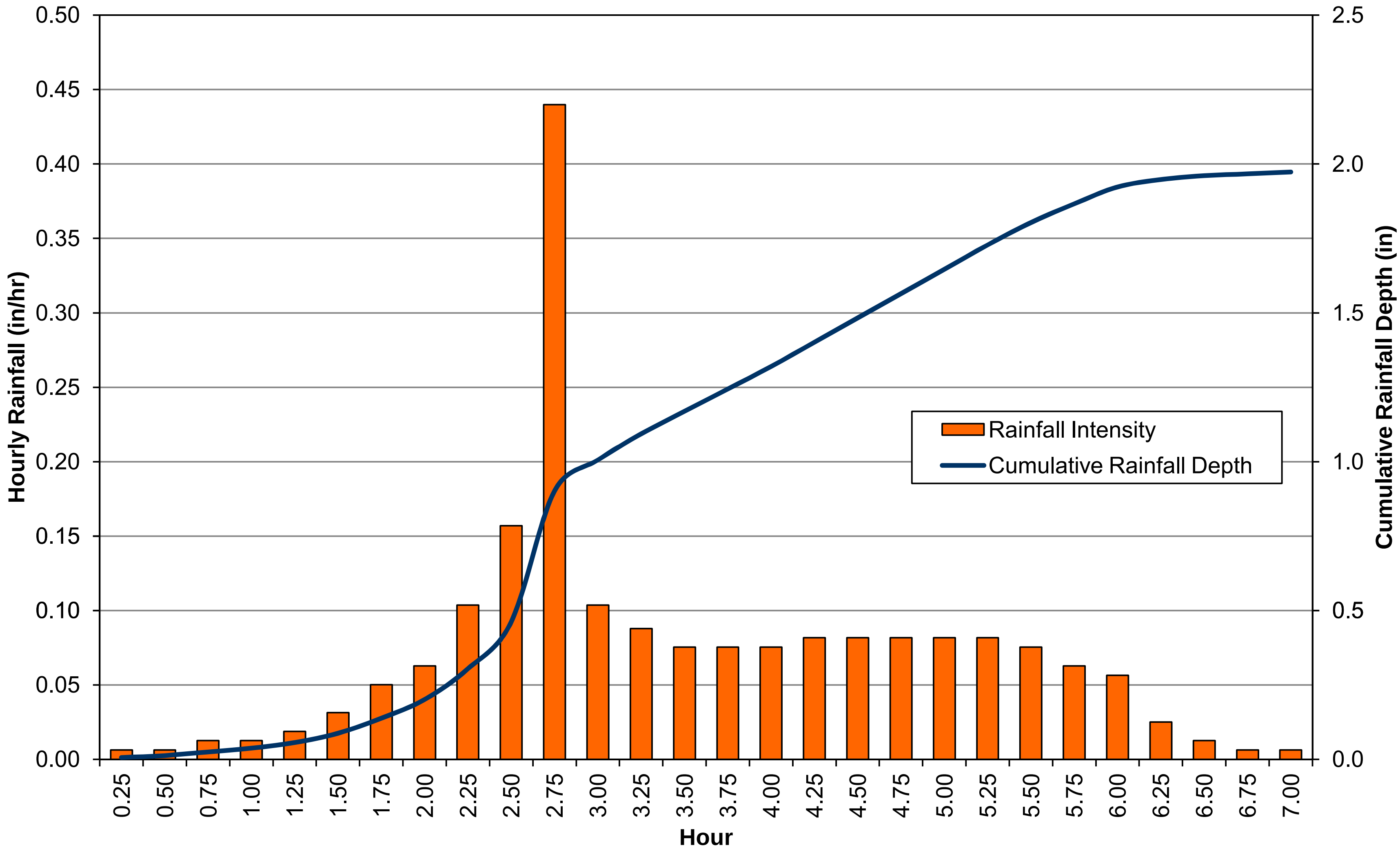


Figure 3.13
METER 83E 5-YEAR,
7-HOUR DESIGN STORM
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS

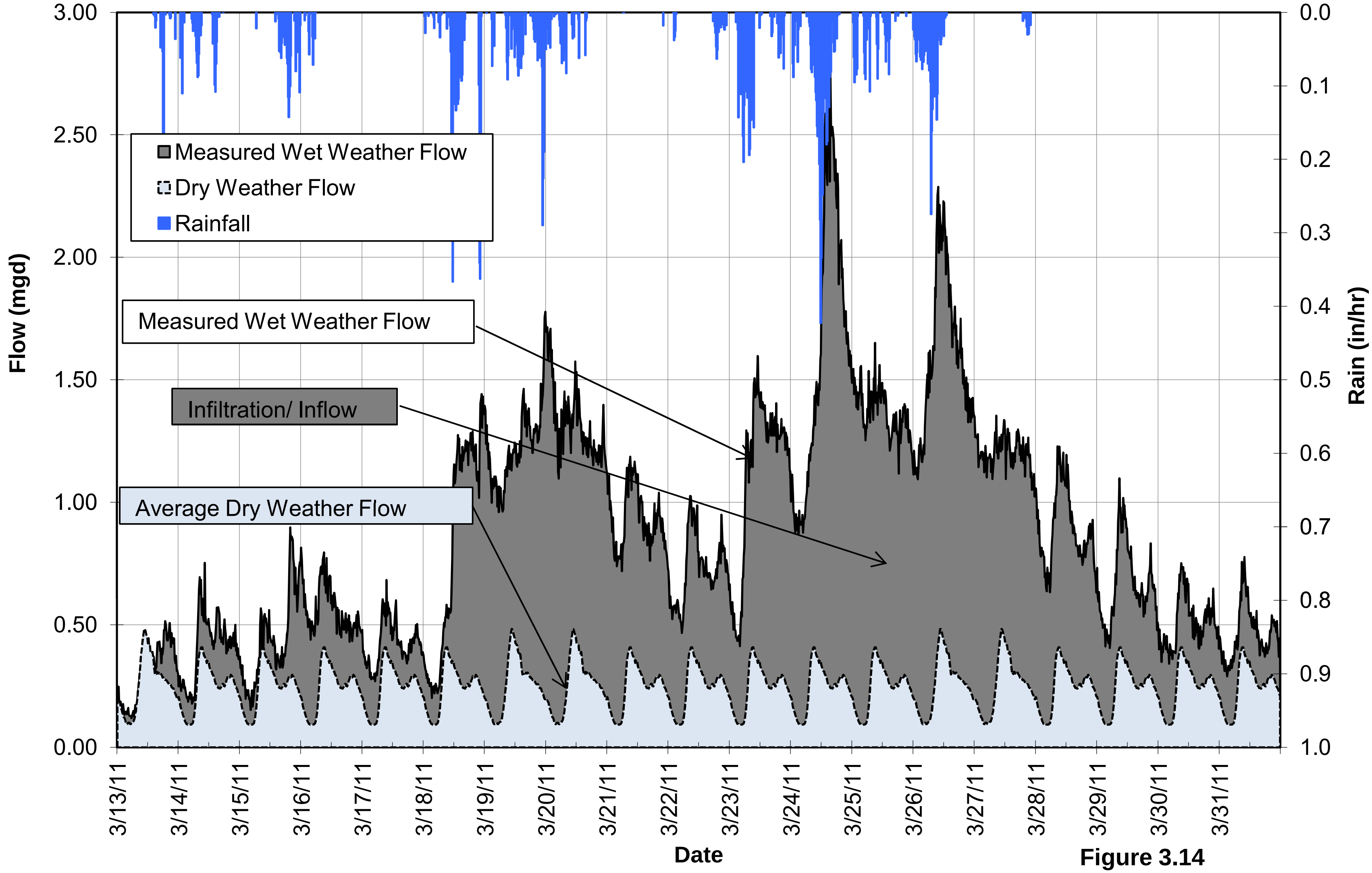


Figure 3.14
EXAMPLE WET WEATHER FLOW REPONSE FOR METER 83E
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS
CITY OF OAKLAND

Table 3.4 R-Value Summary by Basin
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Basin	R-Value (percent)[2]
17	8.7
20	36.5
21	32.1
23	30.5
50	19.5
52	15.0
54[3]	21.4
56	10.5
58	40.7
59	17.7
60	19.5
61	9.3
62	12.7
64	2.4
80	19.2
81	29.3
82	25.1
83	10.9
84	25.2
85	6.9
86	10.3
87	1.1
City-Wide	**12.5**

Notes:

1. Source: Draft Sanitary Sewer Flow Monitoring and Inflow/Infiltration Study, October 2012
2. Calculated from March 18-26, 2011 storm events.
3. Piedmont flows excluded for this calculation.

The R-Value for each basin is determined by isolating I/I associated with individual flow monitoring basins (i.e., excluding flow rates from upstream flow monitors) and calculating the ratio of the volume of water that enters the system as I/I versus the volume of rainfall that fell over the flow monitoring basin tributary area.

As shown in this table, the basin-wide R-Values ranged from approximately a low of 1.1 percent to a high of 40.7 percent. Citywide, the R-Value was calculated to be roughly 12.5 percent. Appendix C contains detailed I/I analysis results for the individual flow monitoring basins.

3.3.5 Locations of Inflow and Infiltration

I/I can be divided into two separate flow components. Inflow is characterized by sharp, direct spikes occurring during a rainfall event. The parameter typically used to characterize Inflow is the Peak I/I Rate and Peaking Factor. Table 3.5 summarizes the Peak I/I Rate and Peaking Factor for the 23 major sewer basins. As can be seen in the table, the peaking factors ranged from a high of 53.3 in Basin 50 to a low of 0.84 in Basin 61. The highest Peak I/I rate measured during the flow-monitoring program was 47.88 in Basin 50. Figure 3.15 illustrates the basins with the highest peaking factor.

Infiltration occurs after the conclusion of the storm event is classified as rainfall-dependant infiltration. The determination of RDI is conducted by looking at the infiltration rates as set points after the conclusion of a storm event. Dependant on the system and the time required for flows to return to ADWF levels, RDI may be examined after different time periods to determine the basins with the greatest or most sustained RDI rates. Table 3.5 provides the RDI rates for each basin. Basin 50 was measured to have the highest RDI rate at 3.33 mgd. In general, the total RDI rate City wide was 17.74 mgd. Figure 3.16 illustrates the basins with the highest RDI rates.

Table 3.5 Inflow and Infiltration Analysis
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Basin	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	RDI Rate (mgd)	RDI per ADWF (Percent)	Peak I/I Rate (mgd)
17	0.18	1.60	8.8	0.19	105	1.41
20	0.26	3.88	15.1	0.19	73	3.57
21	0.41	5.78	14.0	0.27	66	5.60
23	0.13	1.87	14.6	0.07	57	1.77
50	4.66	53.33	11.4	3.33	72	47.88
52	4.86	30.33	6.2	1.16	23	24.15
54	3.47	18.82	5.4	2.49	73	15.19
56	1.72	11.75	6.8	1.46	86	9.74
58	1.45	17.56	12.1	0.62	42	15.85
59	0.63	5.43	8.6	0.19	30	4.76
60	0.73	15.34	21.0	0.36	49	14.55
61	0.16	0.84	5.2	0.06	38	0.67
62	0.32	3.46	10.7	0.10	32	3.08
64	1.65	8.23	5.0	0.24	14	7.06
80	1.76	15.15	8.6	1.63	93	13.16
81	1.78	15.15	8.5	1.23	71	13.20
82	1.00	8.74	8.7	0.39	39	7.59
83	2.35	20.32	8.6	1.33	57	17.76
84	1.87	20.68	11.1	1.83	100	18.47
85	3.11	21.66	7.0	1.76	58	18.07
86	0.68	5.63	8.3	0.34	50	4.85
87	0.33	1.45	4.4	0.09	26	1.02
City Wide	**33.39**	**251.63**	**7.5**	**19.25**	**58**	**211.89**

Notes:

1. Source: Draft Sanitary Sewer Flow Monitoring and Inflow/Infiltration Study, October 2012
2. Calculated from March 18-26, 2011 storm events.
3. Piedmont flows excluded for this calculation. The shortcut key to insert the entire table is ALT+L.

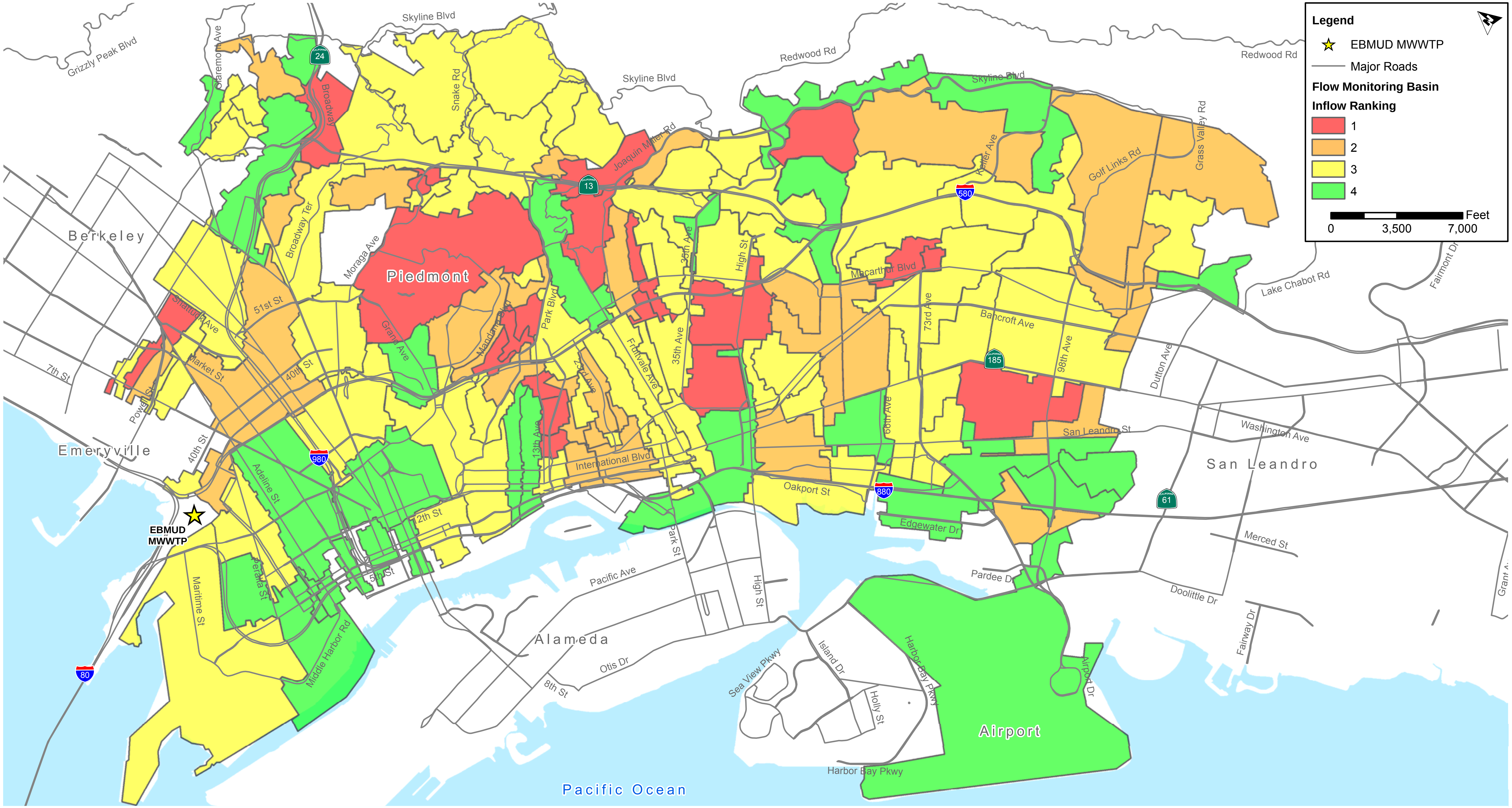


Figure 3.15
HIGHEST INFLOW BASINS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 5.1 Completed and Planned Rehab Subbasins.mxd

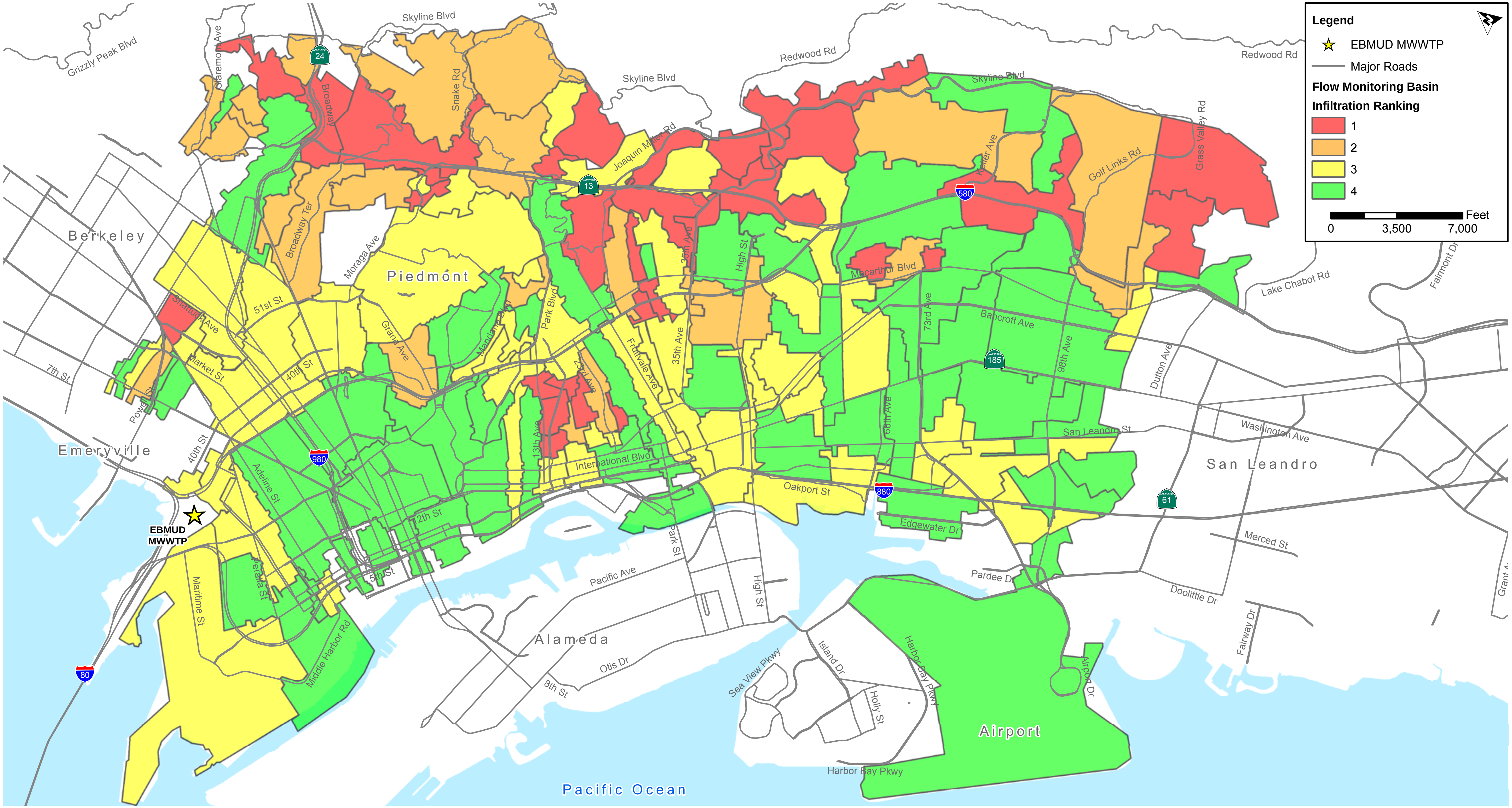


Figure 3.16
HIGHEST INFILTRATION BASINS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 5.1 Completed and Planned Rehab Subbasins.mxd

COLLECTION SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter describes the development and calibration of the City of Oakland (City) sewer collection system hydraulic model.

4.1 COLLECTION SYSTEM OVERVIEW

The City's sanitary sewer collection system serves approximately 400,000 people and includes approximately 930 miles of gravity sanitary sewer mains ranging in size from 4- to 81-inches in diameter. The City's service area includes the Port of Oakland (Port), which owns and maintains the wastewater collection system within its jurisdiction. The Port's wastewater collection system discharges to the City's collection system or to the East Bay Municipal Utility District (EBMUD) interceptor system directly, and includes nine miles of gravity sewer and approximately twelve miles of laterals. Additionally, as previously noted, all sanitary sewer flows from the City of Piedmont are collected and transported through Oakland's collection system. Two basins also flow from Oakland into the City of Emeryville's sewers and one into the City of Berkeley's sewers.

The City's collected wastewater is conveyed to the EBMUD wastewater interceptor system, which transports it to East Bay Municipal Utility District (EBMUD's) main wastewater treatment plant (MWWTP) for treatment. Figure 4.1 shows the estimated breakdown of the City sewer collection system by year of installation. As shown in this figure, roughly 60 percent of the City's sewers were installed between 1940 and 1959. Figure 4.2 illustrates the components of the City's sewer collection system, including sewer diameters and lift station locations.

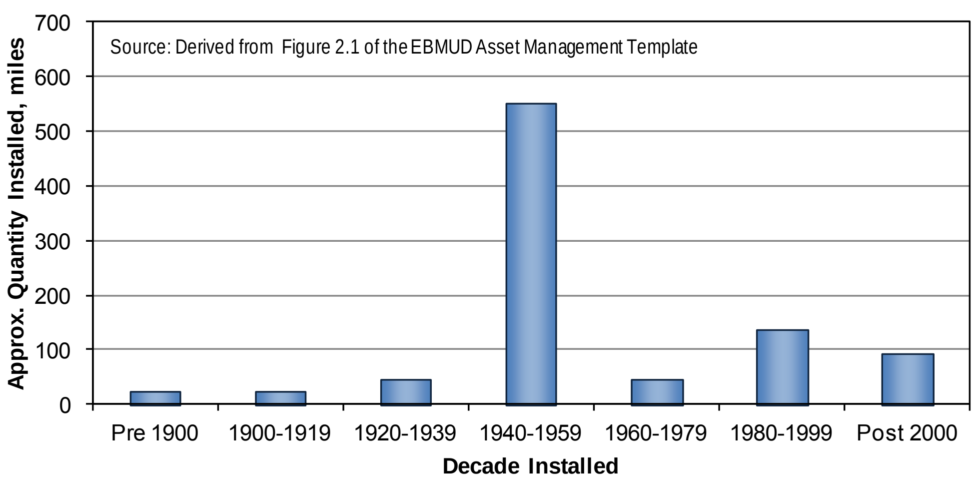


Figure 4.1
SANITARY SEWER INSTALLATIONS BY YEAR
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

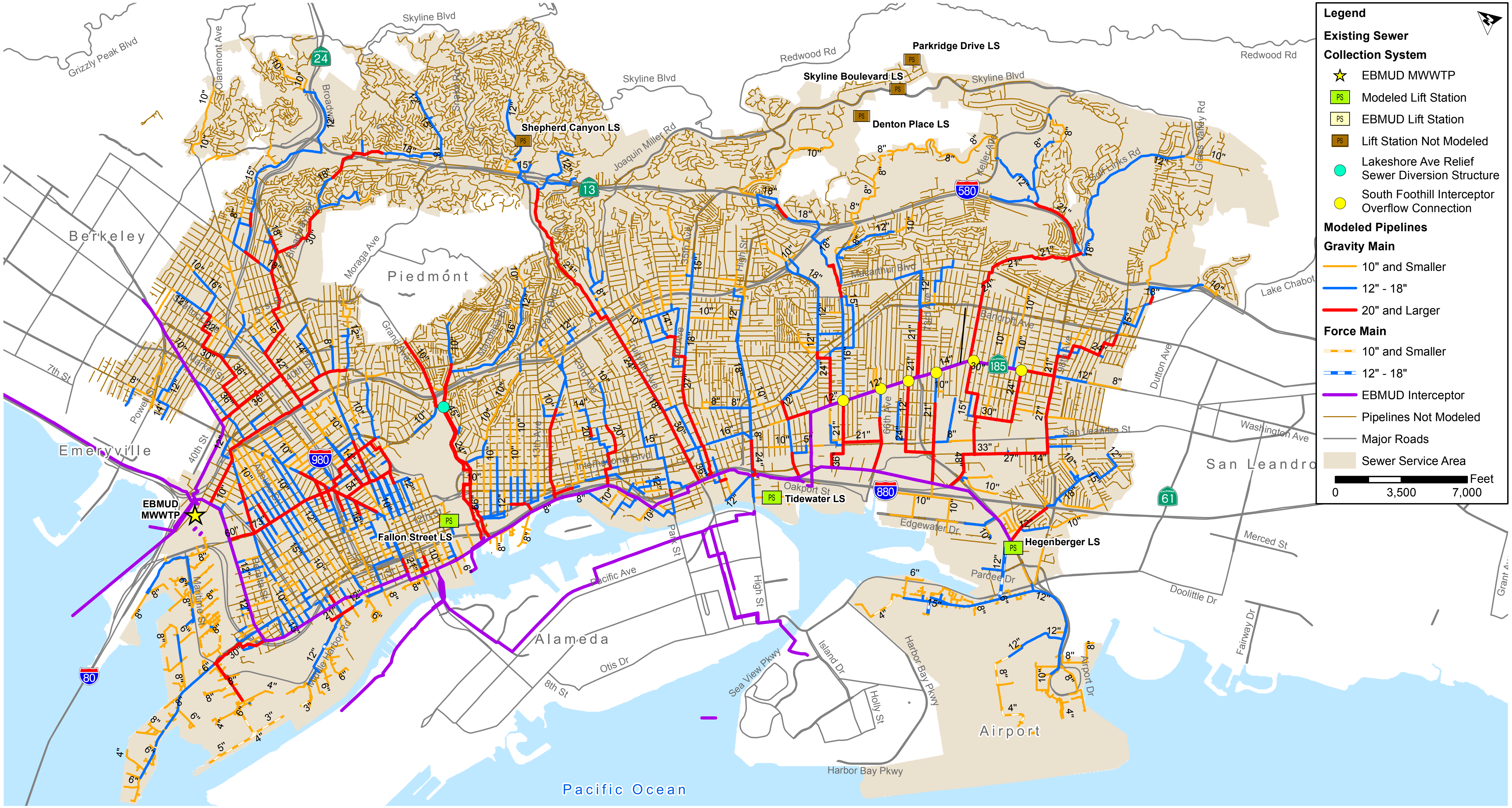


Figure 4.2
EXISTING SEWER COLLECTION SYSTEM
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 4.2 Existing Sewer Collection System.mxd

Table 4.1 presents a summary by diameter of the known sewers in the collection system. As shown in Table 4.1, over 75 percent of the system is 8-inches in diameter and smaller, with the majority (74 percent) of the system being 8-inch diameter sewers.

Table 4.1 Sewer Pipeline Summary Table
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Diameter (inches)	Length (feet)	Percent of System (by length)	Diameter (inches)	Length (feet)	Percent of System (by length)
Less than 8	264,606	5.44	37 to 39	4,606	0.09
8	3,590,956	73.89	40 to 42	6,142	0.13
9 to 12	517,422	10.65	43 to 45	1,512	0.03
13 to 15	104,032	2.14	46 to 50	11,937	0.25
16 to 18	142,759	2.94	51 to 54	7,328	0.15
19 to 21	67,055	1.38	55 to 57	2,275	0.05
22 to 24	55,302	1.14	58 to 60	1,346	0.03
25 to 27	19,922	0.41	61 to 63	44	0.00
28 to 30	20,123	0.41	64 to 66	4,416	0.09
31 to 33	12,496	0.26	> 66	1,930	0.04
34 to 36	28,563	0.59	**Total (feet)**	**4,860,166**	**100**
			Total (miles)	**920**	**100**

Notes:

1. Source: City provided GIS sewer mapping/hydraulic model, totals exclude Port of Oakland sewers.

4.2 MODELED COLLECTION SYSTEM

The modeled sewer system consists of approximately 199 miles of sanitary sewer pipelines ranging in diameter from 3-inches to over 84-inches, and three sewage pump stations.Figure 4.3 presents an overview of the City's modeled wastewater collection system. Table 4.2 presents a summary of the modeled sewer system by diameter and length of pipe. The total lengths of sewer in Table 4.2 include modeled sewers from the Port collection system, as well as the EBMUD Foothill Interceptor, as discussed in the following sections.

Table 4.2	Modeled Sewer System Pipeline Summary Sewer System Hydraulic Modeling and Capacity Evaluation Report City of Oakland		
Diameter (inches)	**Length (feet)**	**Diameter (inches)**	**Length (feet)**
Less than 8	981	37 to 39	4,606
8	52,480	40 to 42	6,142
9 to 12	507,950	43 to 45	1,512
13 to 15	103,960	46 to 50	11,937
16 to 18	142,445	51 to 54	7,328
19 to 21	67,055	55 to 57	2,275
22 to 24	55,302	58 to 60	1,346
25 to 27	19,922	61 to 63	44
28 to 30	20,123	64 to 66	4,416
31 to 33	12,496	> 66	1,930
34 to 36	28,563	**Total (feet)**	**1,048,208**
		Total (mile)	**199**

Notes:

1. Source: City provided GIS sewer mapping/hydraulic model, totals exclude Port of Oakland sewers.

It is common practice in sewer system master planning to exclude small diameter sewers (typically 8-inches in diameter and smaller) when developing a hydraulic computer model of a particular sewer collection system. This process, referred to as “skeletonizing,” reduces the complexity of the hydraulic model, data input requirements, file size, and model run times. The hydraulic model for this study included sewer pipelines 10-inches in diameter and larger. Therefore, in general, the hydraulic model and Table 4.2 does not include these smaller diameter pipelines. Select pipelines 8-inches in diameter and smaller were included in the model for connectivity.

4.2.1 Collection System Basins and Subbasins

The City’s sewer collection system is divided into 22 distinct tributary areas, referred to as “sewer basins.” The City has also broken down the 22 sewer basins into several smaller “sewer subbasins.” The existing sewer basins and subbasins are shown on Figure 4.4.

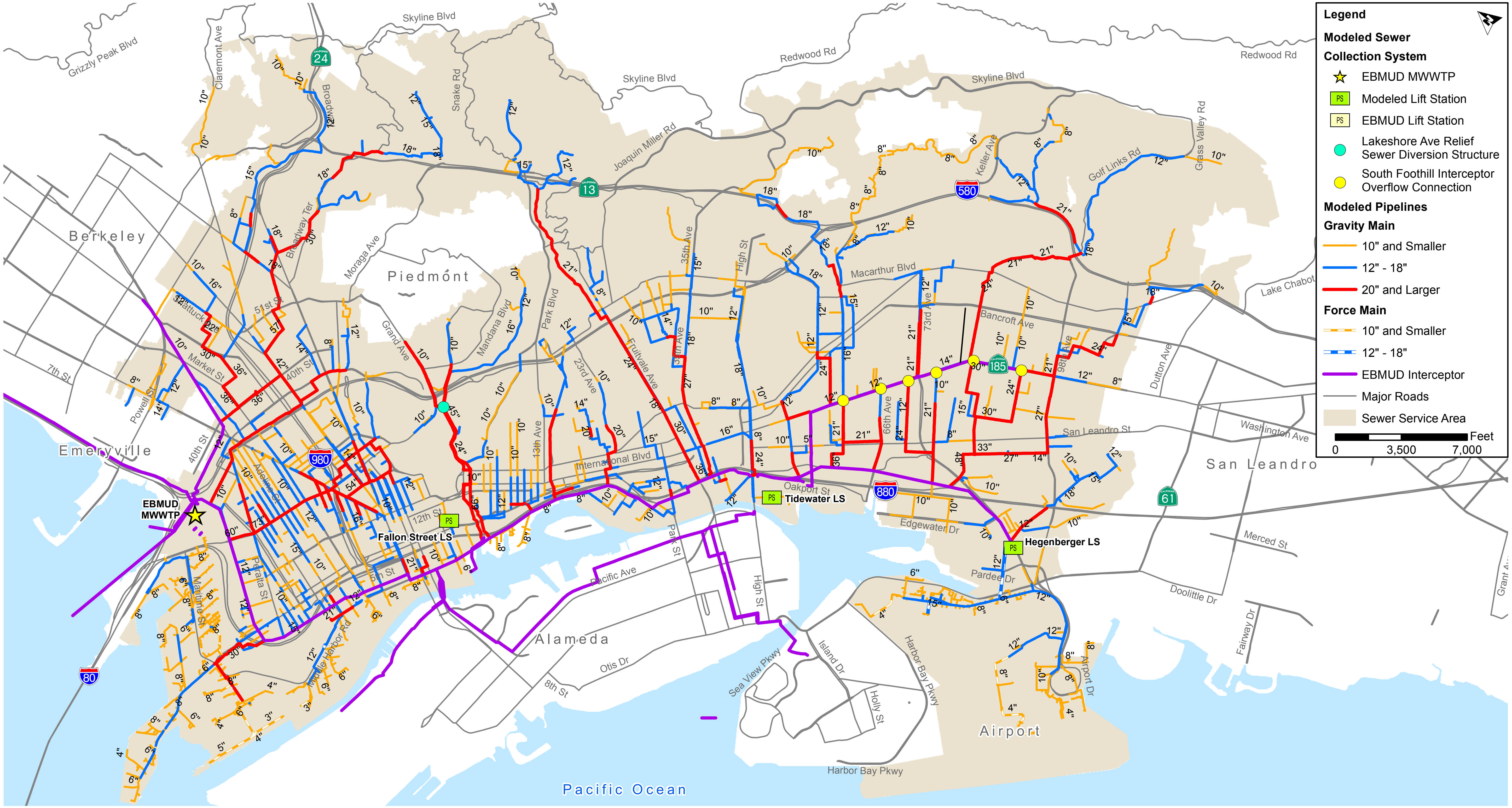


Figure 4.3
MODELED WASTEWATER COLLECTION SYSTEM
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

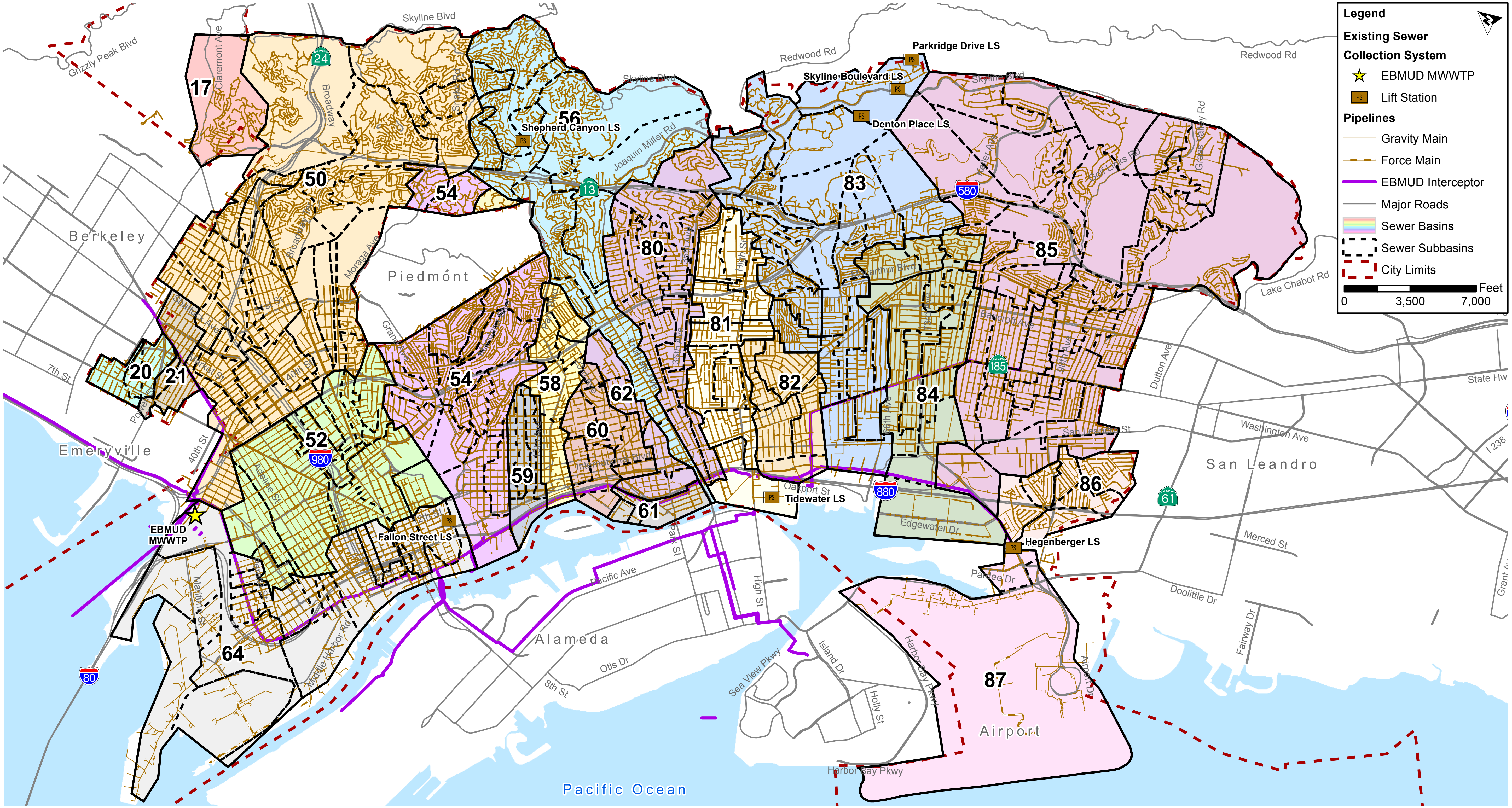


Figure 4.4
SEWER BASINS AND SUBBASINS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012

M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 4.4 Sewer Basins and Subbbasins.mxd

4.2.1.1 Basin 17

Basin 17 serves a small residential land use area in the northeast portion of the Oakland Hills east of the City of Berkeley. Wastewater flows through Basin 17 are conveyed through the City of Berkeley collection system.

4.2.1.2 Basin 20

Basin 20 is a small basin in North Oakland bounded on the north by the City of Berkeley and on the west by the City of Emeryville. This basin serves primarily residential land uses, as well as commercial and institutional land uses. Wastewater flows from Basin 20 are conveyed through the City of Emeryville wastewater collection system. borders the City of Emeryville at the northern end of the City.

4.2.1.3 Basin 21

Basin 21 is also a small basin in North Oakland serving mainly residential and some commercial land uses. It is bounded on the west by the City of Emeryville and in the north by City Basin 20, as well as the City of Berkeley. Wastewater flows from the upper portion of Basin 21, as well as some flow from the City of Berkeley, are conveyed to EBMUD's Adeline Interceptor. Flows from the lower portion of the Basin are conveyed to the City of Emeryville collection system.

4.2.1.4 Basin 23

Basin 23 is a very small basin on the edge of the City of Oakland limits near the EBMUD Wastewater Treatment Plant (WWTP). It receives flow mainly from the City of Emeryville and conveys it to the EBMUD Interceptor. Oakland's portion of Basin 23 is so small that it was not included in the City's hydraulic model.

4.2.1.5 Basin 50

Basin 50 is a large basin in North Oakland and the Northeast Oakland Hills that serves residential, commercial, and institutional land uses. Basin 50 is bounded on the north by the City of Emeryville, City Basin 21, the City of Berkeley, and City Basin 17. Basin 50 extends from Interstate 580 on the west to the City limits on the east. On the south, it is bounded by the City of Piedmont, City Bain 54, and City Basin 56. A portion of the wastewater generated in Basin 50 is conveyed to a connection on the Adeline Interceptor, while the remaining wastewater flows from the Basin are conveyed to a connection on the EBMUD South Interceptor. There are some interconnections between City Basin 50 and 52. Basin 50 also receives some flow from the City of Emeryville and the City of Berkeley.

4.2.1.6 Basin 52

Basin 52 is located in the Downtown Oakland area and serves primarily commercial land uses, as well as residential and institutional land use types. Basin 52 is generally bounded by Interstate 580 to the north, Lake Merritt and City Basin 54 to the east, and City Basin 64 to the south and west. Wastewater flows from Basin 52 are conveyed to a connection on the EBMUD South Interceptor. There are also some interconnections between City Basin 52 and Basins 50 and 64.

4.2.1.7 Basin 54

Basin 54 is located in the Lake Merritt area of Oakland and extends from the waterfront on the west to the City of Piedmont on the northeast. On the east, Basin 54 is bound by City Basins 56, 58, and 59. Flows from the City of Piedmont collection system (which also receives some flow from the City of Oakland northeast of Piedmont) are routed through Basin 54. Basin 54 conveys flows from primarily residential customers to two connection points to the EBMUD South Interceptor. One of the City connections to the South Interceptor is from the Lakeshore Avenue Relief Sewer. Wet weathers flows are diverted to the Lakeshore Avenue relief through diversions in the main trunk system. Details on the Lakeshore Avenue relief sewer are provided in Section 4.2.5.

4.2.1.8 Basin 56

Basin 56 serves primarily residential land uses in the Oakland Hills and the central portion of the City. The basin is bounded on the northwest by Basin 50, 54, 58, and 62, and on the southeast by Basin 80. Wastewater flow from Basin 56 is conveyed to the EBMUD South Interceptor through a single connection.

4.2.1.9 Basin 58

Basin 58 is located in the central portion of the City and serves a mixture of residential, commercial, and institutional land uses. It is bounded on the northwest by Basins 54 and 59, and on the southeast by Basin 56, 60, and 62. Wastewater flow from Basin 58 is conveyed to one connection on the EBMUD South Interceptor. Wastewater flow from Basin 58 is conveyed to one connection on the EBMUD South Interceptor.

4.2.1.10 Basin 59

Basin 59 serves a small residential and commercial land use area in the central portion of the City. It is bounded on the north and west by Basin 54 and of the east by Basin 58.

4.2.1.11 Basin 60

Basin 60 is located in the central portion of the City, bounded by Basin 58 on the northwest and Basins 61 and 62 on the southeast. Basin 60 conveys wastewater flow from a mixture of residential, commercial, and institutional land use areas to a single connection on the EBMUD South Interceptor.

4.2.1.12 <u>Basin 61</u>

Basin 61 is a small waterfront basin located in the central area of the City. Flows collected in this small basin are conveyed to two connections on the EBMUD South Interceptor.

4.2.1.13 <u>Basin 62</u>

Basin 62 is bounded on the west by Basins 58 and 60, on the east by Basin 56, and on the south by Basin 61. Basin 62 is a relatively small basin serving residential, commercial, and institutional land use types. There are three connections from Basin 62 into the EBMUD South Interceptor, one of which is an overflow from the main trunk system.

4.2.1.14 <u>Basin 64</u>

Basin 64 is located in West Oakland and serves the Port of Oakland maritime (i.e., harbor) and commercial (i.e., Jack London Square) collection systems, the former Oakland Army Base, as well as commercial and some residential customers located on the north side of the Embarcadero. The basin is bounded on the south and west by the waterfront, on the north bay Basin 52, and on the by Basin 54. There are numerous connections in this basin to the EBMUD South Interceptor.

4.2.1.15 <u>Basin 80</u>

Basin 80 is located in East Oakland and in the Oakland Hills, bounded by Basin 56 on north and west, and by Basins 81 and 83 on the east. Wastewater flows generated by the residential, commercial, and institutional customers within this basin are conveyed to two connections to the EBMUD South Interceptor.

4.2.1.16 <u>Basin 81</u>

Basin 80 is located in East Oakland, bounded by Basin 80 on the west and north, and by Basins 82 and 83 on the east. This basin serves a mixture of residential, commercial, industrial, and institutional land use areas and conveys wastewater flows to three connections to the EBMUD South Interceptor.

4.2.1.17 <u>Basin 82</u>

Basin 82 serves a mixture of residential, commercial, industrial, and institutional land use areas in East Oakland. The basin is bounded on the north and west by Basin 81 and on the north and east by Basin 83. Flows from the upper portion of the basin are routed to a single connection on the EBMUD Foothill interceptor, and flows from the lower portion of the basin are conveyed to a connection on the EBMUD South Interceptor. The overflow connections are further described in Section 4.2.3.

4.2.1.18 <u>Basin 83</u>

Basin 83 serves a large geographic area in East Oakland and the Oakland Hills. The basin, which serves a mixture of residential, commercial, industrial, and institutional land use areas customers, is bounded by Basins 80, 81, and 82 on the west and by Basins 84 and 85 on the east. The lower portion of the basin features two connections to the EBMUD South Interceptor. The upper portion of the basin also features three overflow connections to the EBMUD South Foothill Interceptor and one direct connection to the EBMUD South Foothill Interceptor (no overflow).

4.2.1.19 Basin 84

Basin 84 is located in East Oakland and is bounded by Basin 83 to the north and west, and Basin 85 to the east. The basin serves a mixture of residential, commercial, industrial, and institutional customers. There are two connections in the lower portion of the basin to the EBMUD South Interceptor. In the upper portion of the basin, there are two overflow connections and one direct connection (no overflow) to the EBMUD South Foothill Interceptor.

4.2.1.20 Basin 85

Basin 85 serves a large area located in East Oakland and the Oakland Hills. The basin, which serves a mixture of residential, commercial, industrial, and institutional land use areas, is bounded by Basin 83 and 84 on the west, Basin 86 on the south, and the City limits on the east. The lower portion of the basin features one connection to the EBMUD South Interceptor, whereas the upper portion of the basin features two overflow connections to the EBMUD South Foothill Interceptor.

4.2.1.21 Basin 86

Basin 86 serves a small primarily residential area in East Oakland south of Basin 85. There is one connection in this basin to the EBMUD South Interceptor.

4.2.1.22 Basin 87

Basin 87 consists of primarily the Port's Aviation collection system (i.e., Oakland International Airport and Northfield area), as well as a few small commercial areas within the City of Oakland's jurisdiction. Flows from Basin 87 are conveyed to the EBMUD South Interceptor.

4.2.2 Sewage Lift Stations and Force Mains

There are seven lift stations within the City's collection system service area. Of these seven lift stations, three were included in the City's hydraulic computer model. Detailed as-built drawings for the City lift stations were not available. Therefore, for the purposes of the City's hydraulic model, the three modeled lift stations were represented in the model as "ideal" pumps (flow in equals flow out). Table 4.3 lists the available information for the City of Oakland lift stations, including whether or not they were included in the hydraulic model. Flow capacity estimates provided in Table 4.3 are from the City's Asset Management Implementation Plan (AMIP).

Table 4.3	Sewage Lift Stations Sewer System Hydraulic Modeling and Capacity Evaluation Report City of Oakland				
Lift Station	**Modeled**	**Address**	**Basin**	**Type**	**Capacity (gpm)**
Denton Place	No	5610 Denton Place	83	Submersible	9
Fallon Street	Yes	900 Fallon Street	64	Dry Pit	1,940
Hegenberger Road	Yes	201 Hegenberger Road	87	Dry Pit	1,780
Parkridge	No	5195 Parkridge Drive	83	Dry Pit	4.5
Shepherd Canyon	No	5921 Shepherd Canyon Road	56	Submersible	45
Skyline Boulevard	No	Skyline Boulevard at Parkridge	83	Submersible	9
Tidewater Avenue	Yes	4575 Tidewater Avenue	81	Dry Pit	1,230

4.2.3 EBMUD Interceptor System

EBMUD has developed a hydraulic model of the EBMUD interceptor system using the same InfoSWMM hydraulic modeling software platform as the City's hydraulic model. Carollo conducted a conference call with EBMUD staff and RMC staff (EBMUD's hydraulic modeling consultant) on the best approach to representing the EBMUD interceptor system within the City of Oakland hydraulic model. It was ultimately decided that the better approach would be to not include the EBMUD interceptor system in the City's hydraulic model. Instead, each City connection point to the EBMUD interceptor system was modeled as an "outfall." In order to accurately simulate the flow depths (hydraulic grade) in the EBMUD interceptor system, EBMUD provided flow depth data for each City interceptor connection during the flow monitoring period, as well as during the design storm condition. An example of the level data provided by EBMUD for node S01 is shown on Figure 4.5.

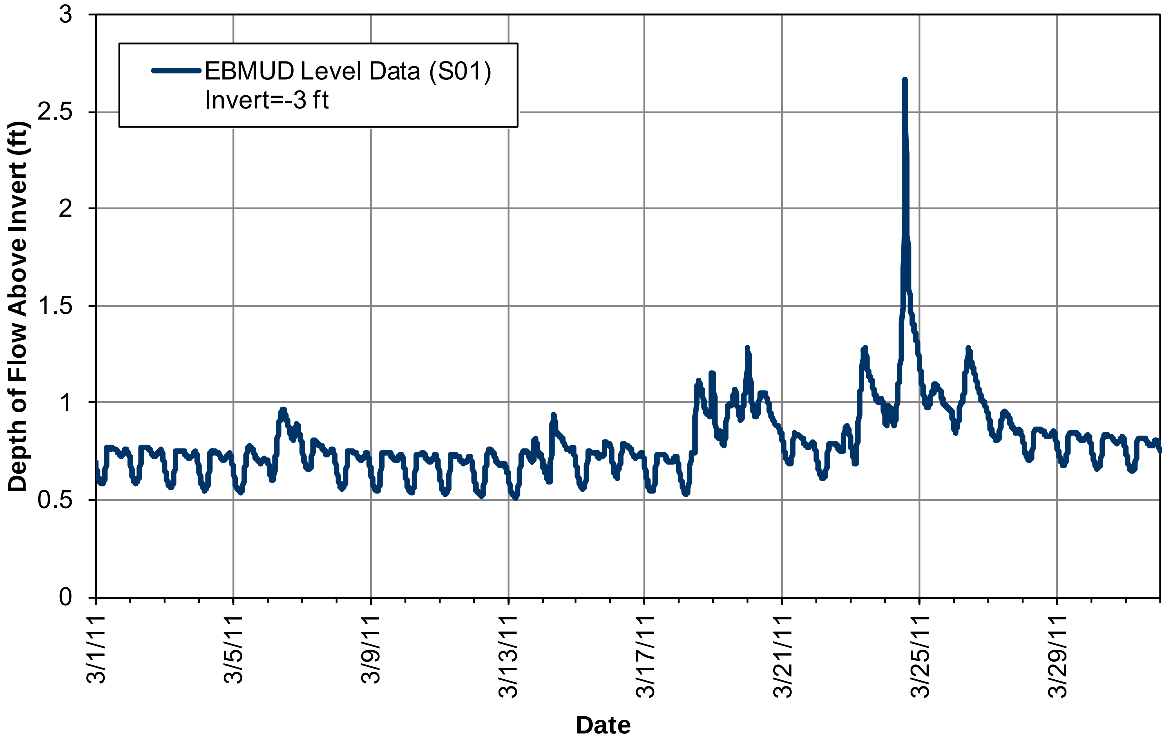


Figure 4.5
EXAMPLE EBMUD LEVEL DATA AT INTERCEPTOR MANHOLE S01
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

An exception to this is the EBMUD South Foothill Interceptor. The EBMUD South Foothill Interceptor scalps a portion of the wastewater from the southern portions of the City and routes them north in the EBMUD South Interceptor. The South Foothill Interceptor was designed with overflow structures that divert wet weather flow from the upper portions of Basins 82 to 85. Figure 4.6 provides an illustration of how the overflow structures work. In simplified terms, the overflows consist of a box structure with a City sewer flowing straight through it. Within the box itself, the top half of the City sewer has been cut off so that when flow depths in the City sewer reach the halfway depth of the pipe, flows spill over into the box and into a pipeline going out the bottom of the box to the South Foothill Interceptor. In reality, build up of debris in the cut off pipe can lead to some dry weather flows going into the Foothill Interceptor as well. Additionally, wet weather flows can break up any built up debris from time to time, which makes modeling of the overflow connections difficult. In order to provide the best possible representation of these complexities, Carollo decided that it was appropriate to include the Foothill Interceptor into the City's hydraulic model.

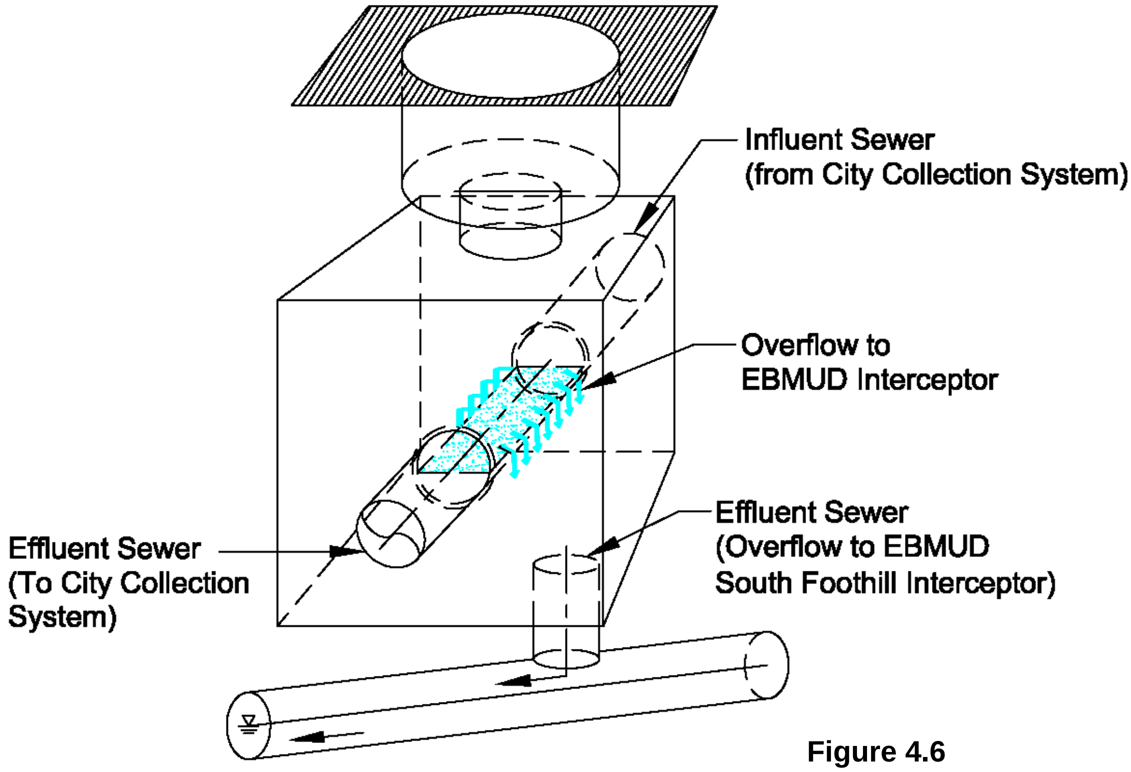


Figure 4.6
TYPICAL SOUTH FOOTHILL INTERCEPTOR OVERFLOW CONNECTION ILLUSTRATION
SEWER SYSTEM HYDRAULIC MODEL AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

4.2.4 Lakeshore Avenue Relief Sewer

A major feature of the City of Oakland collection system is the 66-inch diameter Lakeshore Avenue Relief Sewer, which was constructed in the 1990's to provide additional wet weather flow capacity to Basin 54. Because of the amount of flow conveyed, and the complexity of the Lakeshore Avenue relief sewer, additional attention was given to understanding and accurately simulating the configuration and flows. Basin 54 has two main connections to the EBMUD Interceptor. The main connection from Basin 54 is on a 48-inch diameter sewer that connects at EBMUD Manhole S42 at the Embarcadero west of 5th Street. The second sewer, which is the Lakeshore Avenue Relief Sewer, connects to the EBMUD Interceptor just west of the first connection point, at the Embarcadero near the Lake Merritt Channel.

The Lakeshore Avenue Relief Sewer is an overflow sewer and typically conveys flows during wet weather periods only. The Lakeshore Avenue Relief Sewer begins at the intersection of Lakeshore Drive and El Embarcadero near the northeastern tip of Lake Merritt. At this location, there is a large diversion structure, which collects flow from four parallel 27-inch diameter sewers from the northwest and a 27-inch and two 33-inch diameter sewers from the northeast. During dry weather flows, typically all flow from the seven influent sewers are routed through a 36-inch diameter sewer flowing southwest along Lakeshore Avenue.

As flow depths in the diversion structure increase during wet weather flow conditions, flow begins to spill over a weir into the 54-inch diameter Lakeshore Avenue Relief Sewer that flows southwest along Lakeshore Avenue to Foothill Boulevard. At Foothill Boulevard, the relief sewer becomes a 66-inch diameter sewer and flows southeast to Second Avenue. At Second Avenue, the 66-inch diameter relief sewer flows southwest to Tenth Street. At Tenth Street, the relief sewer continues adjacent to the Lake Merritt channel to the EBMUD Interceptor.

Besides the main overflow connection from the diversion structure at the intersection of Lakeshore Avenue and El Embarcadero, there are two additional overflow connections from the main collection system in Basin 54 to the relief sewer. These overflow connections are located on Lakeshore Avenue roughly 600 feet southwest of El Embarcadero and at the intersection of Foothill Boulevard and 2nd Street.

Figure 4.7 is a schematic representation of the Lakeshore Avenue Relief Sewer. Figure 4.7 also provides an illustration of how wet weather flows were split between the main 48-inch sewer that connects to the interceptor and the 66-inch diameter Lakeshore Avenue Relief Sewer during the wet weather events that occurred from March 12, 2012 to March 30, 2012.

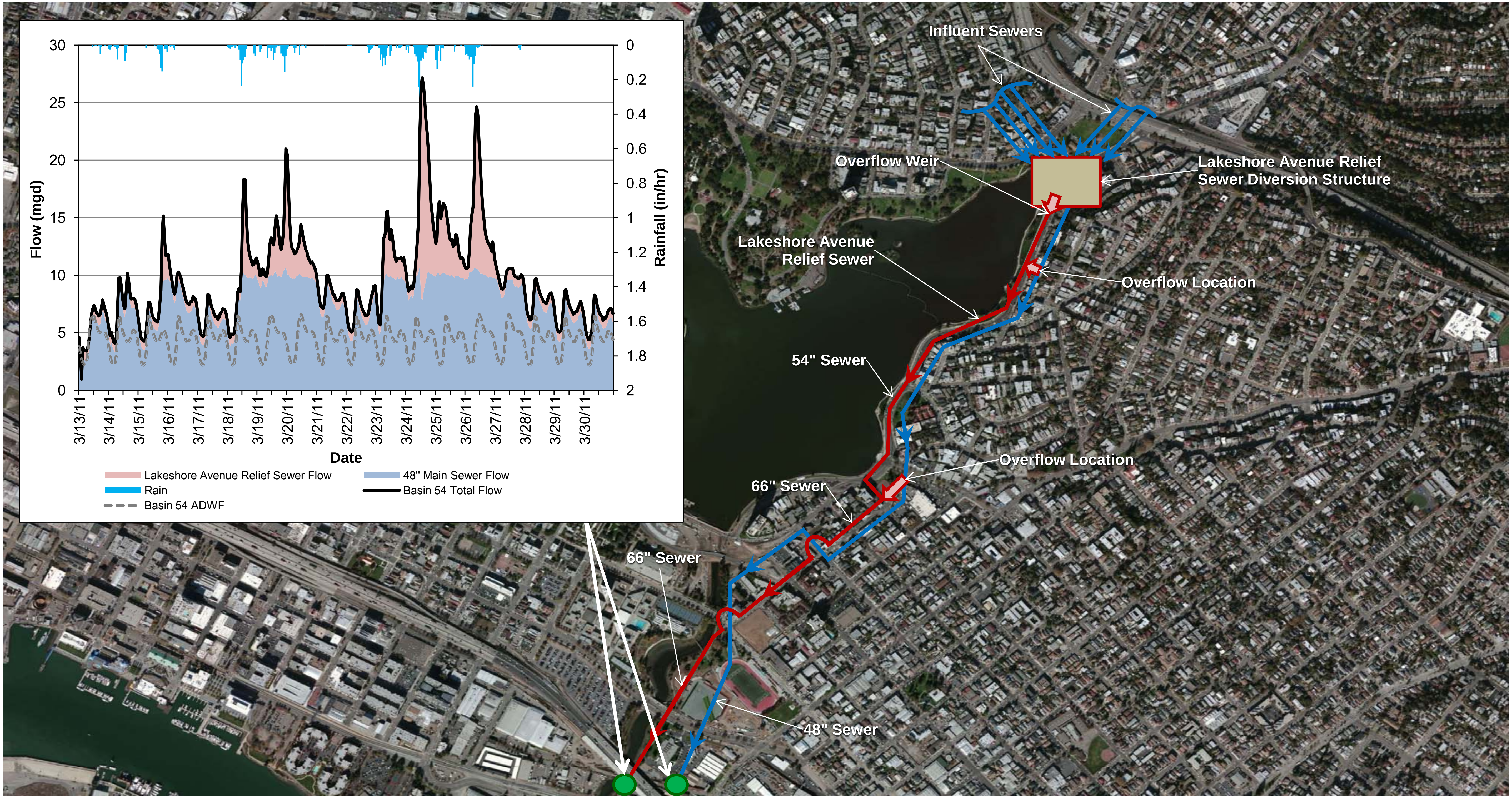


Figure 4.7
LAKESHORE AVENUE RELIEF SEWER SCHEMATIC
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS
CITY OF OAKLAND

4.3 SEWER SYSTEM HYDRAULIC MODEL

A sewer collection system model is a simplified representation of the real sewer system. Sewer system models can assess the conveyance capacity for a collection system. In addition, sewer system models can perform “what if” scenarios to assess the impacts of future developments and land use changes. This section summarizes the process used to develop the City’s hydraulic computer model of the sewer system, including a summary of the modeling software selection, the hydraulic model elements, and the model creation process.

4.3.1 Selected Hydraulic Modeling Software

There is an abundance of sewer analysis software in the marketplace today, with a variety of features and capabilities. The selection of a particular model generally depends on user preferences, software costs, and the complexity of the sewer system.

It was agreed that InfoSWMM, by Innovyze (formerly MWH Soft), would be used to assemble the City’s hydraulic model. InfoSWMM is a fully dynamic, geospatial wastewater and stormwater modeling and management software application, which is built atop ESRI ArcGIS. The hydraulic modeling engine for the InfoSWMM software package uses the Environmental Protection Agency’s (EPA) Storm Water Management Model (SWMM), which is widely used throughout the world for planning, analysis, and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems. The advantage of the InfoSWMM package over the SWMM software is that it offers an enhanced graphical user interface (GUI) and a variety of additional features and functionality, including full integration with the ESRI ArcGIS software package.

Version 11.0 of InfoSWMM was used to assemble the hydraulic model. Version 12.0 of InfoSWMM was released following the creation of the City’s hydraulic model. Therefore, the City’s hydraulic model currently uses Version 12.0 of the InfoSWMM software package.

4.3.2 Elements of the Hydraulic Model

The following provides a brief overview of the major elements of the hydraulic model and the required input parameters associated with each:

- **Junctions**: Sewer manholes, cleanouts, as well as other locations where pipe sizes change or where pipelines intersect are represented by junctions in the hydraulic model. Required inputs for junctions include rim elevation, invert elevation, and surcharge depth (used to represent pressurized systems).
- **Pipes**: Gravity sewers and force mains are represented as pipes in the hydraulic model. Input parameters for pipes include length, friction factor (e.g., Manning’s n for gravity mains, Hazen Williams C for force mains), invert elevations, diameter, and whether or not the pipe is a force main.

- **Storage Nodes**: For sewer system modeling, storage nodes typically are used to represent lift station wet wells (although other storage basins, etc. can be modeled as storage nodes). Input parameters for storage nodes include invert elevation, wet well depth, and wet well cross section.
- **Pumps**: Pumps are included in the hydraulic model as links. Input parameters for pumps include pump curves and operational controls.
- **Outfalls**: Outfalls represent areas where flow leaves the system. For sewer system modeling, an outfall typically represents the connection to the influent pump station at a wastewater treatment plant. For Oakland, outfalls were used to represent connections to the EBMUD interceptor system.
- **Rain Gauges**: Rain gauges are input into the hydraulic model to simulate historical or theoretical hourly rainfall events.
- **Inflows**: The following are the three types of inflow sources that can be injected into individual model junctions (and storage nodes):
  - **External**: External inflows can represent any number of flows into the collection system, such as metered flow data or groundwater inflow. External inflows are applied to a specific model junction by applying a baseline flow value and a pattern that varies the flow by hour, day, or month of the year.
  - **Dry Weather**: Dry weather inflows simulate base sanitary wastewater flows and represent the average flow. The dry weather flows can be multiplied by up to four patterns that vary the flow by month, day, hour, and day of the week (e.g., weekday or weekend). The dry weather diurnal patterns are adjusted during the dry weather calibration process.
  - **RDI/I**: Rainfall Derived Infiltration and Inflows (RDI/I) are applied in the model by assigning a unit hydrograph and a corresponding tributary area to a given junction. The unit hydrographs consists of several parameters that are used to adjust the volume of RDI/I that enters the system at a given location. These parameters are adjusted during the wet weather calibration process.

4.3.3 Model Skeletonization

Skeletonization is the process by which sewer systems are stripped of pipelines not considered essential for the intended analysis purpose. The purpose of skeletonizing a system is to develop a model that accurately simulates the hydraulics of a collection system, while at the same time reducing the complexity of a large model.

It is common practice in sewer system master planning to exclude small diameter sewers when developing a hydraulic computer model. The City’s hydraulic model includes pipelines that are 10-inches in diameter and larger. Some smaller diameter sewers (8-inches in diameter and smaller) are also included in the City’s hydraulic model where needed for connectivity.

4.3.4 Wastewater Load Allocation

Determining the quantity of dry weather wastewater flows generated by a municipality and how they are distributed throughout the collection system is an important component of the hydraulic modeling process. Various techniques can be used to assign wastewater flows to individual model junctions, depending on the type of data that is available. Adequate estimates of the volume of wastewater are important in maintaining and sizing sewer system facilities, both for present and future conditions. Baseline wastewater loads were allocated (assigned to specific nodes) in the hydraulic model based on water billing records provided by EBMUD for customers located within the City's sewer system service area, as described below:

- **Step 1** – The City's service area was broken up into 3,138 individual loading polygons. Each loading polygon represents the geographic area that contributes flows into a single model node (i.e., trunk system manhole). In an all pipe model, however, a loading polygon could be as small as a few parcels. In a skeletonized model, such as the City's hydraulic model, a loading polygon will usually encompass a particular subdivision or grouping of lots.
- **Step 2** – The winter water demand was calculated for each customer within the City service area, excluding dedicated irrigation meters and other known non-sewered water uses. Winter demands are used for this process because irrigation water usage is minimal during this period, and so the water demands will more closely represent the base wastewater flows.
- **Step 3** – The individual customer water demands were assigned to the appropriate sewer loading polygon using GIS techniques and a total water demand for each loading polygon was calculated and assigned to the appropriate model node.
- **Step 4** – The baseline water demands were adjusted as necessary during the dry weather flow calibration process (see Section 4.4) to closely match the actual measured dry weather flows recorded during the flow monitoring period.

4.3.5 Hydraulic Model Construction

The City's hydraulic model combines information on the physical and operational characteristics of the wastewater collection system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes.

The model creation process consisted of seven steps, as described below:

- **Step 1 -** The City's geographic information system (GIS) shape files for the sewer collection system were obtained.
- **Step 2 -** The GIS data were reviewed and formatted to allow easy import into the InfoSWMM modeling platform.

- **Step 3 -** The City's GIS data were skeletonized to exclude gravity sewers 8-inches in diameter and smaller (except where needed for connectivity).
- **Step 4 -** The collection system pipeline and facility data were imported into the modeling software and verified. Certain physical and operational data for the City's wastewater collection facilities was not available from the GIS data. This type of data, such as wet well dimensions, pump stations, and other special features (e.g., diversion structures to the Foothill Interceptor), were input manually into the model based on available information. In addition, pipelines and junctions with missing inverts or invert discrepancies were reviewed and manually input or modified based on City records, field reconnaissance, and engineering judgment.

  Once all the relevant data was input into the hydraulic model, the model was reviewed to verify that the model data was input correctly and that the flow direction and size of the modeled pipelines were logical.
- **Step 5** – Connections to the EBMUD interceptor hydraulic model were digitized (represented as outfalls in the model).
- **Step 6 -** The existing dry weather wastewater flows were allocated to the model junctions using EBMUD's water consumption records. These flows were scaled up or down, as necessary, to match the dry weather flows recorded during the flow monitoring period.
- **Step 7 -** The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include run dates, time steps, reporting parameters, output units, and flow routing method. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

4.4 HYDRAULIC MODEL CALIBRATION

Model calibration is a crucial component of the hydraulic modeling effort. Calibrating the model to match flow data collected during the flow monitoring program helps to verify that the model is accurately simulating actual flow conditions in the field. The calibration process consists of calibrating to both dry and wet weather conditions.

The DWF calibration ensures an accurate depiction of base wastewater flow generated within the study area. The WWF calibration consists of calibrating the hydraulic model to a specific storm event or events to accurately simulate the peak and volume of infiltration/inflow (I/I) into the sewer system. The amount of I/I is essentially the difference between the WWF and DWF components.

4.4.1 Calibration Standards

Proper calibration requires an assessment of the precision and accuracy of modeled variables compared to measured variables. In this case, flows are the primary variable used for calibration. The goal of calibration depends on the specific use of the model. The model needs to be accurately calibrated to flow volume, peaks, and hydrograph shape.

The model was calibrated in accordance with international modeling standards. The Wastewater Planning Users Group (WaPUG), a section of the Chartered Institution of Water and Environmental Management, has established generally agreed on principles for model verification. The wet weather calibration for this project focused on meeting the recommendations on model verification contained in the "Code of Practice for the Hydraulic Modeling of Sewer Systems," version 3.001, published by the WaPUG.

The WaPUG criteria for hydraulic model calibration are summarized below:

- **Dry Weather Flow Calibration**. The DWF hydrographs should closely follow each other in shape and magnitude, and meet the following criteria as a general guide:
  - Timing of flow peaks and troughs should be within one hour.
  - The peak flow rate should be in the range of ±10 percent.
  - The volume of flow should be in the range of ±10 percent, with care taken to exclude periods of missing or inaccurate data.
- **Wet Weather Flow Calibration**. The WWF hydrographs should closely follow each other in shape and magnitude until the flow has substantially returned to the dry weather flow rates, and meet the following criteria as a general guide:
  - Timing of flow peaks and troughs should be similar having regard to the duration of the event.
  - The peak flow rate should be in the range of +25 percent to -15 percent.
  - The volume of flow should be in the range of +20 percent to -10 percent, with care taken to exclude periods of missing or inaccurate data.

4.4.2 Dry Weather Flow Calibration

The DWF calibration consists of several elements: 1) dividing the sewer system into areas tributary to each of the flow meter stations; 2) defining the flow volumes within each area; and 3) creating diurnal patterns to match the temporal distribution of flow. The diurnal curve is a pattern of hourly multipliers that are applied to the base flow to simulate the variation in flow that occurs throughout the day.

The first step in the calibration process was to divide the City service area into flow meter tributary areas. One tributary area was created for each flow meter. The next step was to define the flow volumes within each area, which was accomplished in the flow-loading step discussed in Section 4.3.4. Two diurnal curves based on the flow monitoring data were created for nodes tributary to a specific flow meter, one representing weekday flows, and the other representing weekend flows. Figure 4.8 displays the weekday and weekend diurnal curves for the area tributary to Meter 83E. Similar diurnal curves were developed for each of the meters and its tributary area. These additional curves are available in Appendix D.

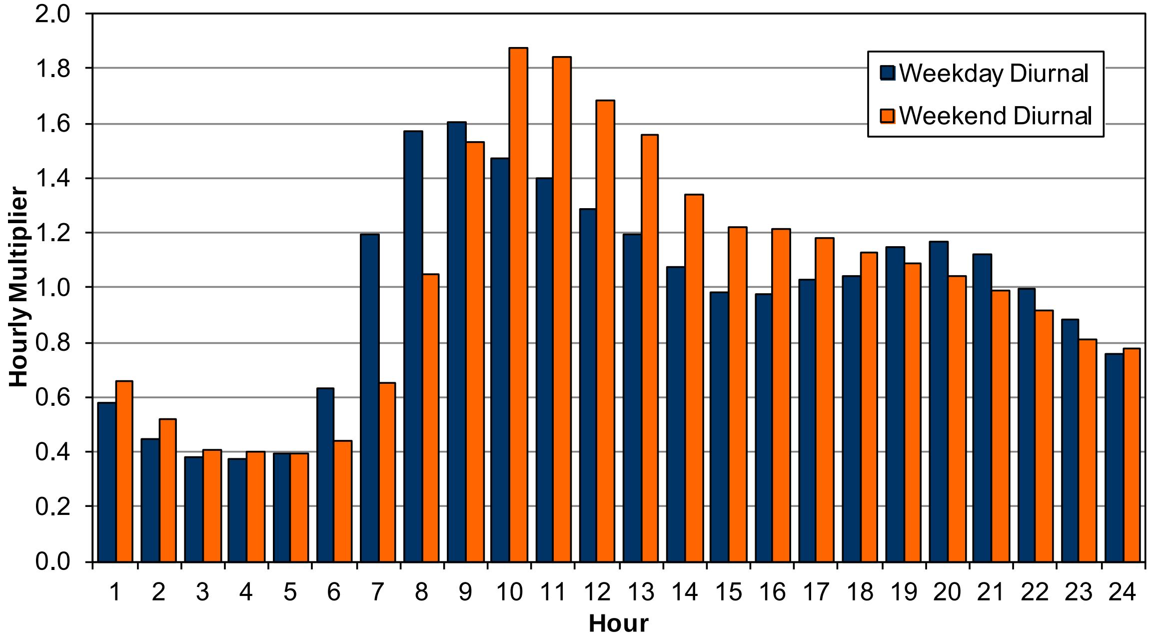


Figure 4.8
METER 83E DIURNAL PATTERNS
SEWER SYSTEM HYDRAULIC MODEL
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

The calibration process compared the meter data with the model output. Comparisons were made for minimum, maximum, and average flows as well as the temporal distribution of flow. Table 4.4 provides an overall summary of the DWF calibration. Appendix D provides a detailed summary table with the DWF calibration using minimum, maximum, and average flow results.

A sample of the DWF calibration for Meter 83E is presented in Figure 4.9. This figure shows the measured flow at the meter versus the model predicted flows for both weekday and weekend periods. The remaining DWF calibration plots are provided in Appendix D. As shown in Appendix D and Figure 4.8, the model showed good correlation between the measured flows and simulated flows.

Table 4.4 Dry Weather Flow Calibration Summary
Sewer System Hydraulic Modeling and Capacity Analysis Report
City of Oakland

Meter Site	Average Dry Weather Flow[4] Metered Daily Average (mgd)	Modeled Daily Average (mgd)	Percent Difference[3] (%)
Basin 17			
17A[1]	0.026	--	--
17B[1]	0.041	--	--
17U-S1	0.066	0.066	0.0%
17U-S2	0.070	0.070	0.0%
17U-S3[1]	0.046	--	--
Basin 20			
20A[1]	0.006	--	--
20B	0.049	0.049	-0.2%
20-S1	0.171	0.170	-0.1%
20-S2[1]	0.080	--	--
Basin 21			
21A	0.044	0.044	0.0%
21U-1	0.152	0.152	-0.3%
21L-S1	0.225	0.225	0.0%
21L-S2	0.103	0.103	0.0%
21L-S3[1]	0.067	--	--
Basin 23			
23-1[1]	0.128	--	--
Basin 50			
50L-S1	0.092	0.092	-0.2%
50	2.496	2.453	-1.7%
50A	0.986	0.987	0.0%
50B	0.697	0.698	0.1%
50U-1	2.216	2.277	2.8%
50L-1	2.538	2.458	-3.2%
50C.1	0.469	0.468	-0.2%
50C.2	0.150	0.150	0.0%
50D	0.856	0.846	-1.1%
50E	0.069	0.069	0.4%
50F	0.114	0.113	-0.1%
50G	0.658	0.672	2.1%
50H	0.285	0.284	-0.2%
Basin 52			
52A	4.030	4.053	0.6%
52B	1.574	1.578	0.2%
52C	1.030	1.029	-0.1%
52-1	4.858	4.969	2.3%
Basin 54			
54-S1	0.277	0.277	0.0%
54-S2	0.336	0.336	0.1%
54B.1	0.109	0.114	4.7%
54B.2	0.482	0.473	-1.8%
54B.3	0.189	0.195	3.2%
54B.4	0.106	0.106	0.1%
54-1	4.377	4.341	-0.8%
54-2	0.000	0.000	0.0%
54-S3	0.073	0.073	0.0%
54-S4	0.010	0.010	0.0%
54-S4A	0.031	0.031	-0.1%
54D	0.391	0.394	0.6%
54D.1	0.040	0.041	1.4%
54-S5[1]	0.104	--	--
54-S6	0.095	0.095	0.1%
54-S7	0.072	0.072	0.0%
54-S8[1]	0.021	--	--
54-S9[1]	0.067	--	--
54A	0.483	0.482	0.0%

Table 4.4 Dry Weather Flow Calibration Summary
Sewer System Hydraulic Modeling and Capacity Analysis Report
City of Oakland

Meter Site	Average Dry Weather Flow[4]		
	Metered Daily Average (mgd)	Modeled Daily Average (mgd)	Percent Difference[3] (%)
54C	0.512	0.511	-0.2%
54C.1	0.385	0.385	0.0%
Basin 56			
56A	0.359	0.359	0.0%
56A.1	1.086	1.085	-0.1%
56B	0.365	0.365	-0.1%
56C	0.090	0.090	0.0%
56D	0.109	0.109	0.0%
56E	0.235	0.235	0.0%
56-1	1.718	1.749	1.8%
Basin 58			
58A	0.544	0.546	0.3%
58B	0.398	0.398	0.0%
58-1	1.451	1.457	0.4%
Basin 59			
59A	0.381	0.381	0.0%
59-1	0.635	0.634	-0.1%
Basin 60			
60A	0.232	0.232	0.0%
60B	0.287	0.287	0.0%
60-1	0.730	0.734	0.6%
Basin 61			
61A	0.163	0.163	0.0%
Basin 62			
62A	0.283	0.283	0.0%
62-1	0.323	0.326	0.9%
Basin 64			
64-1	0.149	0.157	5.5%
64-2	0.106	0.106	0.0%
64-3	0.124	0.122	-1.7%
64-4	0.461	0.461	0.0%
64-5	0.377	0.377	0.0%
64-6	0.298	0.298	0.0%
64-7	0.039	0.036	-8.3%
64-8	0.096	0.096	0.0%
Basin 80			
80A	0.158	0.158	0.1%
80B	1.396	1.400	0.3%
80C	0.148	0.148	0.0%
80D	0.337	0.335	-0.6%
80E	0.293	0.293	0.2%
80-1	1.556	1.558	0.1%
80-2	0.202	0.204	0.9%
Basin 81			
81A	0.078	0.078	0.0%
81A.1	0.254	0.259	1.7%
81B	0.844	0.843	-0.1%
81C	0.585	0.585	0.0%
81-1	0.922	0.880	-4.6%
81-2	0.678	0.722	6.6%
81-3	0.179	0.179	0.0%
Basin 82			
82A	0.056	0.056	0.0%
82B	0.441	0.441	0.0%
82U-1	0.553	0.548	-0.8%
82L-1	0.447	0.447	0.1%
Basin 83			
83B	0.132	0.135	2.6%

Table 4.4 Dry Weather Flow Calibration Summary
Sewer System Hydraulic Modeling and Capacity Analysis Report
City of Oakland

Meter Site	Average Dry Weather Flow(4)		
	Metered Daily Average (mgd)	Modeled Daily Average (mgd)	Percent Difference(3) (%)
83B.1	0.222	0.223	0.1%
83C	0.346	0.346	0.0%
83D	0.389	0.389	0.0%
83E	0.249	0.249	0.0%
83L-1	1.978	1.991	0.6%
83L-2	0.373	0.366	-1.9%
83U-1	0.508	0.501	-1.4%
83U-2	0.604	0.616	2.0%
83U-3	0.148	0.148	0.0%
83U-4	0.639	0.634	-0.8%
83U-F	1.186	1.153	-2.8%
83U-1X	0.424	0.502	18.2%
83U-2X	0.592	0.617	4.2%
83U-3X	0.323	0.323	0.0%
Basin 84			
84A	0.444	0.456	2.6%
84B	0.721	0.728	0.9%
84C	0.126	0.128	1.9%
84C.1	0.063	0.060	-3.5%
84U-1	0.472	0.480	1.8%
84U-2	0.445	0.452	1.6%
84U-3	0.430	0.467	8.6%
84U-1X	0.595	0.614	3.2%
84U-3X	0.407	0.409	0.5%
84L-1	1.144	1.211	5.8%
84L-2	0.077	0.077	0.0%
84U-F	1.190	1.153	-3.2%
Basin 85			
85D	0.324	0.324	-0.2%
85D.1	0.100	0.100	0.0%
85D.2	0.102	0.102	0.2%
85E	0.212	0.212	0.1%
85E.1	0.105	0.105	0.0%
85U-1	0.807	0.832	3.2%
85A	1.707	1.777	4.1%
85B	0.739	0.725	-1.9%
85C	0.316	0.316	0.0%
85U-2	1.513	1.513	-0.1%
85U-F	0.542	0.624	15.1%
85L-1	2.570	2.606	1.4%
85U-2BX	0.000	0.000	0.0%
Basin 86			
86A	0.533	0.533	0.0%
86B	0.210	0.210	0.0%
86-1	0.682	0.684	0.2%
Basin 87			
87-1	0.332	0.305	-7.9%

Notes:
(1) Some flow meters were located on small, 8-inch and smaller diameter sewers, which were not included in the hydraulic model.
(2) Source: 2011 Flow Metering Data from V&A and EBMUD (ADS).
(3) Percent Difference = (Modeled Flow - Measured Flow)/Measured Flow x 100.
(4) ADWF = (5xWeekday Flow + 2xWeekend Flow)/7

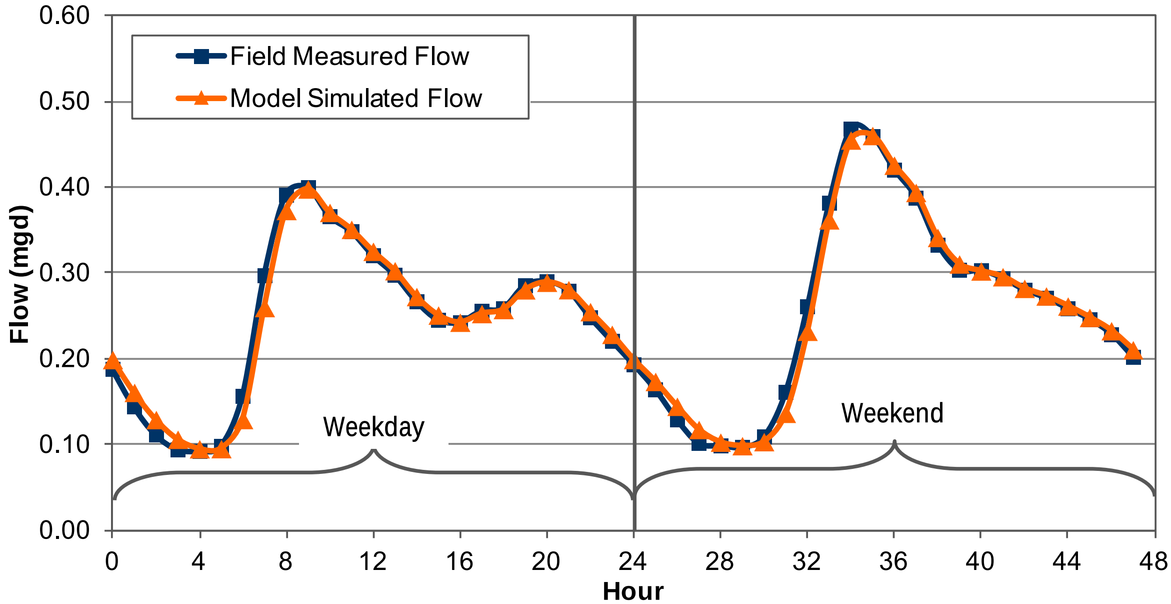


Figure 4.9
METER 83E DRY
WEATHER FLOW CALIBRATION
SEWER SYSTEM HYDRAULIC MODEL
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

4.4.3 Wet Weather Flow Calibration

The WWF calibration enables the hydraulic model to accurately simulate I/I entering a sewer system during a large storm. WWF calibration consists of two steps: 1) determining a rainfall event that characterizes the most significant impact on the sewer system facilities, preferably during wet antecedent soil moisture conditions; and 2) creating a database of I/I parameters for this rainfall event.

For WWF calibration, it is necessary to calibrate flows against two or more rainfall events. For example, model parameters for I/I are adjusted for one event so that projected flows align with measured flows. These same parameters are then used to project flows for a second measured event. If both events provide an accurate and precise estimate of the independent measured flow events, the model is calibrated.

As previously mentioned, the collection system I/I response was greatest during the late March 2011 rainfall events, a period of high soil saturation due to several back to back rainfall events. The hydraulic model was calibrated to the rainfall events that occurred from March 12 to March 30, 2011.

The wet weather calibration process involves creating custom unit hydrographs for each flow meter tributary using the "RTK Method." The Rainfall Dependent Infiltration and Inflow (RDI/I) unit hydrograph is the summation of three separate triangular hydrographs (short-term, medium-term, and long-term), which are each defined by three parameters: R, T, and K. R represents the fraction of the rainfall over the watershed that enters the sanitary sewer system; T represents the time to peak; and K represents the ratio of the time to recession to the time to peak. Therefore, there are a total of nine variables for each RDI/I unit hydrograph. Figure 4.10 shows an example RDI/I hydrograph.

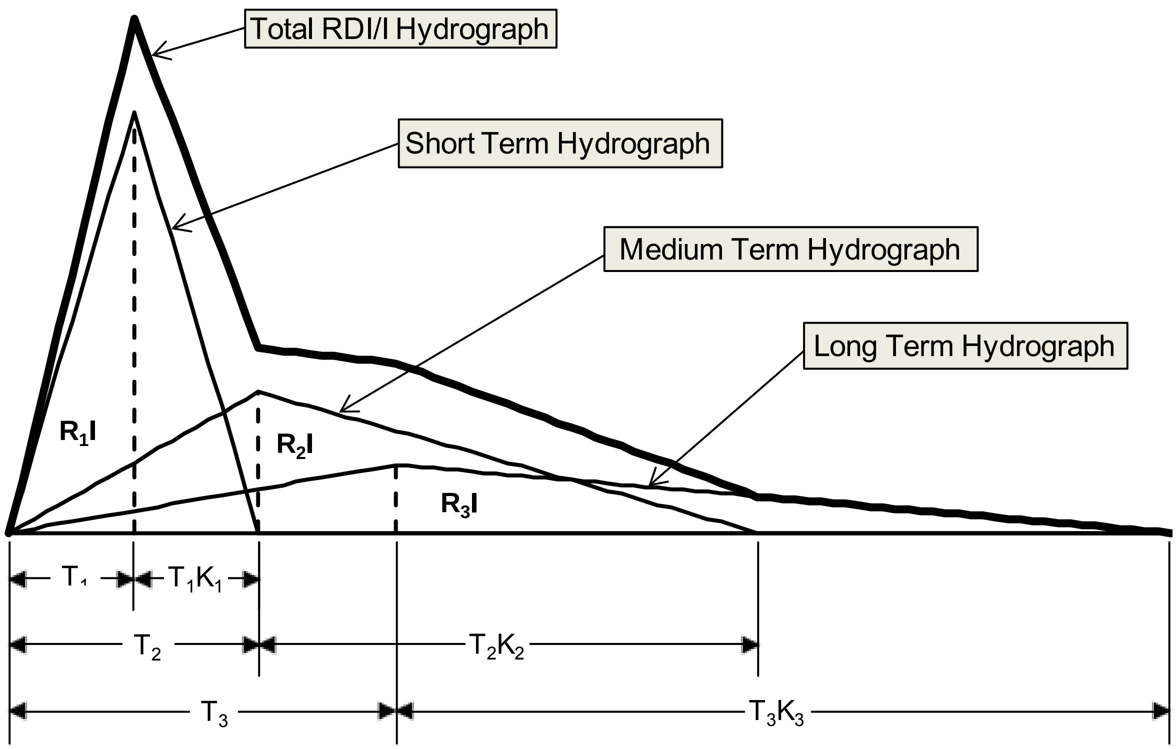


Figure 4.10
EXAMPLE RDI/I HYDROGRAPH
SEWER SYSTEM HYDRAULIC MODEL
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

The WWF calibration process consists of adjusting the nine variables in the RDI/I hydrographs for each flow meter until the peak I/I rate measured during the flow monitoring program are simulated for each of the series of rainfall events. Figure 4.11 illustrates the results for the wet weather calibration for Meter 83E. The remaining WWF calibration plots are provided in Appendix E. As shown in Appendix E and Figure 4.11, the model showed good correlation between the measured flow and simulated flow.

Similar to the DWF calibration plots, comparisons were made for maximum and average flows as well as the temporal distribution of flow. Appendix E contains a detailed summary table with the WWF calibration for each site using peak and average flow results. Table 4.5 provides a summary of the information presented in Appendix E.

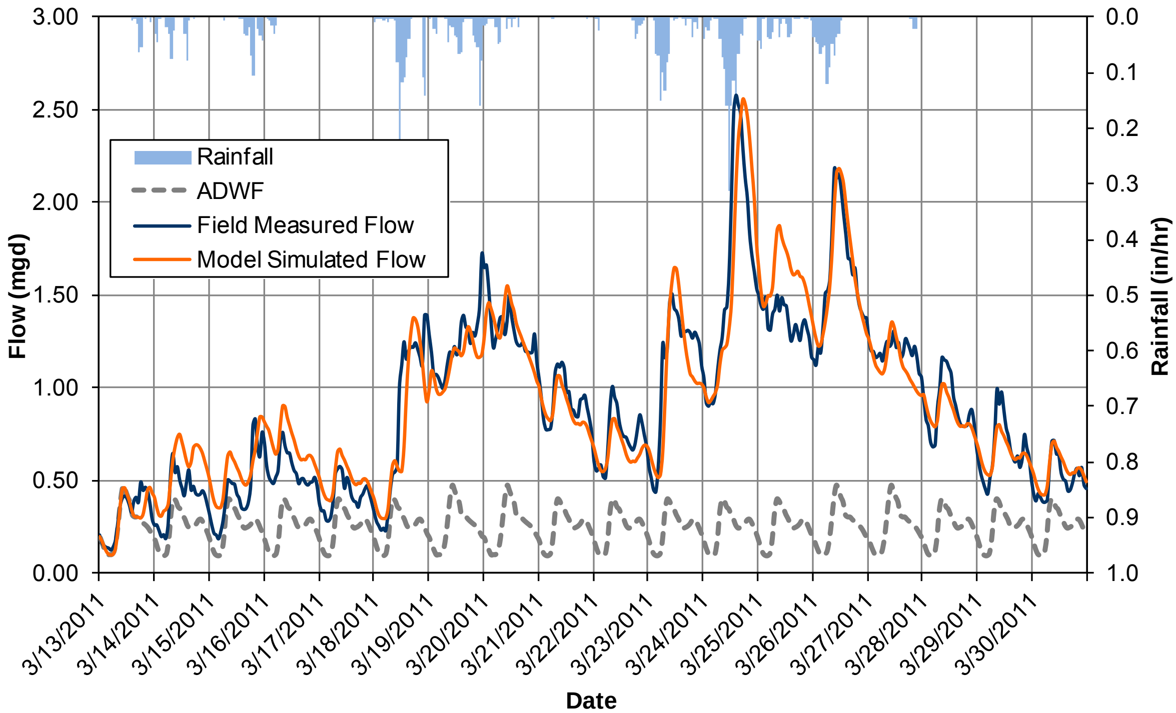


Figure 4.11
METER 83E WET WEATHER FLOW CALIBRATION
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS
CITY OF OAKLAND

Table 4.5 Wet Weather Flow Calibration Summary
Sewer System Hydraulic Modeling and Capacity Analysis
City of Oakland

Difference Between Observed and Simulated Values (percent)	Number of Meters in Range		Percent of Meters in Range	
	Peak Flow	Volume	Peak Flow (percent)	Volume (percent)
0 to 5	43	62	33	48
5 to 10	28	29	22	22
10 to 20	34	25	26	19
20 to 25	5	3	4	2
> 25	20	11	15	8
Total Meters	**130**	**130**	**100**	**100**

4.4.4 Hydraulic Model Calibration Summary

Calibration of the City's hydraulic model was a multi-step process that involved comparing model simulated flow to the actual field measured data for both dry and wet weather conditions. The model results matched up very well with the field measured data. There were a few sites for dry or wet weather conditions with percent errors that were outside the generally accepted calibration standards, which were further evaluated on a site specific basis. All of these instances are thought to be associated with anomalous data or unknown field conditions requiring further investigation, or the flows were not significant enough in the overall scope of the modeling process to warrant further attention.

Of the 130 meter sites used for model calibration, 85 percent of the meters were within a range of 25 percent for peak flows, and 90 percent were within a range of 20 percent for flow volume. Based on the complexity of the City's collection system and the large number of calibration points, Carollo has a high level of confidence in the model's accuracy. Therefore, for the purposes of this study, the model was considered calibrated and ready to use for capacity analysis purposes.

COLLECTION SYSTEM REHABILITATION AND REPLACEMENT PLAN

This chapter summarizes the collection system rehabilitation and replacement (R&R) that has been performed by the City of Oakland (City), provides a description of future R&R work within the City collection system, and documents infiltration and inflow (I/I) reduction assumptions for the City's planned future R&R work.

5.1 REHABILITATION AND REPLACEMENT PROGRAM

In 1986, the California Regional Water Quality Control Board issued Cease and Desist Order (CDO) 93-134 to eight agencies including the City of Oakland. Since that time, the City has continued to address the issues in the CDO with its 25-year Inflow/Infiltration (I/I) program[1]. In 2009, the California Regional Water Quality Control Board revised Oakland's Cease and Desist Order. As part of that revision, five additional rehabilitation projects were added to Oakland's I/I Correction Program and its completion was extended from 2014 to 2019. When the I/I Correction Program is completed, approximately 25 percent of the City's sewers will have been rehabilitated.

The City developed a 10-year financial plan that includes funding for projects to address the requirements of the CDO (Table 5.1). The City has allocated approximately $36 million for CDO projects through financial year 2013 – 2014, and $2.5 million for the five following years (through 2018-2019).

The financial plan also includes funding for major sewer repairs and rehabilitation to fund the I/I correction program and future condition based repairs. The financial plan includes $22 million from 2012 through financial year 2020 – 2021 for major repairs and the I/I correction projects.

Starting in financial year 2014-2015, the City has allocated between $7 and $9 million for rehabilitation projects through 2020-2021 for a total of approximately $55 million. Figure 5.1 shows a map of completed subbasin rehabilitation projects, as well as the two additional subbasins that have already been identified and scheduled for rehabilitation by the City.

Using data from the 2010-2012 flow-monitoring program identifying the basins with the highest inflow and infiltration rates (See Figures 3.15, and 3.16), a prioritized list of basins targeted for rehabilitation over the next five-years was developed. The five year plan was developed by comparing the highest inflow and infiltration basins against the map of the basins that have already been rehabilitated by the City. The list of targeted basins was also developed by coordinating with EBMUD to identify the reaches of their interceptor system

[1] The 1986 CDO was a 20-year compliance plan. It was revised to a 25-year plan in 1993.

that currently experience capacity constraints. Figure 5.2 shows the collection system sub-basins targeted for rehabilitation in the first five years.

The City will continue to coordinate with EBMUD to develop recommendations for future rehabilitation projects to target I/I reduction. Table 5.2 summarizes the preliminary list of subbasins that are targeted for rehabilitation. The sub-basins were prioritized based on the combination of severity of inflow and infiltration. The sub-basins were broken into five separate priority categories. Figure 5.3 color codes the targeted basins based on priority with red being the highest priority and green being the lowest priority.

It should be noted that the Private Lateral Inspection and Repair (PLR) program is on-going City-wide and will have an impact on I/I rates in basins that have been rehabilitated in the past. Assumptions on rates of I/I reduction from rehabilitation and the PLR Program are discussed in Section 5.2 of this chapter.

5.1.1 Private Lateral Inspection and Repair

On July 21, 2011, the Oakland City Council passed ordinance number 13080 stating that it is the responsibility of the property owner to perform all required maintenance, repairs and replacement of the upper and lower building sewer lateral in accordance with EBMUD's and the City's ordinance requirements. The new ordinance is provided as Appendix F. A statement of roles and responsibilities between the City and EBMUD for the implementation of East Bay Regional Private Sewer Lateral Program is provided as Appendix G.

A property owner is required to obtain a "Compliance Certificate" when one or more of the following situations occurring:

- **Title Transfer**. Prior to transferring title associated with the sale of any real property that contains any structure with a building sewer. Title transfer means the sale or transfer of an entire real property estate or the fee interest in that real property estate and does not include the sale or transfer of partial interest, including a leasehold. In addition, the following shall not be included: (1) transfer by a fiduciary in the course of the administration of a decedent's estate, guardianship, conservatorship, or trust, (2) transfer from one co-owner to one or more other co-owners, or from one or more co-owners into or from a revocable trust, if the trust is for the benefit of the grantor or grantors, (3) transfer made by a trustor to fund an inter vivos trust. (4) Transfers made to a spouse, to a registered domestic partner as defined in Section 297 of the Family Code, or to a person or persons in the lineal line of consanguinity of one or more of the transferors. (5) Transfers between spouses or registered domestic partners resulting from a decree of dissolution of marriage or domestic partnership, or a decree of legal separation or from a property settlement agreement incidental to a decree. (6) Transfers from property owners to any financial institution as a result of a foreclosure or similar process.

Table 5.1 10-Year Financial Plan
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

April 2012	FY 11-12	FY 12-13	FY 13-14	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20	FY 20-21
Revenue ($)										
Sewer Fee	41,980,000	46,180,000	48,500,000	49,000,000	49,500,000	50,000,000	50,500,000	51,000,000	51,500,000	52,000,000
Other Revenue	2,713,800	2,713,800	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Total Revenue	**44,693,800**	**48,893,800**	**51,200,000**	**51,700,000**	**52,200,000**	**52,700,000**	**53,200,000**	**53,700,000**	**54,200,000**	**54,700,000**
Expenses ($)										
O & M	25,972,673	25,681,793	26,800,000	27,600,000	28,400,000	29,200,000	30,100,000	31,000,000	31,900,000	32,800,000
Fee Admin (EBMUD)	1,011,800	1,063,022	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Franchise Fee	4,372,480	4,372,480	4,850,000	4,900,000	4,950,000	5,000,000	5,050,000	5,100,000	5,150,000	5,200,000
Capital-CDO	12,615,000	13,150,000	10,200,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	---	---
Capital-Major Repairs	2,000,000	2,000,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000
Capital-Rehabilitation	---	---	----	8,000,000	7,750,000	7,400,000	7,450,000	7,000,000	9,050,000	8,600,000
Rate Stabilization	500,000	500,000	500,000	500,000	500,000	500,000	---	---	---	---
Debt Service	4,910,450	4,913,850	4,900,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000
Total Expenses	**51,382,403**	**51,681,145**	**50,850,000**	**51,700,000**	**52,200,000**	**52,700,000**	**53,200,000**	**53,700,000**	**54,200,000**	**54,700,000**
Surplus/(Deficit)	**(6,688,603)**	**(2,787,345)**	**350,000**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

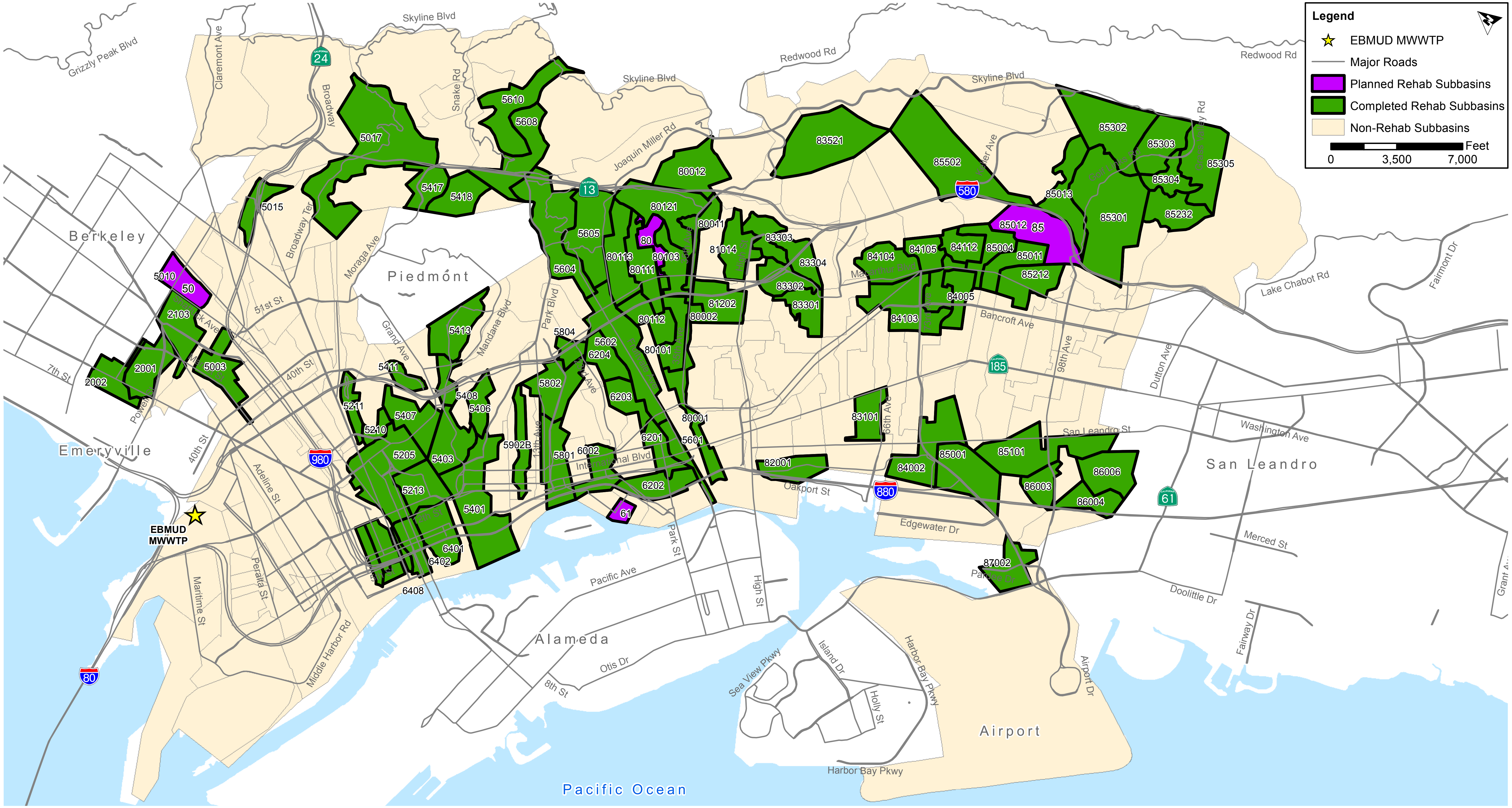


Figure 5.1
COMPLETED AND PLANNED 2013 REHABILITATION SUBBASINS
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
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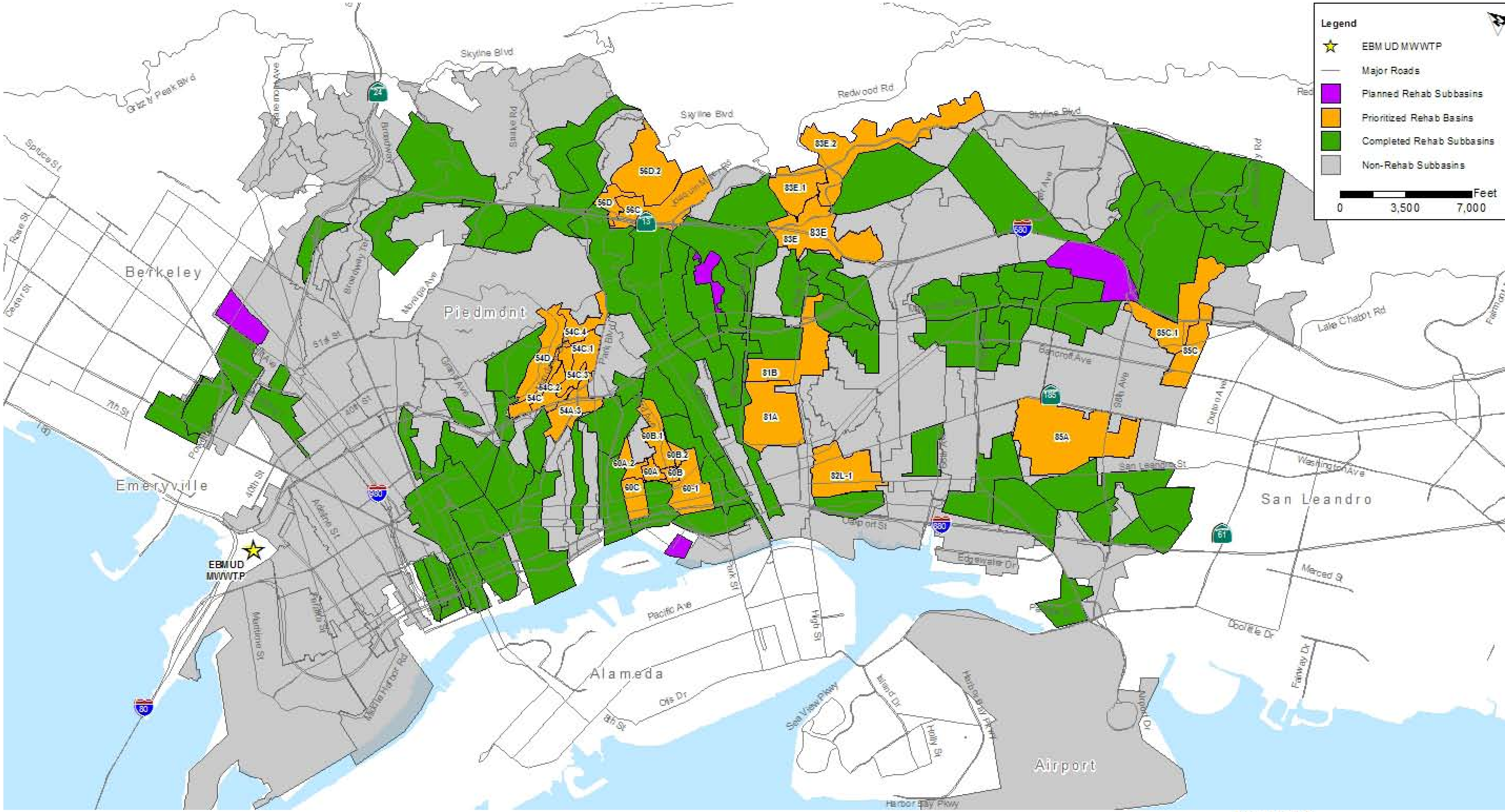

Figure 5.2
PRIORITIZED REHABILITATION BASINS (NEXT FIVE YEARS)
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 5.1 Completed and Planned Rehab Subbasins.mxd

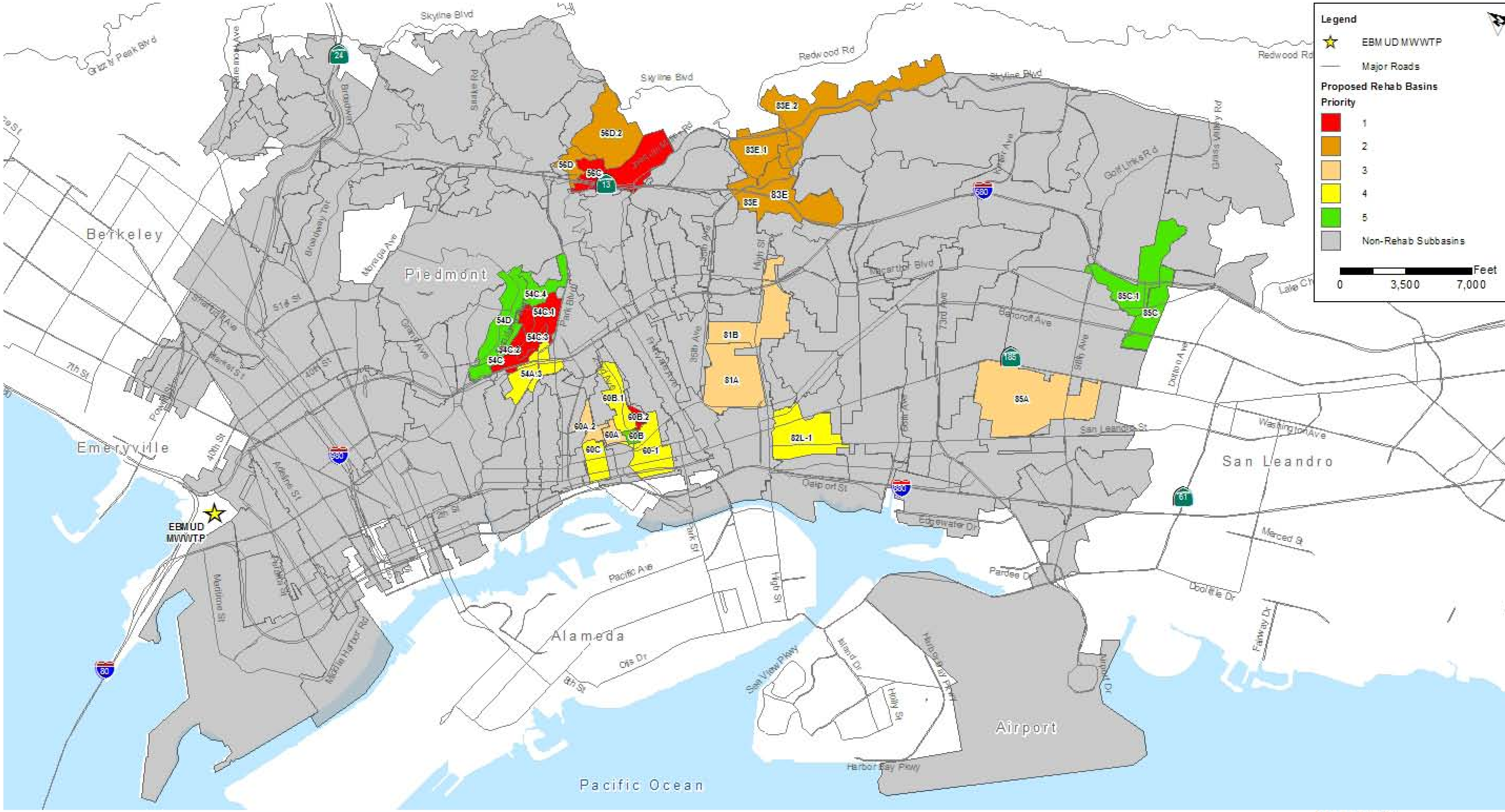

Figure 5.3
TARGETED SUBBASIN PRIORITIZATION
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 5.1 Completed and Planned Rehab Subbasins.mxd

**Table 5.2 Target Rehabilitation Basins – Next Five Years
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland**

Basin	Priority
54C.1	1
54C.2	1
54C.3	1
56C	1
60B.2	1
56D	2
56D.2	2
83E	2
83E.1	2
83E.2	2
81A	3
81B	3
85A	3
60A	4
60A.2	4
60B.1	4
82L-1	4
60C	4
60-1	4
54A.3	5
54C	5
54C.4	5
54D	5
60B	5
85C	5
85C.1	5

Notes:
1. Source: Draft Sanitary Sewer Flow Monitoring and Inflow/Infiltration Study, October 2012
2. Calculated from March 18-26, 2011 storm events.
3. Piedmont flows excluded for this calculation.

- **Construction or Remodeling**. Whenever a property owner applies for any permit or other approval needed for construction, remodeling, modification, or alteration of any structure with a building sewer where the cost of the work is estimated to exceed $100,000.

- **Change in Water Service**. Whenever a property owner applies for any permit or other approval from the EBMUD for an increase or decrease in size of the owner's water meter.
- **Development of an Individually-Owned Unit in a Multi-Unit Structure Served by a Common Private Sewer or Shared Lateral**. Within the period of time set forth in the EBMUD Regional Ordinance, the homeowners' association or a responsible party-for this type of multi-unit structure shall determine if the sewer lateral(s) is (are) in compliance with the EBMUD Regional PSL Ordinance and perform any necessary repair or replacement work to achieve compliance. Thereafter, re-certification of the sewer lateral shall occur at twenty (20) year intervals.
- **Property Developments Other Than Those Specified above with Sanitary Sewers Totaling Greater than 1,000 Feet in Length**. Within the period of time set forth in the EBMUD Regional PSL Ordinance, property owners or responsible parties for property development with sanitary sewers totaling greater than 1,000 feet in length, shall submit for EBMUD approval, a Condition Assessment Plan with a schedule to perform testing to assess the condition of all of the sewer laterals n the property to determine compliance with the EBMUD Regional PSL Ordinance. Within the period of time specified in the EBMUD Regional PSL Ordinance, property owners or responsible parties shall complete all condition assessment testing, and submit a Corrective Action Work Plan for EBMUD approval. After the work is completed, re-certification of the sewer lateral shall occur at twenty (20) year intervals.
- **Exception**. A property owner with an un-expired sewer lateral Compliance Certification or similar documentation from another agency, or with a dated approved building/sewer documentation from another agency, or with a dated approved building/sewer permit from a permitting authority indicating that the sewer lateral was replaced in total within 10 years of the period of time set forth in the EBMUD Regional PSL Ordinance may submit the information to EBMUD along with a request for and Exemption Certificate. Upon review and approval, an Exemption Certificate will be issued by EBMUD.
- **Dangerous and Insanitary Sewer Condition**. Whenever a dangerous or insanitary sewer condition is found as set forth by this Chapter and a notice to abate is provided according to the procedure established by the Director of Public Works.

A Compliance Certificate confirms that the sewer lateral serving the subject property is in good condition and is not a source of infiltration or inflow of rainwater.

The property owner is responsible for all work required for the certification of the private sewer lateral (PSL) in accordance with EBMUD's procedures. All repair and replacement work must conform to the City of Oakland's standards and permit requirements.

The City intends to continue its existing practice of evaluating the condition of lower laterals connected to those sewer mains and rehabilitating defective lower laterals when replacing sewer mains as part of I/I reduction program.

5.2 PLANNING LEVEL I/I REDUCTION ASSUMPTIONS

Continued implementation of the City's R&R program will result in a reduction in the rate of I/I that enters the collection system. At this phase, however, it is impossible to quantify exactly how much I/I reduction will be achieved through the implementation of the program. In order to analyze the capacity of the City collection system following complete implementation of the R&R program, it is necessary to assume the rate of I/I that will be reduced in the future. Based on a review of the available literature[2] and discussions with City staff, this project has established criteria for future I/I reduction that was built into the capacity analysis of the collection system, as well as the development of capacity related improvement projects (see Chapter 6).

The City's overall goal with their current R&R program is to reduce I/I throughout the entire collection system, which will directly reduce flows within the system and to the EBMUD Interceptor System. The City's approach to estimate the amount of I/I reduction that will be achieved in the future consists of two main elements, as summarized below:

- **I/I Reduction in Previously Rehabilitated Subbasins**. The City expects to achieve reduction in the future rate of I/I in subbasins that have previously been rehabilitated through the implementation of the City's private lateral inspection and repair program. The City has estimated a projected I/I reduction of 35-percent for private lateral rehabilitation alone.
- **I/I Reduction in Subbasins That Have not Been Rehabilitated**. For all other City subbasins (i.e., subbasins that have not already been rehabilitated), the City has estimated a projected I/I reduction of 65-percent associated with a combination of manhole rehabilitation, sewer rehabilitation, and private lateral rehabilitation.

To simulate the I/I reductions in the model, the R-values were reduced in the unit hydrographs according to the percentage reductions established in this section. The model was then run and corresponding flow reductions were determined. It should be noted that flows from the Port of Oakland, as well as the other Satellite agencies that discharge into the City collection system (most significantly the City of Piedmont) were not reduced to account for I/I reduction. This approach is more conservative in the capacity evaluation of the City collection system, because the City does not have direct control over I/I reduction activities in these areas.

[2] *Reducing Peak Rainfall-Derived Infiltration/Inflow Rates- Case Studies and Protocol*, Water Environmental Research Foundation, 2003.

DESIGN FLOW ANALYSIS AND CAPACITY EVALUATION

This chapter discusses the modeled design flows for the City of Oakland (City) sewer collection system, the hydraulic evaluation of the collection system, and the proposed projects that correct capacity deficiencies.

6.1 DESIGN FLOWS

This section summarizes the modeled average dry weather flow (ADWF) as well as the peak wet weather flows (PWWF), or design flows, that were simulated in the City's hydraulic model as part of this study.

6.1.1 Modeled Average Dry Weather Flow

A summary of the modeled average dry weather flow (ADWF) by City sewer basin is presented in Table 6.1. It should be noted that the flow numbers presented in this table do not include flows associated with certain small tributary areas (typically small areas served by 8-inch diameter and smaller sewers) that were not included in the City's hydraulic model. These flows are expected to be minor with regard to the overall flows associated with the City collection system. In addition, the flows provided in Table 6.1 include flows from the Port of Oakland, as well as other Satellites that discharge to the City collection system (e.g., City of Piedmont) as noted in the table.

6.1.2 Peak Flow Analysis

The City's sewers and lift stations were evaluated based on their capacity to convey the design flow (PWWF). If the sewers violated the flow depth criterion described in Chapter 2, then they were considered capacity deficient and improvements were proposed. Based on the hydraulic modeling results, we were able to derive peak flows throughout the system. This was accomplished by routing the 5-year, 7-hour design storm through the hydraulic model in 15-minute time intervals, which was calibrated to both dry weather and wet weather conditions (see Chapter 4). Table 6.1 shows a summary of the PWWF, as well as the PWWF to ADWF peaking factor, for each basin before and after the infiltration/inflow (I/I) reductions.

To simulate the I/I reductions in the model, the R-values were reduced in the unit hydrographs according to the percentage reductions established in Chapter 5. The model was then run and corresponding flow reductions were determined. Based on these assumptions, Table 6.1 shows a summary of the effect of the assumed percent reductions on the modeled PWWF by basin. In addition, the flows provided in Table 6.1 include flows from the Port of Oakland, as well as other Satellite dischargers that discharge to the City collection system as noted in the table. The City of Piedmont flows are the most significant.

Table 6.1 Modeled ADWF and PWWF by Basin
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Basin	Average Dry Weather Flow (mgd)	Peak Wet Weather Flow (mgd)				Modeled Peak Flow Reduction (percent)
		Existing	Peaking Factor	with I/I Reduction	Peaking Factor	
17[1]	0.14	1.5	11.3	0.7	5.0	56.0
20[2]	0.17	3.2	18.6	3.1	18.4	1.2
21[3]	0.33	6.5	19.9	3.5	10.5	47.2
50[4]	4.50	73.4	16.3	36.2	8.0	50.7
52	4.86	53.0	10.9	34.0	7.0	35.8
54[5]	4.38	45.4	10.4	32.3	7.4	28.9
56	1.72	19.1	11.1	10.0	5.8	47.9
58	1.55	17.8	11.5	9.8	6.4	44.8
59	0.66	6.2	9.5	3.9	5.9	38.1
60	0.73	13.4	18.4	6.5	8.9	51.5
61	0.23	1.4	6.0	0.7	2.9	51.1
62	0.42	5.0	12.0	3.9	9.2	23.1
64	2.16	15.2	7.0	11.7	5.4	22.7
80	1.76	19.8	11.2	11.8	6.7	40.1
81	1.84	24.3	13.2	14.7	8.0	39.4
82	0.10	16.5	16.5	7.1	7.1	57.2
83	2.99	44.9	15.0	22.5	7.5	49.9
84	1.78	27.0	15.2	16.5	9.3	38.9
85	3.19	33.9	10.6	18.6	5.8	45.2
86	0.68	6.7	9.8	4.0	5.8	40.7
87	0.36	3.8	10.5	3.1	8.5	18.5
System Wide			**11.8**		**6.4**	**45.2**

Notes:

1. Basin 17 flows into the City of Berkeley Collection System.
2. Basin 20 flows into the City of Emeryville Collection System.
3. Basin 21 receives flows from City of Emeryville, is routed through the City of Oakland, and then back into Emeryville.
4. Basin 50 receives flow from the City of Berkeley.
5. Basin 54 flows into the City of Piedmont and the combined flow then flows back into the City of Oakland

For this reason, the PWWF estimates provided in Table 6.1 include the City of Piedmont. For more information regarding the impact of the City of Piedmont flows to the City of Oakland collection system and EBMUD Interceptor, refer to a technical memorandum prepared by V&A that is included in Appendix H.

The results from the hydraulic model showed that by applying the 65 percent and 35 percent reduction criteria to the amount of I/I that enters the collection system, the peak flows were reduced by approximately 45 percent system wide, and the PWWF to ADWF peaking factor was reduced from 11.8 to 6.4. The range of flow reduced varied by basin from a low of 1.2 percent to a high of 57 percent. The range of peak flow reduction is dependent of the system hydraulics and capacity bottlenecks, which can constrict or throttle flow in the collection system.

6.2 CAPACITY EVALUATION

This section summarizes the results of the capacity evaluation of the City's sewer collection system, which includes a gravity pipeline capacity evaluation, as well as a lift station capacity evaluation. The evaluation considers current PWWF conditions, as well as the impact of infiltration and inflow (I/I) reduction associated with the City's proposed I/I reduction program, as outlined in Chapter 5.

In general, the capacity analysis found relatively few capacity related issues. This fact is a direct result of the extensive work the City has conducted over the last twenty years installing relief sewers and completing rehabilitation of approximately 25 percent of the collection system. Some areas in the system were discovered to have capacity constraints that were not identified in previous work conducted by the City. This was attributed to an extensive flow monitoring program that resulted in a more robust model calibration process that utilized more sophisticated hydraulic modeling tools than were available in the past.

The hydraulic model should be updated and the capacity of the system reevaluated after significant rehabilitation projects have been conducted. However, since a portion of the I/I reduction was assumed to occur as a result of the Private Sewer Lateral replacement program, the total impact of rehabilitation will not be realized in the short term.

6.2.1 Pipeline Capacity Evaluation

Following the dry and wet weather flow calibration (Chapter 4), a capacity analysis of the collection system was performed. The capacity analysis entailed identifying areas in the sewer system where flow restrictions occur or where pipe capacity is insufficient to convey design flows. Sewers that lack sufficient capacity to convey design flows create bottlenecks in the collection system that can potentially cause sewer system overflows (SSOs). The sewer system was evaluated based on planning criteria presented in Chapter 2.

This section discusses the locations of the model simulated hydraulic deficiencies resulting from flows exceeding the maximum flow depth criteria.

For the sewer collection system, the design flow was routed through the hydraulic model using the calibrated rainfall derived infiltration and inflow (RDI/I) unit hydrographs. In accordance with the established flow depth criteria for existing sewers, manholes where the hydraulic grade line (HGL) encroached within five feet of the manhole rim were identified.

Note that the pipelines with an HGL that encroached within five feet of the manhole rim are not necessarily capacity deficient. In many cases, a surcharged condition within a given pipeline segment is due to backwater effects created by a downstream bottleneck. An illustration of backwater effects is shown on Figure 6.1. For this reason, the hydraulic model was used to identify the pipeline segments that are the cause of the surcharged conditions. The location of the capacity deficient pipelines under current design flow conditions (including I/I reductions) are shown on Figure 6.2 in red.

One other factor that must be considered during the evaluation of a collection system is the elimination of backwater effects associated with implementation of capacity related improvement projects. Replacing a capacity deficient (bottleneck) sewer with a larger diameter sewer will allow higher peak flows to be conveyed to downstream collection system facilities. In some cases, this increase in flow is enough to overwhelm the downstream facilities, which creates additional capacity deficiencies. These additional deficiencies, which are referred to as “secondary deficiencies” for the purposes of this report, are identified in green on Figure 6.2.

As described in Section 6.2, capacity related improvements were recommended for the pipelines highlighted in red and green only..

6.2.2 Lift Station Capacity Evaluation

In accordance with the established planning criteria, the City’s three modeled lift stations were evaluated to determine if each lift station has available capacity to convey the model simulated PWWF. It has been determined that the existing capacity of the lift stations is sufficient to convey the design flows. For this reason, there are no capacity deficiencies present at this time.

6.3 COLLECTION SYSTEM CAPACITY IMPROVEMENTS

Figure 6.3 illustrates the improvements recommended to mitigate capacity deficiencies in the existing sewer collection system as identified by the hydraulic analysis. Detail maps for each of the proposed improvements are provided in Appendix I for clarity. The improvements are summarized in Table 6.2 with a cross-referenced number system. The columns used in Table 6.2 refer to the following:

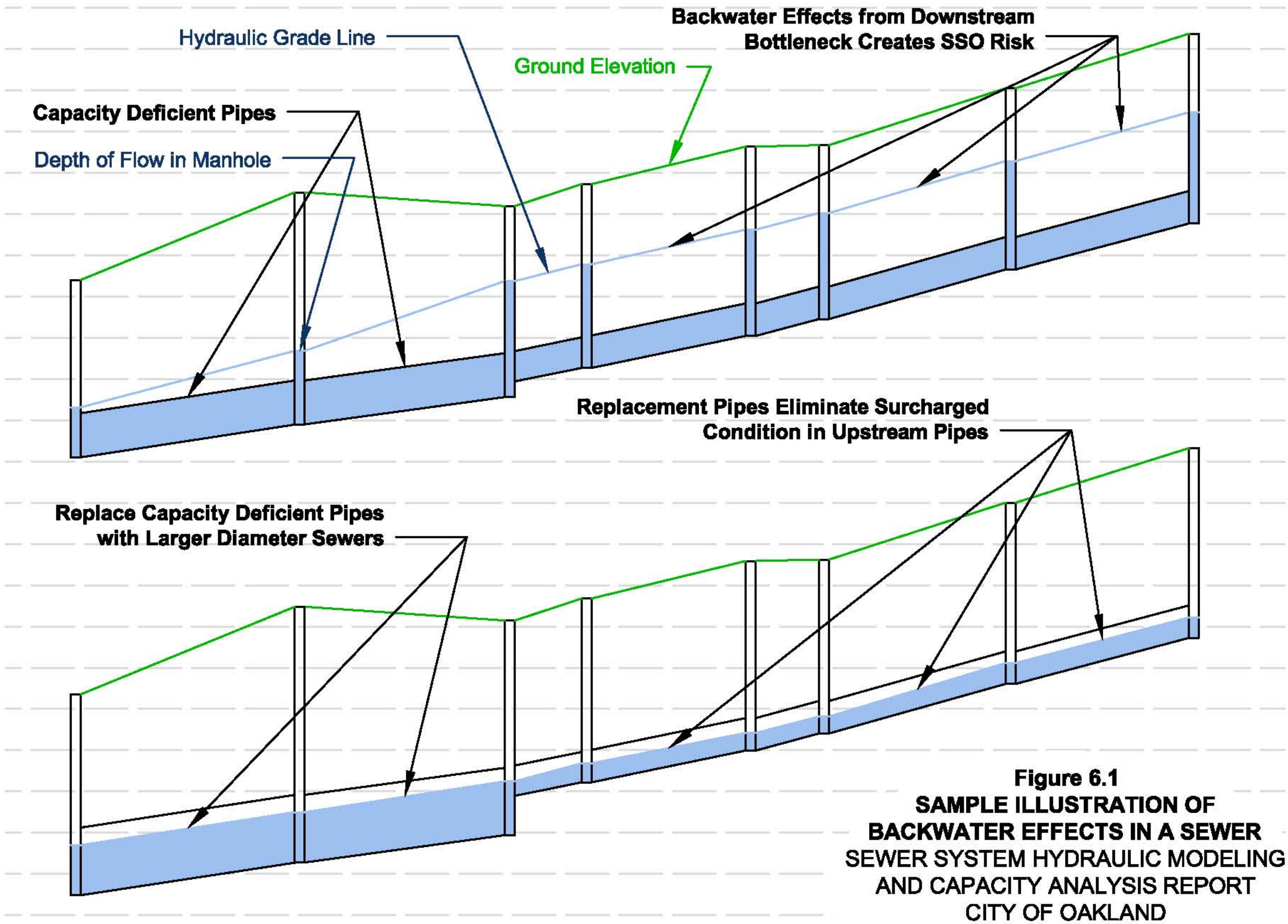

Figure 6.1
SAMPLE ILLUSTRATION OF
BACKWATER EFFECTS IN A SEWER
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Backwater Figure.dwg

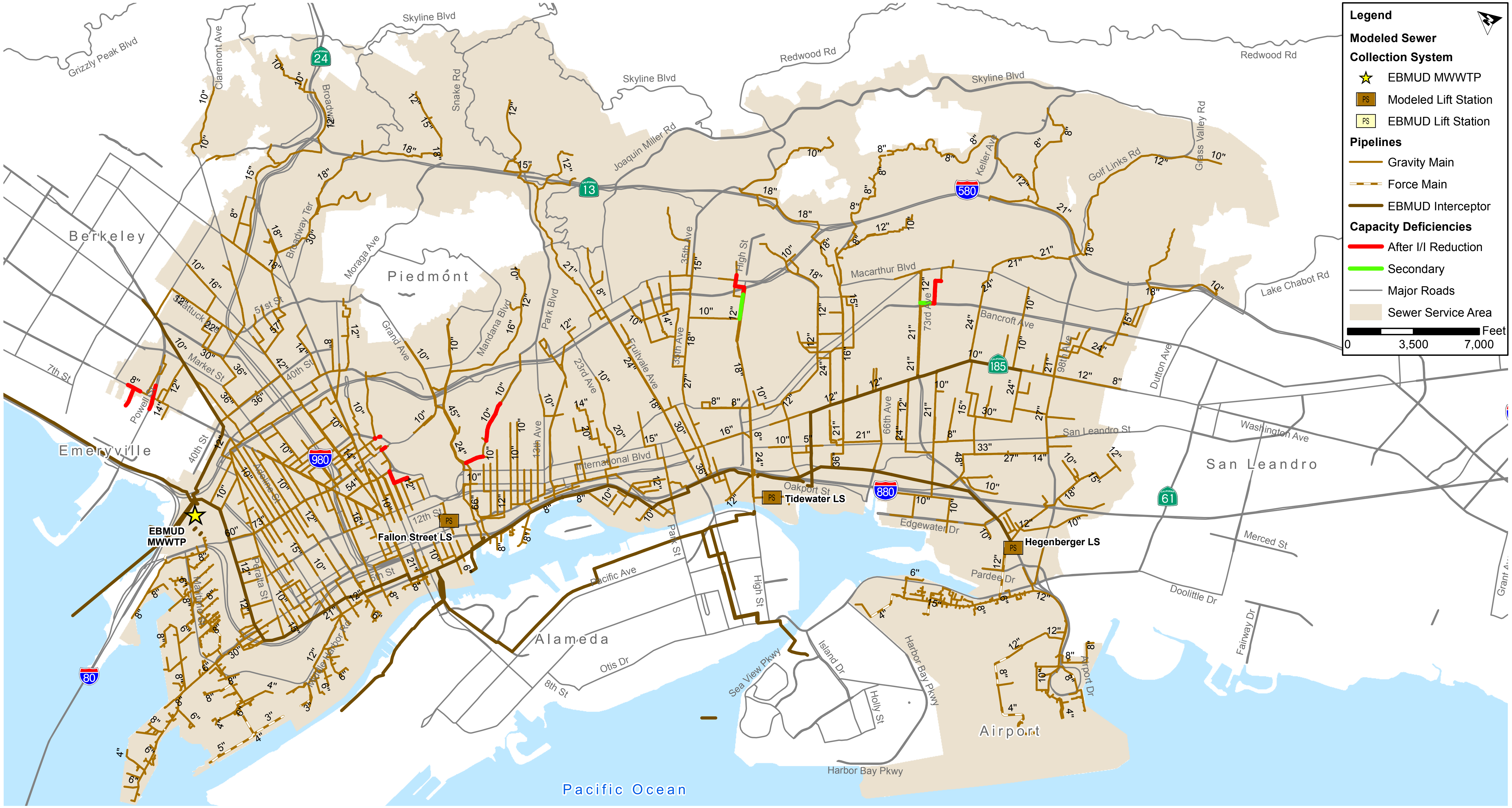

Figure 6.2
COLLECTION SYSTEM CAPACITY DEFICIENCIES
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

Figure 6.3
PROPOSED CAPITAL IMPROVEMENTS
SEWER SYSTEM HYDRAULIC MODELING AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

November 15, 2012

M:\Oakland_FNO\GIS\Figures\Report_Figs\Figure 6.3 Proposed Capital Improvements.mxd

Table 6.2 Proposed Capacity Related Improvements
Sewer System Hydraulic Modeling and Capacity Analysis Report
City of Oakland

Project Description				Project Details			
ID	**Type of Improv.**	**Description/Street**	**Description/Limits**	**Existing Size (in.)**	**Proposed Size (in)**	**Replace/ New**	**Length (ft)**
Project 1							
1A	Gravity	San Pablo Avenue	From 62nd Street to 61st Street	8	12	Replace	390
1B	Gravity	San Pablo Avenue	From 60th Street to 61st Street	10	15	Replace	380
1C	Gravity	61st Street	From San Pablo Avenue to Emeryville Collection System	12	18	Replace	900
Project 2							
2	Gravity	Stanford Avenue	From Gaskill Street to Fremont Street	10	15	Replace	1,160
Project 3							
3A	Gravity	27th Street	At Vernon Street	8	10	Replace	80
3B	Gravity	Harrison Street	At 27th Street	15	24	Replace	60
Project 4							
4A	Gravity	Grand Avenue	At Harrison Street	10	12	Replace	40
4B	Gravity	Grand Avenue	At Harrison Street	10	15	Replace	230
Project 5							
5A	Gravity	19th Street	From Jackson Street to Alice Street	12	15	Replace	380
5B	Gravity	19th Street/ Harrison Street	From Alice Street to 20th Street	14	18	Replace	980
Project 6							
6	Gravity	Park Boulevard	From Spruce Street to Newton Avenue	10	15	Replace	2,180
Project 7							
7	Gravity	18th Avenue	From 4th Avenue to 1st Avenue	18	24	Replace	990
Project 8							
8A	Gravity	Maybelle Avenue	From Masterson Street to Macarthur Boulevard	10	12	Replace	240
8B	Gravity	Maybelle Avenue/Redding Street/High Street	From MacArthur Boulevard to I-580	10	15	Replace	560
8C	Casing	Redding Avenue/High Street	Crossing I-580	10	15/30	Replace	550
8D	Gravity	High Street	From I-580 to Porter Street	10	15	Replace	220
8E	Gravity	High Street	From Porter Street to Penniman Avenue	12	15	Replace	1,190
Project 9							
9	Gravity	76th Avenue/Bancroft Avenue	From Garfield Avenue to 73rd Avenue	8	12	Replace	1,390

- **Figure Number**: Assigned number that corresponds to the Proposed Improvements Table. This is an alphanumeric number that starts with one letter indicating the type of improvement P= Pipe, LS = Lift Station and continues with a number.
- **Type of improvement**: Pipelines, lift stations, force mains, and jacked steel casings.
- **Street Description**: Street in which the improvement is proposed.
- **Limits**: Description of the beginning and end of a proposed pipeline project.
- **Ex. Size/Diameter**: This is the size of the existing pipeline/facility. It represents the diameter of the existing pipelines (in inches), and the total capacity of lift stations (in mgd).
- **New Size/Diameter**: This is the size of the proposed improvement. It represents the diameter of the proposed pipelines (in inches), and the total capacity of lift stations (in mgd).
- **Additionally**, for jacked steel casings, the size of the casing as well as the carrier pipe are indicated (in inches).
- **Length**: Estimated length of the proposed improvement (in feet). It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions.

6.3.2 Pipeline Capacity Improvements

When an increase to capacity is required, existing sewers can be upgraded or a parallel or relief sewer can be constructed. For the purposes of this Study, we assumed that a capacity deficient sewer would be upgraded to a larger diameter sewer. The upgraded pipeline generally followed the same slope as the existing pipeline, unless the available data revealed negative or flat slopes in an existing alignment.

In essence, there are two alternatives for every trunk sewer project, but the decision to replace or construct a parallel sewer should be made during the preliminary design phase.

During the preliminary design phase, the existing sewer should be inspected by closed circuit television (CCTV) to determine its structural condition. If severely deteriorated, the existing sewer should be upgraded. If moderately deteriorated, slip lining or cured-in-place pipe lining can rehabilitate the existing sewer.

Based on the results of the system analysis, the following projects are recommended:

- **Capacity Improvement Project 1**: In order to mitigate capacity deficiencies in the 8-inch, 10-inch, and 12-inch diameter sewers along San Pablo Avenue and 61st Street, it is recommended that the City construct new 12-inch, 15-inch, and 18-inch diameter replacement pipelines. Capital Improvement Costs for Project 1 are estimated at $0.53 million.

- **Capacity Improvement Project 2**: In order to mitigate capacity deficiencies in the 10-inch diameter sewer along Stanford Avenue, it is recommended that the City construct a new 15-inch diameter replacement pipeline. Capital Improvement Costs for Project 2 are estimated at $0.35 million.
- **Capacity Improvement Project 3**: In order to mitigate capacity deficiencies in the 8-inch and 15-inch diameter sewers along 27th and Harrison Streets, it is recommended that the City construct new 10-inch and 24-inch diameter replacement pipelines. Capital Improvement Costs for Project 3 are estimated at $0.05 million.
- **Capacity Improvement Project 4**: In order to mitigate capacity deficiencies in the 10-inch diameter sewers along Grand Avenue, it is recommended that the City construct new 12-inch and 15-inch diameter replacement pipelines. Capital Improvement Costs for Project 4 are estimated at $0.08 million.
- **Capacity Improvement Projects 5**: In order to mitigate capacity deficiencies in the 12-inch and 14-inch diameter sewers along 19th Street and Harrison Street, it is recommended that the City construct new 15-inch and 18-inch diameter replacement pipelines. Capital Improvement Costs for Project 5 are estimated at $0.45 million.
- **Capacity Improvement Project 6**: In order to mitigate capacity deficiencies in the 10-inch diameter sewer along Park Boulevard, it is recommended that the City construct a new 15-inch diameter replacement pipeline. Capital Improvement Costs for Project 6 are estimated at $0.64 million.
- **Capacity Improvement Project 7**: In order to mitigate capacity deficiencies in the 18-inch diameter sewer along 18th Avenue, it is recommended that the City construct a new 24-inch diameter replacement pipeline. Capital Improvement Costs for Project 7 are estimated at $0.44 million.
- **Capacity Improvement Project 8**: In order to mitigate capacity deficiencies in the 10-inch and 12-inch diameter sewers along Maybelle Avenue, Redding Street, and High Street, it is recommended that the City construct new 12-inch and 15-inch diameter replacement pipelines. This includes one crossing under I-580, which requires a steel casing. Capital Improvement Costs for Project 8 are estimated at $1.86 million.
- **Capacity Improvement Project 9**: In order to mitigate capacity deficiencies in the 8-inch diameter sewer along 76th Avenue and Bancroft Avenue, it is recommended that the City construct a new 12-inch diameter replacement pipeline. Capital Improvement Costs for Project 9 are estimated at $0.39 million.

6.3.3 Lift Station Improvements

As discussed in Section 6.2, the City's lift stations are capable of adequately conveying the design flow with the largest pump out of service. Since there are no known capacity deficiencies for the City lift stations, no lift station capacity related improvement projects are recommended.

However, as discussed in the City's Asset Management Implementation Plan (AMIP), the City has developed a Pump Station Reliability Plan which is based upon an update of the work completed in the City's September 2007 Pump Station Master Plan.

The Pump Station Master Plan study analyzed each lift station service area, land uses, influent and effluent piping, design flows, pump size and capacity, and concluded that all existing pump stations are adequately sized for current design flows. This conclusion was confirmed by the hydraulic modeling results for the three modeled lift stations. The scope of work for all future lift station upgrades will include replacing pumps, mechanical piping, electrical components, providing stand-by power for portable back up generators, and a remote auto-dialer alarm system.

The Tidewater Lift Station was given the highest priority, and is currently under construction.. The City plans to implement all the other Pump Station Master Plan recommended improvements for each lift station. For more information related to the estimated costs and schedule for the City's planned lift station improvements, refer to the City's Asset Management Implementation Plan (AMIP) report.

6.3.4 Collection System Rehabilitation Program

It is important to reiterate that the recommended capacity related improvements described in this chapter were developed considering the I/I reduction assumptions presented in Chapter 5. In other words, the recommended capacity improvements are identified to mitigate collection system capacity deficiencies that would be still be present even after the City's collection system were fully rehabilitated. Without considering the future I/I reduction assumptions associated with the City's R&R program, there would be a larger number of recommended capacity related improvements.

For more information regarding the City's planned R&R plan, including costs associated with the program, refer to Chapter 5, as well as the City's AMIP.

CAPITAL IMPROVEMENT PLAN

This section presents the recommended capacity related capital improvement plan (CIP) for the City of Oakland (City) sewer collection system and a summary of the capital costs. This chapter is organized to assist the City in making financial decisions. The CIP is based on the evaluation of the City's sewer system, planning area, and zoning designations.

7.1 CAPITAL IMPROVEMENT PROJECT COSTS

The capacity upgrades set the foundation for the City's capacity related sewer system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, Inc. (Carollo) experience on other projects. The costs are based on an Engineering News Record Construction Cost Index (ENR CCI) 20-City Average of 10,386 (June 2012).

7.2 COST ESTIMATING ACCURACY

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate, deemed appropriate for master plan studies, as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.3 CONSTRUCTION UNIT COSTS

The construction costs are representative of sewer system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction.

7.3.1 Sewer Trunk Unit Costs

Sewer pipeline improvements range in size from 10-inches to 24-inches in diameter in this study. Pipe casings up to 30-inches in diameter are included for major crossings (e.g., creeks, canals, highways, and railroad) of the trunk sewers. Unit costs for the construction of pipelines and appurtenances (i.e., manholes) are shown in Table 7.1.

The construction cost estimates are based upon these unit costs. The unit costs are for “typical” field conditions with construction in stable soil at a depth ranging between 10 feet to 15 feet.

Table 7.1 Pipeline Construction Unit Costs
Sewer System Hydraulic Modeling and Capacity Evaluation Report
City of Oakland

Pipe Size (inches)	Pipeline Unit Cost ($/Linear Foot)
8	149
10	156
12	164
15	176
18	191
21	246
24	266
27	301
30	334
33	380
36	419
39	455
42	491
48	536
Pipeline Casing for Major Crossings	
12/24	1,069
15/30	1,337
18/30	1,337
24/42	1,871
27/48	2,139

Notes:

1. ENR CCI 20 City average used for estimating (June 2012) = 10,286

7.4 PROJECT COSTS AND CONTINGENCIES

Project cost estimates are calculated based on elements, such as the project location, size, length, land acquisition needs, and other factors. Allowances for project contingencies consistent with an "Order of Magnitude" estimate are also included in the project costs prepared as part of this study, as outlined in this section.

7.4.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement for pipelines and lift stations. Baseline construction costs were developed using the following criteria:

- **Pipeline**: Calculated by multiplying the estimated length by the unit cost.

7.4.2 Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, contingency costs will be added to the planning budget as percentages of the total construction cost, divided into two categories: Estimated Construction Cost and Capital Improvement Cost.

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 25 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 25 percent contingency to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns are typical for master planning projects. The Estimated Construction Cost for the proposed sewer system improvement consists of the Baseline Construction Cost plus the 25 percent construction contingency.

7.4.3 Capital Improvement Cost

Other project construction contingency costs are divided into three subcategories, totaling 30 percent: The 30 percent contingency is divided accordingly; 10 percent for project engineering, 10 percent for construction phase professional services, and 10 percent for project administration. Engineering services associated with new facilities include preliminary investigations and reports, ROW acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to equal 10 percent of the Estimated Construction Cost.

Construction phase professional services cover such items as construction management, engineering services, materials testing, and inspection during construction. The cost of these items can also vary, but for the purpose of this study, it is assumed that construction phase professional services expenses will equal approximately 10 percent of the Estimated Construction Cost.

Finally, there are project administration costs, which cover such items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. The cost of these items can also vary, but for the purpose of this Master Plan, it is assumed that project administration costs will equal 10 percent of the estimated construction cost.

The capital improvement cost is the total of the estimated construction cost (including contingency) plus the other costs discussed in the previous paragraphs.

As shown in the following sample calculation of the capital improvement cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 62.5 percent of the baseline construction cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 62.5 percent is the overall mark-up on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	$1,000,000
Construction Contingency (25%)	250,000
Estimated Construction Cost	1,250,000
Engineering Cost (10%)	125,000
Construction Management (10%)	125,000
Project Administration (10%)	125,000
Capital Improvement Cost	$1,625,000

A summary of the capacity related capital project costs is presented in Table 7.2. This table identifies the projects, provides a brief description of the project, identifies facility size (e.g., pipe diameter and length), and the capital improvement cost. The table also shows the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

It should be noted that the costs provided in Table 7.2 do not include costs associated with the City's sewer system rehabilitation and replacement (R&R) program, or the City's planned lift station improvements, which are based on the recommendations provided in the City's 2007 Pump Station Master Plan. Costs associated with these projects are provided for reference in the City's Asset Management Implementation Plan (AMIP).

Table 7.2 Capacity Related Capital Improvement Plan
Sewer System Hydraulic Modeling and Capacity Analysis Report
City of Oakland

Project Description				Project Size and Cost							
ID	Type of Improv.	Description/Street	Description/Limits	Existing Size (in.)	Proposed Size (in)	Replace/ New	Length (ft)	Unit Cost[1] ($/LF)	Baseline Construction Cost[2] ($)	Estimated Construction Cost[3] ($)	Capital Improvement Cost[2],[3],[4] ($)
Project 1											
1A	Gravity	San Pablo Avenue	From 62nd Street to 61st Street	8	12	Replace	390	$ 171	$ 66,700	$ 83,400	$ 108,000
1B	Gravity	San Pablo Avenue	From 60th Street to 61st Street	10	15	Replace	380	$ 188	$ 71,300	$ 89,100	$ 116,000
1C	Gravity	61st Street	From San Pablo Avenue to Emeryville Collection System	12	18	Replace	900	$ 212	$ 190,400	$ 238,000	$ 309,000
								Project 1 Subtotal	**$ 328,400**	**$ 410,500**	**$ 533,000**
Project 2											
2	Gravity	Stanford Avenue	From Gaskill Street to Fremont Street	10	15	Replace	1,160	$ 188	$ 217,500	$ 271,900	$ 353,000
								Project 2 Subtotal	**$ 217,500**	**$ 271,900**	**$ 353,000**
Project 3											
3A	Gravity	27th Street	At Vernon Street	8	10	Replace	80	$ 160	$ 12,800	$ 16,000	$ 21,000
3B	Gravity	Harrison Street	At 27th Street	15	24	Replace	60	$ 274	$ 16,400	$ 20,500	$ 27,000
								Project 3 Subtotal	**$ 29,200**	**$ 36,500**	**$ 48,000**
Project 4											
4A	Gravity	Grand Avenue	At Harrison Street	10	12	Replace	40	$ 171	$ 6,800	$ 8,500	$ 11,000
4B	Gravity	Grand Avenue	At Harrison Street	10	15	Replace	230	$ 188	$ 43,200	$ 54,000	$ 70,000
								Project 4 Subtotal	**$ 50,000**	**$ 62,500**	**$ 81,000**
Project 5											
5A	Gravity	19th Street	From Jackson Street to Alice Street	12	15	Replace	380	$ 188	$ 71,300	$ 89,100	$ 116,000
5B	Gravity	19th Street/ Harrison Street	From Alice Street to 20th Street	14	18	Replace	980	$ 212	$ 207,300	$ 259,100	$ 337,000
								Project 5 Subtotal	**$ 278,600**	**$ 348,200**	**$ 453,000**
Project 6											
6	Gravity	Park Boulevard	From Spruce Street to Newton Avenue	10	15	Replace	2,180	$ 188	$ 408,800	$ 511,000	$ 664,000
								Project 6 Subtotal	**$ 408,800**	**$ 511,000**	**$ 664,000**
Project 7											
7	Gravity	18th Avenue	From 4th Avenue to 1st Avenue	18	24	Replace	990	$ 274	$ 270,900	$ 338,600	$ 440,000
								Project 7 Subtotal	**$ 270,900**	**$ 338,600**	**$ 440,000**
Project 8											
8A	Gravity	Maybelle Avenue	From Masterson Street to Macarthur Boulevard	10	12	Replace	240	$ 171	$ 41,000	$ 51,300	$ 67,000
8B	Gravity	Maybelle Avenue/Redding Street/High Street	From MacArthur Boulevard to I-580	10	15	Replace	560	$ 188	$ 105,000	$ 131,300	$ 171,000
8C	Casing	Redding Avenue/High Street	Crossing I-580	10	15/30	Replace	550	$ 1,337	$ 735,200	$ 919,000	$ 1,195,000
8D	Gravity	High Street	From I-580 to Porter Street	10	15	Replace	220	$ 188	$ 41,300	$ 51,600	$ 67,000
8E	Gravity	High Street	From Porter Street to Penniman Avenue	12	15	Replace	1,190	$ 188	$ 223,100	$ 278,900	$ 363,000
								Project 8 Subtotal	**$ 1,145,600**	**$ 1,432,100**	**$ 1,863,000**
Project 9											
9	Gravity	76th Avenue/Bancroft Avenue	From Garfield Avenue to 73rd Avenue	8	12	Replace	1,390	$ 171	$ 237,700	$ 297,100	$ 386,000
								Project 9 Subtotal	**$ 237,700**	**$ 297,100**	**$ 386,000**
Capital Improvement Plan Total											
								Capital Improvement Plan Total	**$ 2,966,700**	**$ 3,708,400**	**$ 4,821,000**

Notes:
(1) ENR CCI = 10,386 (San Francisco, June 2012).
(2) Baseline Construction Costs = Length x Unit Cost
(3) Estimated Construction Cost includes a 25% construction contingency applied to the Baseline Construction Cost to account for unforseen events and unknown conditions.
(4) Capital Improvement Cost includes a 30% contingency applied to the Estimated Contruction Cost to account for engineering services, construction management, and project administration.

APPENDIX A - EPA STIPULATED ORDER DOCKET NO. CWA 309(A)-10-009

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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

UNITED STATES OF AMERICA and PEOPLE OF THE STATE OF CALIFORNIA ex rel. CALIFORNIA STATE WATER RESOURCES CONTROL BOARD and CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, SAN FRANCISCO BAY REGION,

Plaintiffs,

SAN FRANCISCO BAYKEEPER,

Intervenor-Plaintiff,

v.

CITY OF ALAMEDA, et. al,

Defendants.

Case No. C 09-05684 RS

STIPULATED ORDER FOR PRELIMINARY RELIEF

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TABLE OF CONTENTS

Page

WHEREAS:

1. Plaintiff United States of America ("United States"), on behalf of the United States Environmental Protection Agency ("EPA"), filed a Complaint against the Defendants City of Alameda, City of Albany, City of Berkeley, City of Emeryville, City of Oakland, City of Piedmont, and the Stege Sanitary District pursuant to Section 309 of the Clean Water Act ("CWA"), 33 U.S.C. § 1319.

2. The Complaint alleges that each Defendant has discharged pollutants without a permit in violation of CWA Section 301(a), 33 U.S.C. § 1311(a), and has discharged pollutants in violation of the terms and conditions of its National Pollutant Discharge Elimination System ("NPDES") Permit. The Complaint joined the State of California to this action pursuant to Section 309(e) of the CWA, 33 U.S.C. § 1319(e).

3. The People of the State of California *ex rel.* California State Water Resources Control Board ("State Water Board") and California Regional Water Quality Control Board, San Francisco Bay Region ("Regional Water Board") (collectively "Water Boards") is realigning as a Plaintiff and is adding state law claims to the Complaint against the Defendants City of Alameda, City of Albany, City of Berkeley, City of Emeryville, City of Oakland, City of Piedmont, and the Stege Sanitary District pursuant to Cal. Water Code Sections 13376, 13385 and 13386.

4. Each Defendant owns and operates a Collection System. Collectively, these Collection Systems serve a total population of approximately 650,000. Each Defendant's Collection System delivers wastewater to a sewer interceptor system owned and operated by the East Bay Municipal Utility District ("EBMUD"). The interceptor system transports wastewater to EBMUD's year-round main wastewater treatment plant near the eastern anchorage of the Bay Bridge ("MWWTP"). During wet weather, EBMUD at times discharges wastewater from one or more of three wet weather facilities, located at 2755 Point Isabel Street, Richmond; 225 5th Avenue, Oakland; and 5597 Oakport Street, Oakland (collectively the "WWFs"). Defendants' and EBMUD's connected systems shall be referred to collectively as the "East Bay Sanitary Sewer System."

5. In the Amended Complaint filed in this action, the United States and the Water

Boards allege that sanitary sewer overflows ("SSOs") from the Collection Systems of each Defendant had occurred in violation of the terms and conditions of the NPDES permits regulating discharges from the Collection Systems, and in violation of the Clean Water Act. The United States and the Water Boards also alleged that each Defendant violated the terms and conditions of its NPDES permit regulating discharges from its Collection System by operating and maintaining its Collection System in such a manner that the Collection System causes or contributes to discharges from the WWFs.

6. On January 22, 2010, the Court granted the motion to intervene by San Francisco Baykeeper ("Baykeeper" or "Intervenor"), and ordered Baykeeper to file its Complaint in Intervention forthwith. Defendants filed a challenge in opposition to Baykeeper's motion for intervention, but on August 26, 2010, Baykeeper filed a stipulation on behalf of itself and the Satellites acknowledging Baykeeper's status as Intervenor. On August 27, 2010, the Court entered an Order granting the relief requested in the stipulation.

7. Defendants do not admit any liability to Plaintiffs or Intervenor for the transactions or occurrences alleged in the Complaints.

8. The Parties desire to avoid further litigation and to work cooperatively on issues relating to SSOs and wet weather flows.

9. To comply with the provisions of this Stipulated Order, Defendants are obligated to perform work. To pay for their share of the work needed to comply with a valid federal court order entered for the purpose of facilitating compliance with the Clean Water Act, each Defendant intends to rely on funds generated through levying taxes, fees and/or assessments. The work set forth in this Stipulated Order reflects the outcome of inspections conducted by EPA in March and April, 2009, of each of the Satellites' Collection Systems. The Stipulated Order does not specifically address programs that EPA deemed to be satisfactory during those inspections, but requires the Satellites to maintain these programs. The Parties recognize that, to address issues relating to wet weather flows in the East Bay Sanitary Sewer System service area, further analysis of technical issues will be needed, and that doing so will require the active participation of EBMUD. Therefore, the Parties recognize and agree that this Stipulated Order

for Preliminary Relief ("Stipulated Order") is a partial remedy for the civil claims of the United States, the Water Boards and Baykeeper for the violations alleged in the Complaints; does not resolve these civil claims and is without prejudice to the United States', the Water Boards' and/or Baykeeper's right to seek further relief to address these claims or any future claims, including, but not limited to, further injunctive relief and civil penalties. In addition, the Satellites reserve all defenses to any such claims, as set forth in Paragraphs 119, 122 and 124. Such further action may include, but is not necessarily limited to, additional enforcement litigation involving the Parties and, possibly, EBMUD. The Parties further recognize that, as appropriate, EBMUD will be informed of the need to cooperate with the work being implemented pursuant to this Stipulated Order and, therefore, the Parties will jointly undertake to engage in outreach to and dialogue with EBMUD with regard to work undertaken pursuant to this Stipulated Order.

10. The Parties recognize, and the Court by entering this Stipulated Order finds, that (1) this Stipulated Order has been negotiated by the Parties in good faith and will facilitate the ultimate resolution of the claims stated in the Complaints, and (2) this Stipulated Order is fair, reasonable, and in the public interest.

NOW, THEREFORE, IT IS HEREBY ADJUDGED, ORDERED, AND DECREED as follows:

I. JURISDICTION AND VENUE

11. For purposes of enforcement of this Stipulated Order only, Defendants agree that this Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331, 1345, 1355, and 1367, Sections 309(b) and 505(b)(1)(B) of the CWA, 33 U.S.C. §§ 1319(b), 1365(b)(1)(B), and Sections 13376, 13385 and 13386 of the California Water Code; and the Court has jurisdiction over the Parties. Venue lies in this District pursuant to Section 309(b) of the CWA, 33 U.S.C. § 1319(b), and 28 U.S.C. §§ 1391(b) and 1395(b), because this is the District in which Defendants are located. For purposes of enforcement of this Stipulated Order only, Defendants agree that the Complaints state claims upon which relief may be granted pursuant to the CWA and the California Water Code.

12. Notice of the commencement of the United States' action was provided to the Regional Water Board pursuant to Section 309(b) of the CWA, 33 U.S.C. § 1319(b).

II. APPLICABILITY

13. The provisions of this Stipulated Order shall apply to and be binding upon the Parties and any successors or other entities or persons otherwise bound by law.

14. Each Defendant shall provide a copy of this Stipulated Order to all officers, employees, and agents whose duties might reasonably include compliance with any provision of this Stipulated Order, as well as to any contractor retained to perform work required under this Stipulated Order. Each Defendant shall condition any such contract upon performance of the work in conformity with the terms of this Stipulated Order.

15. In any action to enforce this Stipulated Order, no Defendant shall raise as a defense the failure by any of its officers, directors, employees, agents, or contractors to take any actions necessary to comply with the provisions of this Stipulated Order.

16. Each Defendant shall provide a copy of this Stipulated Order to any successor in interest at least 30 days prior to transfer of that interest, and simultaneously shall verify in writing to Plaintiffs that such notice has been given. Absent agreement of the Parties or order of the Court, any sale or transfer of a Defendant's interests in, or operating role with respect to, its Collection System shall not in any manner relieve that Defendant of its responsibilities for meeting the terms and conditions of this Stipulated Order.

III. OBJECTIVES

17. The objectives of this Stipulated Order are to develop measures to address excess wet weather flow associated with the East Bay Sanitary Sewer System and to address unauthorized SSOs in furtherance of the objectives of the Clean Water Act as set forth in Section 101 of the Act, 33 U.S.C. § 1251, and the objectives of the Porter-Cologne Water Quality Control Act as set forth at California Water Code Sections 13000, 13001, 13370, and 13372. The Parties recognize that the work required by this Stipulated Order will not fully resolve these issues. It is the intent of the Parties to avoid litigation and to use information developed pursuant

to this Stipulated Order to tailor a final remedy that, when implemented, will fully resolve the pending litigation.

IV. DEFINITIONS

18. Unless otherwise defined herein, terms used in this Stipulated Order shall have the meaning given to those terms in the Clean Water Act, 33 U.S.C. §§ 1251 et seq., and the regulations promulgated there-under. Whenever terms set forth below are used in this Stipulated Order, the following definitions shall apply:

"Acute Defect" shall mean a failing in a sewer pipe in need of an urgent response to address an imminent risk of an SSO.

"Amended Complaint" shall mean the complaint filed by the United States, as amended to realign the Water Boards as a Plaintiff and to add state law claims.

"Basin" shall mean the major divisions of the Satellite Collection Systems established in the East Bay I&I Study prepared by EBMUD and the Satellites from 1980-1986 ("Study"), or as modified by changes in Collection System configuration due to sewer improvements constructed since completion of the Study or more accurate delineation of the boundaries established in the Study. In general, a basin represents an area of the Collection System discharging to a single point on the EBMUD interceptor system or several points in close proximity.

"Baykeeper" shall mean San Francisco Baykeeper.

"Complaints" shall mean the Amended Complaint and the Complaint in Intervention.

"Complaint in Intervention" means the complaint filed by Baykeeper.

"Complete Renovation" shall mean that all work required by the EPA approved plan addressing a pump station or force main is complete, and the Defendant has beneficial use of all the material improvements.

"CWA" shall mean the Clean Water Act, 33 U.S.C. §§ 1251 et seq.

"Day", regardless of whether it is capitalized, shall mean a calendar day unless expressly stated to be a working day. In computing any period of time under this Stipulated Order, where the last day would fall on a Saturday, Sunday, or federal or State holiday, the period shall run until the close of business of the next working day. Wherever this Stipulated Order requires an act to be performed by a specified date (e.g., by December 31, 2011 or by August 31 of each year), and the date falls on a Saturday, Sunday, or federal or State holiday, the time for performing the act shall be extended until the close of business of the next working day.

"Deliverable" shall mean any written report or other document required to be submitted to EPA for review and approval, in consultation with the Regional Water Board, pursuant to this Stipulated Order.

"East Bay Sanitary Sewer System" shall mean, collectively, the Satellites' Collection Systems and EBMUD's interceptor system, WWFs, MWWTP and related wastewater handling facilities.

"EBMUD" shall mean East Bay Municipal Utility District.

"EBMUD SO" shall mean the Stipulated Order entered in *United States v. East Bay Municipal Utility District* by the Court on July 22, 2009, requiring EBMUD to take certain actions with regard to the East Bay Sanitary Sewer System.

"Effective Date" is that date established in Section XXII (Effective Date).

"EPA" shall mean the United States Environmental Protection Agency.

"Inflow and Infiltration" or "I&I" shall mean the introduction of storm water and groundwater into EBMUD's interceptor system, the Satellites' Collection Systems and private sewer laterals via direct connections, mis-connections, cracks and other imperfections in system pipes, joints and manholes.

"Interceptor Connection Point" shall mean a point at which a Satellite's Collection System is connected to EBMUD's interceptor system.

"Intervenor" shall mean San Francisco Baykeeper.

"MWWTP" shall mean the Muncipal Wastewater Treatment Plant located at 2020 Wake Avenue, Oakland, California, and permitted to operate under NPDES Permit No. CA0037702.

"Paragraph" shall mean a portion of this Stipulated Order identified by an Arabic numeral.

"Parties" shall mean the United States, the State Water Board, the Regional Water Board, Baykeeper and each of the Satellites.

"Plaintiffs" shall mean the United States, the State Water Board and the Regional Water Board.

"Regional Water Board" shall mean the California Regional Water Quality Control Board, San Francisco Bay Region.

"Sanitary Sewer Collection System" or "Collection System" shall mean all parts of the wastewater collection system owned or operated by a Satellite that are intended to convey domestic or industrial wastewater to EBMUD's interceptor system and wastewater treatment plants, including, without limitation, sewers, pipes, pump stations, lift stations, sewer manholes, force mains, and appurtenances to each of the above.

"Sanitary Sewer Overflow" or "SSO" shall mean an overflow, spill, or release of wastewater from a Satellite's Collection System, except that the term "Sanitary Sewer Overflow" does not include wastewater backups caused by a blockage or other malfunction in a lateral that is privately owned, but does include backups caused by blockages in a Collection System.

"Satellite" shall mean each city and district that owns or operates a Collection System from which EBMUD's interceptor system receives wastewater. As of the Effective Date, the Satellites are the cities of Alameda, Albany, Berkeley, Emeryville, Oakland, and Piedmont; and the Stege Sanitary District.

"Section" shall mean a portion of this Stipulated Order (unless another document is specified) identified by an uppercase Roman numeral.

"Sewer System Management Plans" or "SSMPs" shall mean those plans required by State Water Board Order No. 2006-003-DWQ.

"State" shall mean the State of California.

"State Water Board" shall mean the California State Water Resources Control Board.

"Stipulated Order" shall mean this Stipulated Order for Preliminary Relief.

"Sub-Basin" shall mean the subdivision of sewer basins as established in the East Bay I&I Study, or as modified by changes in Collection System configuration due to sewer improvements constructed since completion of the Study or by more accurate delineation of the boundaries established by the Study.

"United States" shall mean the United States of America.

"Water Boards" shall mean the Regional Water Board and the State Water Board.

"WWFs" shall mean EBMUD's three wet weather facilities, located at 2755 Point Isabel Street, Richmond, 225 5th Avenue, Oakland, and 5597 Oakport Street, Oakland, respectively.

"Year" shall mean the calendar year, beginning on January 1 and ending on December 31, unless otherwise specified herein.

V. WORK – GENERAL

19. The work requirements set out in Sections VI through XII below are intended to further each Defendant's ongoing efforts to improve management of its Collection System, to address SSOs, to reduce I&I in its Collection System and to develop information, which, in conjunction with information developed by EBMUD pursuant to the EBMUD SO, will assist in the development of a final remedy for the violations alleged in the Complaints. The work requirements are set out separately for each Defendant, and each Defendant is responsible only for the work described in the Section applicable to it. Where appropriate, this Stipulated Order requires work in addition to ongoing work identified in the SSMPs. The work requirements of this Stipulated Order are intended to supplement, not supersede, the SSMPs. The Defendants may need to amend their SSMPs in order to arrive at consistent obligations under the SSMPs and this Stipulated Order that are not in conflict; provided, however, that only the requirements of this Stipulated Order are enforceable, and amendments to the SSMPs are not subject to review and approval under this Stipulated Order. In addition, each Defendant is aware of Paragraph 39 of the EBMUD SO, which sets out a process by which EBMUD is developing a Collection System Asset Management Plan Template ("EBMUD Template") to be provided to the Satellites and EPA at the last of six meetings. The Satellites reserve their rights to comment on the EBMUD Template, and to submit an alternative template to EBMUD ("Alternative Template"), EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. The Satellites will provide any Alternative Template to Baykeeper at the same time they provide it to EBMUD, EPA and the Regional Water Board.

VI. WORK - CITY OF ALAMEDA

20. Maintain Current Program. The City of Alameda shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

21. Implement Improvements. The City of Alameda shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Alameda may submit a description of its program for review and approval by EPA pursuant to Section XIV.

22. Asset Management Program

A. The City of Alameda shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Alameda and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 22.B.3. At a minimum, the AMIP shall include a description of the City of Alameda's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection System maintenance protocols**, including the following:

a) A schedule for routine cleaning of the City of Alameda's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods;

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Alameda shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process; and

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10-year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII, the City of Alameda shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

23. Private Sewer Lateral Inspection and Repair or Replacement Program

A. Consistent with the requirements at Section V.C., Paragraph 29 of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Alameda has the option of submitting an application to EBMUD for a determination that the City has a private sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application").

B. By **October 15, 2010**, the City of Alameda shall:

1. If submitting a "No Less Stringent Application" as described in (A) above and defined in Section V.C., Paragraph 31 of the EBMUD SO, provide a copy of the application to EPA at the same time it is submitted to EBMUD, and include in the application, at a minimum, the following:

a) Ordinance/Code citation and date of adoption of program, or proposed amendments to the City's existing ordinance and a schedule for the adoption of the amendments;

b) Criteria under which a lateral is subject to inspection and repair or replacement;

c) Testing and performance requirements;

d) Duration of certificate issued, including differences in duration based on whether the lateral passes the test, is repaired, or undergoes replacement;

e) A statement that the City does include, as part of the application process for the permits and approvals described in subparagraph 23.A that it issues, a requirement that the applicant submit a valid Compliance Certificate;

f) A description of how the program is implemented, including the process for coordination among the following authorities: (i) the City authorities responsible for enforcing the program; (ii) the City authorities responsible for permitting activities that trigger the duty to comply with the City's private sewer lateral ordinance, including, but not limited to, City authorities responsible for building permits; and (iii) the County authorities responsible for recording transfers of title.

g) Program resources (funding and staffing);

h) A description of the record keeping system used for tracking compliance with the lateral program requirements, including, but not limited to, dates of testing, results of testing, and date and type of certificate issued; and

i) Process for enforcing violations of the ordinance, including a description of the authorities responsible for enforcing the program.

2. If not submitting a "No Less Stringent Application":

a) A description of how the City of Alameda will cooperate with EBMUD in the implementation of its private sewer lateral program within its service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

b) A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 23.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

c) A copy of an agreement, if any, between the City and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy.

C. The City of Alameda shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program, unless a No Less Stringent Application has been approved by EPA. If the City implements a building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy, the City, to satisfy the requirements of this subparagraph, shall annually document, in spreadsheet format, the building permits issued, the certificates of occupancy issued, and whether a compliance certificate was submitted prior to issuance of the certificate of occupancy.

D. If the City of Alameda continues to use its current Private Sewer Lateral Ordinance, beginning in 2012, as part of its Annual Report provided for in Section XIII, the City of Alameda shall submit information to EPA describing the effectiveness of the City's lateral replacement program. This information shall include the following:

1. Number and percent of laterals replaced since program adopted;

2. Number and percent of laterals repaired since program adopted;

3. Failure rate of laterals in testing

4. Number and percent of property owners failing to comply with testing and/or replacement provisions; and

5. Description of any enforcement actions taken for non-compliance.

E. Lower Laterals

1. Each year from 2011 to 2020, the City of Alameda shall replace 2.6 miles of sewer mains and all lower laterals associated with those sewer mains.

2. If lower laterals in a particular area are a potential source of excessive I&I, the City of Alameda shall include such considerations in its planning and scheduling for sewer main and lower lateral replacements pursuant to Paragraph 23.E.1.

3. When an event occurs that triggers inspection of an upper private sewer lateral pursuant to Alameda's private sewer lateral ordinance, the City of Alameda shall take one of the following actions with respect to the corresponding lower lateral:

a) In areas where the sewer main and lower laterals have been replaced since 1986 pursuant to the City of Alameda's Inflow & Infiltration Correction Program and Cyclic Sewer Replacement Program, no action need be taken solely as a result of a triggering event.

b) Where the property owner is in possession of a valid Compliance Certificate for the upper lateral, issued pursuant to the City's private sewer lateral ordinance, no action need be taken solely as a result of a triggering event.

c) In all other areas of the City of Alameda, the City of Alameda shall require that the lower lateral be inspected at the same time that the upper lateral is inspected pursuant to the City's private sewer lateral ordinance. The results of such inspections shall be used in planning and scheduling as set forth in subparagraph 23.E.2.

d) In addition to the elements listed in subparagraph 23.D, the City shall include the following in the Annual Report:

i) number of lower lateral inspections performed;

ii) results of the inspections; and

iii) whether main work is scheduled and/or has been conducted for any areas in which lower laterals have failed inspection.

24. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Alameda shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **July 15, 2010**, the City of Alameda submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the City of Alameda shall submit a report to EPA for review and approval pursuant to Section XIV on the activities undertaken pursuant to the Sub-Basin Flow Monitoring/I&I Assessment Plan to provide the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

25. Inflow Identification and Reduction

A. On **July 15, 2010**, the City of Alameda submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of its Annual Report provided for in Section XIII, the City of Alameda shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

26. Pump Station Reliability Certification

A. On **July 15, 2010**, the City of Alameda submitted, and EPA has reviewed and approved, a Pump Station Prioritization Plan that outlines the criteria to be used in identifying the highest priority pump station locations. The Plan will serve as the basis for establishing a schedule in which the pump stations will undergo upgrade and renovation.

B. By July 15, 2012, the City of Alameda shall submit to EPA for review and approval pursuant to Section XIV a Pump Station Renovation Plan, including a schedule and financial plan, for completing necessary repairs, renovations, and upgrades on each pump station and force main using the criteria developed in the Pump Station Prioritization Plan. The improvements shall be designed to ensure adequate capacity for peak weather flows, and to provide an automatic alarm system with SCADA communications and backup or redundant equipment (pumps and power supply) so that pump station operations can be restored in a timely manner in the event of electrical failure, mechanical failure, or power outage. The schedule and financial plan shall be sufficient to ensure completion of all improvements to High Priority pump stations identified in the Pump Station Prioritization Plan by October 15, 2022.

C. Beginning in 2013, as part of the Annual Report provided for in Section XIII, the City of Alameda shall submit information to EPA documenting pump station and force main renovations, and upgrades during the previous year, and describing projects to be completed in the next year.

27. Sewer Cleaning and Root Control Program

A. On **July 15, 2010**, the City of Alameda submitted, and EPA has reviewed and approved, a Sewer Cleaning and Root Control Plan that ensures regular cleaning of sewer pipes. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved. The Plan may be submitted in lieu of the Collection System Maintenance Protocols required by subparagraph 22.B.2 upon a determination by EPA that the Plan meets or exceeds the criteria specified in the City of Alameda's Asset Management Plan required under subparagraph 22.B.2.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Alameda shall submit information to EPA documenting activities conducted under its Sewer Cleaning and Root Control Program during the previous year, including miles of pipe cleaned as part of the routine and hot spot cleaning programs, and miles of pipe treated by each method used for controlling roots. The City shall include a description of the success of the Sewer Cleaning and Root Control Program at preventing blockages and SSOs as well as any changes to be made to the program to further reduce SSOs. If EPA determines that the City's Sewer Cleaning and Root Control Plan meets or exceeds the requirements of subparagraph 22.B.2, the reporting obligations of this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the AMIP provided for in subparagraph 22.C.

28. Annual Overflow Reports. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Alameda shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows ("Annual Overflow Report") required by the Regional Water Board. To the extent that the information is not included in the Annual Overflow Report, the City shall provide a listing of the number and location(s) of repeat SSOs, a list of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

VII. WORK – CITY OF ALBANY

29. Maintain Current Program. The City of Albany shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

30. Implement Improvements. The City of Albany shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Albany may submit a description of its program for review and approval by EPA pursuant to Section XIV.

31. Asset Management Program.

A. The City of Albany shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Albany and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 28.B.3. At a minimum, the AMIP shall include a description of the City of Albany's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection System maintenance protocols, including**:

a) A schedule for routine cleaning of the City of Albany's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods; and

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Albany shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10-year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII , the City of Albany shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

32. <u>Private Sewer Lateral Inspection and Repair or Replacement Program</u>

A. Consistent with the requirements at Section V.C., Paragraph 29 of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Albany has the option of submitting an application to EBMUD for a determination that the City has a private sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application").

B. By January 31, 2011, the City of Albany shall:

1. If submitting a "No Less Stringent Application" as described in (A) above and defined in Section V.C., Paragraph 31 of the EBMUD SO, provide a copy of the application to EPA at the same time it is submitted to EBMUD, and include in the application, at a minimum, the following:

a) Ordinance/Code citation and date of adoption of program, or proposed amendments to the City's existing ordinance and a schedule for the adoption of the amendments;

b) Criteria under which a lateral is subject to inspection and repair or replacement;

c) Testing and performance requirements;

d) Duration of certificate issued, including differences in duration based on whether the lateral passes the test, is repaired, or undergoes replacement;

e) A statement that the City does include, as part of the application process for the permits and approvals described in subparagraph 23.A that it issues, a requirement that the applicant submit a valid Compliance Certificate;

f) A description of how the program is implemented, including the process for coordination among the following authorities: (i) the City authorities responsible for enforcing the program; (ii) the City authorities responsible for permitting activities that trigger the duty to comply with the City's private sewer lateral ordinance, including, but not limited to, City authorities responsible for building permits; and (iii) the County authorities responsible for recording transfers of title.

g) Program resources (funding and staffing);

h) A description of the record keeping system used for tracking compliance with the lateral program requirements, including, but not limited to, dates of testing, results of testing, and date and type of certificate issued; and

Process for enforcing violations of the ordinance, including a description of the authorities responsible for enforcing the program

2. If not submitting a "No Less Stringent Application":

a) A description of how the City of Albany will cooperate with EBMUD in the implementation of its private sewer lateral program within its service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

b) A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 23.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

c) A copy of an agreement, if any, between the City and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy.

C. The City of Albany shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program, unless a No Less Stringent Application has been approved by EPA. If the City implements a building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy, the City, to satisfy the requirements of this subparagraph, shall annually document, in spreadsheet format, the building permits issued, the certificates of occupancy issued, and whether a compliance certificate was submitted prior to issuance of the certificate of occupancy.

D. If the City of Albany continues to use its current Private Sewer Lateral Ordinance, beginning in 2012, as part of its Annual Report provided for in Section XIII, the City of Albany shall submit information to EPA describing the effectiveness of the City's lateral replacement program. This information shall include the following:

1. Number and percent of laterals replaced since program adopted;

2. Number and percent of laterals repaired since program adopted;

3. Failure rate of laterals in testing

4. Number and percent of property owners failing to comply with testing and/or replacement provisions; and

5. Description of any enforcement actions taken for non-compliance.

E. Lower Laterals: The City of Albany shall continue its existing practice of, when replacing sewer mains, evaluating the condition of lower laterals connected to those sewer mains and replacing defective lower laterals. When the owner of a private residence is required to repair or replace its upper lateral, the City of Albany shall continue its existing practice of ensuring that the lower lateral is repaired or replaced, if needed, at the time the work is performed on the upper lateral.

33. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Albany shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **September 30, 2010**, the City of Albany submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the City of Albany shall submit a report to EPA for review and approval pursuant to Section XIV on all activities undertaken pursuant to the Sub-Basin Flow Monitoring/I&I Assessment Plan to provide the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

34. Inflow Identification and Reduction

A. On **September 30, 2010**, the City of Albany submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Albany shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

35. Computerized Maintenance Management System (MMS). On **October 15, 2010**, the City of Albany certified to EPA that the City's MMS has been linked to a Geographic Information System (GIS) map of the Collection System, which is linked to an inventory of Collection System assets that includes available information on asset age, material, dimensions, and capacities, and locations of SSOs, along with information on inspection history, condition ratings and sewers repaired, rehabilitated, or replaced.

36. Sewer Cleaning And Inspection Program

A. On **July 15, 2010**, the City of Albany submitted, and EPA has reviewed and approved, a Sewer System Cleaning and Inspection Program Plan to ensure regular cleaning of sewer pipes. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved. This Plan may be submitted in lieu of the Routine Inspection and Collection System Maintenance Protocols required by subparagraphs 31.B.1 and 31.B.2 upon a determination by EPA that the Plan meets or exceeds the criteria specified in subparagraphs 31.B.1 and 31.B.2.

B. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Albany shall submit information to EPA documenting activities conducted under its Sewer Cleaning and Inspection Program during the previous year, including miles of pipe cleaned as part of the routine and hot spot cleaning programs, and miles of pipe treated by each method used for controlling roots. The City shall include a description of any changes to be made to the program to further reduce SSOs. If EPA approves the City's Sewer Cleaning and Inspection Program in lieu of the Routine Inspection and Collection System Maintenance Protocols required by subparagraphs 31.B.1 and 31.B.2., the reporting obligations of this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the AMIP provided for in Paragraph 31.C.

37. Annual Overflow Reports. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Albany shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows ("Annual Overflow Report") required by the Regional Water Board. To the extent that the information is not included in the Annual Overflow Report,

the City shall provide a listing of the number and location(s) of repeat SSOs, a list of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

VIII. WORK – CITY OF BERKELEY

38. Maintain Current Program. The City of Berkeley shall implement the programs for controlling sewage SSOs and reducing I&I set forth in its SSMP.

39. Implement Improvements. The City of Berkeley shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Berkeley may submit a description of its program for review and approval by EPA pursuant to Section XIV.

40. Asset Management Program

A. The City of Berkeley shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Berkeley and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 39.B.3. At a minimum, the AMIP shall include a description of the City of Berkeley's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection System maintenance protocols, including**:

a) A schedule for routine cleaning of the City of Berkeley's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods;

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Berkeley shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program

("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10 year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII, the City of Berkeley shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

41. <u>Private Sewer Lateral Inspection and Repair or Replacement Program</u>

A. Consistent with the requirements at Section V.C., Paragraph 29.of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Berkeley has the option of submitting an application to EBMUD for a determination that the City has a private lateral sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application").

B. By **October 15, 2010**, the City of Berkeley shall:

1. If submitting a "No Less Stringent Application" as described in (A) above and defined in Section V.C., Paragraph 31 of the EBMUD SO, provide a copy of the application to EPA at the same time it is submitted to EMBUD, and include in the application, at a minimum, the following:

a) Ordinance/Code citation and date of adoption of program, or proposed amendments to the City's existing ordinance and a schedule for the adoption of the amendments;

b) Criteria under which a lateral is subject to inspection and repair or replacement;

c) Testing and performance requirements;

d) Duration of certificate issued, including differences in duration based on whether the lateral passes the test, is repaired, or undergoes replacement;

e) A statement that the City does include, as part of the application process for the permits and approvals described in subparagraph 41.A that it issues, a requirement that the applicant submit a valid Compliance Certificate;

f) A description of how the program is implemented including the process for coordination among the following authorities: (i) the City authorities responsible for enforcing the program; (ii) the City authorities responsible for permitting activities that trigger the duty to comply with the City's private sewer lateral ordinance, including but not limited to, City authorities responsible for building permits; and (iii) the County authorities responsible for recording transfers of title;

g) Program resources (funding and staffing);

h) A description of the record keeping system used for tracking compliance with the lateral program requirements, including but not limited to dates of testing, results of testing, and date and type of certificate issued; and

i) Process for enforcing violations of the ordinance, including a description of the authorities responsible for enforcing the program.

2. If not submitting a "No Less Stringent Application":

a) A description of how the City of Berkeley will cooperate with EBMUD in the implementation of its private sewer lateral program within its service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

b) A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 41.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

c) A copy of an agreement, if any, between the City and

EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy.

C. The City of Berkeley shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program, unless a No Less Stringent application has been approved by EPA.

D. If the City of Berkeley continues to use its current Private Sewer Lateral Ordinance, beginning in 2012, as part of its Annual Report provided for in Section XIII, the City of Berkeley shall submit information to EPA describing the effectiveness of the City's lateral replacement program. This report shall include the following information:

1. Number and percent of laterals replaced since program adopted;

2. Number and percent of laterals repaired since program adopted;

3. Failure rate of laterals in testing

4. Number and percent of property owners failing to comply with testing and/or replacement provisions; and

5. Description of any enforcement actions taken for non-compliance.

E. <u>Lower Laterals</u>

1. The City of Berkeley shall, by 2020, replace all lower laterals that have not been replaced since 1986 through its existing program of replacing lower laterals when it repairs or replaces sewer mains.

2. The City of Berkeley shall amend its existing ordinance and/or policies limiting trenching in public streets to exempt lower laterals it determines are in need of immediate replacement.

3. When the City of Berkeley learns that lower laterals in an area are potentially a source of excessive I&I, it shall include such considerations in its planning and scheduling for sewer line and lower lateral replacements.

4. When an event occurs that triggers inspection of a private sewer lateral (upper lateral) under the City's Private Sewer lateral ordinance (BMC Chapter 17.24) the

City of Berkeley shall take one of the following actions with respect to the corresponding lower lateral:

a) In areas where the sewer main and lower laterals have been replaced since 1986 pursuant to the Sewer System Evaluation Study completed in 1985 by CDM Jordan/Montgomery which was prepared in response to Order No. 86-17 issued by the California Regional Water Quality Control Board, San Francisco Bay Region, and implementing plans adopted by the City of Berkeley, no action need be taken solely as a result of the triggering event.

b) In all other areas of the City of Berkeley, the City of Berkeley shall include the corresponding lower lateral in the routine inspection program required by subparagraph 40.B.1, and shall inspect the corresponding lower lateral within 30 days of notice of the triggering event. The results of such inspections shall be used in planning and scheduling as set forth in subparagraph 41.E.3.

42. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Berkeley shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **July 15, 2010**, the City submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the City of Berkeley shall submit a report to EPA for review and approval pursuant to Section XIV on the activities performed under the Sub-Basin Flow Monitoring/I&I Assessment Plan to provide the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

43. Inflow Identification and Reduction

A. On **July 15, 2010**, the City of Berkeley submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Berkeley shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

44. Sewer Cleaning And Inspection Program

A. On **July 1, 2010**, the City of Berkeley submitted, and EPA has reviewed and approved, a Sewer System Cleaning and Inspection Program Plan to ensure regular inspection and cleaning of sewer pipes. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved. This Plan may be submitted in lieu of the Routine Inspection and Collection System Maintenance Protocols required by subparagraphs 40.B.1 and 40.B.2 upon a determination by EPA that the Plan meets or exceeds the criteria specified in subparagraphs 40.B.1 and 40.B.2.

B. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Berkeley shall provide information to EPA documenting activities conducted under its Sewer Cleaning and Inspection Program during the previous annual cycle, including miles of pipe cleaned and/or inspected as part of the routine and hot spot cleaning programs, and miles of pipe treated by each method used for controlling roots. The City shall include a description of the success of the Sewer Cleaning and Inspection Program at preventing blockages and SSOs as well as any changes to be made to the Program to further reduce SSOs. If EPA approves the Sewer Cleaning and Inspection Program in lieu of the Routine Inspection and Collection System Maintenance Protocols required by subparagraphs 40.B.1 and 40.B.2, the reporting required by this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the Asset Management Plan provided for in subparagraph 40.C.

45. <u>Computerized Maintenance Management System (MMS)</u> On **October 15, 2010,** the City of Berkeley certified to EPA that the City's MMS has been linked to a Geographic Information System (GIS) map of the Collection System, which is linked to an inventory of sewer Collection System assets that includes the available information on asset age, material, dimensions, and capacities, and locations of SSOs, along with information on inspection history, condition ratings and sewers repaired, rehabilitated, or replaced.

46. <u>Sewer Repair, Rehabilitation and Replacement</u> Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Berkeley shall submit information to EPA documenting sewer repair, rehabilitation, or replacement activities completed in the previous year; describing projects to be completed in the next year; and discussing the reductions in flows and/or SSOs that have been achieved. Beginning in 2013, this information may be

incorporated into the section of the Annual Report pertaining to implementation of the Asset Management Plan provided for in subparagraph 40.C .

47. Annual Overflow Reports. Beginning in 2010, as part of the Annual Report provided for in Section XIII, the City of Berkeley shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows ("Annual Overflow Report") required by the Regional Water Board. To the extent that the information is not included in the Annual Overflow Report, the City shall provide a listing of the number and location(s) of repeat SSOs a list of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

IX. WORK – CITY OF EMERYVILLE

48. Maintain Current Program. The City of Emeryville shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

49. Implement Improvements. The City of Emeryville shall implement improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Emeryville may submit a description of its program for review and approval by EPA pursuant to Section XIV.

50. Asset Management Program

A. The City of Emeryville shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Emeryville and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 49.B.3. At a minimum, the AMIP shall include a description of the City of Emeryville's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection system maintenance protocols, including**:

a) A schedule for routine cleaning of the City of Emeryville's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods; and

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Emeryville shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10 year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII, the City of Emeryville shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

51. <u>Private Sewer Lateral Inspection and Repair or Replacement Program</u>

A. Consistent with the requirements at Section V.C., Paragraph 29.of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Emeryville has the option of either submitting an application to EBMUD for a determination that the City has a private lateral sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application")", but has chosen to be covered under the EBMUD Regional Ordinance.

B. On **October 15, 2010**, the City of Emeryville submitted the following to EPA for review and comment (these documents do not require EPA approval):

1. Procedures for cooperating with EBMUD in the implementation of its private sewer lateral program within the City's service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

2. A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 51.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

3. A copy of an agreement, if any, between the City and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates prior to the City inspector's completion of the final inspection.

C. The City of Emeryville shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program.

D. Lower Laterals

1. The City of Emeryville shall continue its existing practice of, when replacing sewer mains, evaluating the condition of lower laterals connected to those sewer mains and replacing or requiring replacement of defective lower laterals. The City of Emeryville may issue a Compliance Certificate to the owner of any private sewer lateral whose lower lateral is replaced pursuant to this practice covering the replaced portion of the private sewer lateral.

2. By April 20, 2011, the City of Emeryville shall enact an ordinance which requires that each owner of a private sewer lateral show proof that the lower lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service.

This ordinance shall be designed to extend the application of the Regional Ordinance to lower laterals and Compliance Certificates for lower laterals shall have the same duration as Compliance Certificates provided for in the Regional Ordinance.

52. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Emeryville shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **July 30, 2010**, the City of Emeryville submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. On July 30, 2010, the City of Emeryville submitted, and EPA has reviewed and approved, a report to EPA on the activities undertaken pursuant to the Sub-Basin Flow Monitoring/I&I Assessment Plan, which includes the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

53. Inflow Identification and Reduction

A. On **July 30, 2010**, the City of Emeryville submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Emeryville shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

54. <u>SSO Response, Recordkeeping, Notification, & Reporting</u>

A. On April 15, 2010, the City of Emeryville submitted, and EPA has reviewed and approved, a Sanitary Sewer Overflow Response Plan that describes the following: (1) emergency response and contingency procedures to address SSOs from its Collection System; (2) recordkeeping procedures for maintaining SSO reports, including a procedure for linking the SSOs to the MMS; (3) procedures for notifying members of the public who may be impacted by the SSO; (4) procedures for reporting to and notifying appropriate regulatory agencies. The City of Emeryville shall ensure that agency staff and responders are adequately trained to perform the procedures outlined in the SSO response plan, and shall implement the Plan in accordance with the procedures specified in the Plan, as approved. The City shall retain appropriate records and evaluate on an annual basis agency staff's and responders' adherence to the Plan as approved, and report findings of its evaluation in the Annual Report required in Section XIII.

55. Maintenance Management System (MMS)

A. On **July 30, 2010**, the City of Emeryville submitted, and EPA has reviewed and approved, a Plan for obtaining and implementing computerized sewer maintenance management systems capable of scheduling work assignments and tracking completion of sewer cleaning, maintenance, repairs, and SSOs ("MMS Plan"). The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. By October 15, 2011, the City of Emeryville shall certify to EPA that the City's MMS has been fully implemented, and has been linked to a Geographic Information System (GIS) map of the Collection Systems, which is linked to an inventory of sewer Collection System assets that includes the information on asset age, material, dimensions, and capacities, along with information on inspection history, condition ratings and sewers repaired, rehabilitated, or replaced.

56. Sewer Pipe and Maintenance Hole Inspection

A. On April 15, 2010, the City of Emeryville submitted, and EPA reviewed and approved, a Sewer Pipe and Maintenance Hole Inspection Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved. The Plan may be submitted in lieu of the Routine Inspection provisions required by subparagraph 50.B.1 upon a determination by EPA that the Plan meets or exceeds the criteria specified in subparagraph 50.B.1.

B. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Emeryville shall submit information to EPA summarizing inspection methods and findings of the sewer pipe and maintenance hole condition assessment conducted during the previous year and the estimated miles of sewer pipe and number of maintenance holes to be inspected during the current year, along with a description of how the findings are being used to prioritize rehabilitation projects. If EPA determines that the Sewer Pipe and Maintenance Hole Inspection Plan meets or exceeds the requirements of subparagraph 50.B.1 the reporting required under this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the AMIP provided for in subparagraph 50.C.

57. Annual SSO Reports. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Emeryville shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows required by the Regional Water Board ("Annual Overflow Report"). To the extent that the information is not included in the Annual Overflow Report, the City shall provide a listing of the number and location of any repeat SSOs, a list of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

X. WORK – CITY OF OAKLAND

58. Maintain Current Program. The City of Oakland shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

59. Implement Improvements. The City of Oakland shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Oakland may submit a description of its program for review and approval by EPA pursuant to Section XIV.

60. Asset Management Program

A. The City of Oakland shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Oakland and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 60.B.3. At a minimum, the AMIP shall include a description of the City of Oakland's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection system maintenance protocols, including**:

a) A schedule for routine cleaning of the City of Oakland's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods; and

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Oakland shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10 year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII , the City of Oakland shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

61. Private Sewer Lateral Inspection and Repair or Replacement Program

A. Consistent with the requirements at Section V.C., Paragraph 29 of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Oakland has the option of submitting an application to EBMUD for a determination that the City has a private sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application"), but has elected to be covered under the EBMUD Regional Ordinance.

B. On **October 15, 2010**, the City of Oakland submitted the following to EPA for review and comment (these documents do not require EPA approval):

1. A description of how the City of Oakland will cooperate with EBMUD in the implementation of its private sewer lateral program within its service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

2. A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 61.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

3. A copy of an agreement, if any, between the City and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates prior to the City inspector's completion of the final inspection.

C. The City of Oakland shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program. If the City implements a building permit process that requires permittees to submit Compliance Certificates before the City completes its final inspection of a building remodel project as the approval triggering the Compliance Certificate requirement in the EBMUD Ordinance, the City, to satisfy the requirements of this subparagraph, shall:

1. beginning January 31, 2012, before issuing a permit or other authorization for construction or significant modification of a structure at a cost in excess of $100,000, require every recipient of such a permit or authorization to submit information, on a postcard or other format chosen by the City, to the City of Oakland including, at a minimum, the following information: property parcel number, the name and phone number of the property owner, the name, address, phone number and contractor license number (if any) of the person issued the permit, the address of the building for which the permit is issued, whether a Compliance Certificate has been issued for the property;

2. submit to EBMUD, by copies of such postcards or other means chosen by the City, the information submitted to the City pursuant to subparagraph 1 in a timely manner, and also maintain records or copies of such postcards or other submittals sent to

EBMUD under this subsection, in a segregated notebook or electronic location for inspection by EPA or other regulating agency;

3. beginning July 1, 2012, submit to EBMUD, in either electronic or hard copy format as the City chooses, a monthly log of all remodel permits for jobs greater than $100,000 where a final inspection has been completed to finalize the project; and

4. maintain records available for inspection by EBMUD or Plaintiffs, beginning January 31, 2012, of all such permits or other authorization for construction or significant modification of a structure at a cost in excess of $100,000, as well as records of all the final inspections completed for such work . Upon request of EBMUD or Plaintiffs, the City shall verify whether any particular permittee had a final inspection conducted on their remodel project.

D. Lower Laterals

1. The City of Oakland shall continue its existing practice of, when replacing sewer mains, evaluating the condition of lower laterals connected to those sewer mains and replacing or requiring replacement of defective lower laterals. The City of Oakland may establish a process to notify homeowners and/or EBMUD regarding improvements it may make to lower laterals.

2. By August 19, 2011, the City of Oakland shall enact an ordinance which extends EBMUD's Regional Ordinance to apply to lower sewer laterals. The owner of a lower sewer lateral (unless already holding a valid Compliance Certificate) shall be required to obtain a Compliance Certificate from EBMUD (a) prior to transferring title to the residential, commercial, or industrial structure, (b) prior to obtaining final inspection on any permit or other approval needed for the construction or significant modification of such structure at a cost in excess of $100,000, or (c) prior to obtaining approval from EBMUD for an increase or decrease in size of the owner's water service. It is anticipated that, in January 2012 (after a city ordinance is passed as described above), EBMUD will extend the administration of the Regional Ordinance to lower laterals in the same way as upper laterals, under its Stipulated Order with the United

States, and that EBMUD's Compliance Certificates shall cover lower laterals as well as upper laterals.

62. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Oakland shall cooperate with EBMUD in the development and implementation of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **September 30, 2010**, the City of Oakland submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/Data Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the City of Oakland shall submit a report to EPA for review and approval pursuant to Section XIV on the activities undertaken pursuant to the Sub-Basin Flow Monitoring/Data Assessment Plan. The report shall assess Sub-Basin flows and hydraulic capacity within the Sub-Basins. The assessments shall include the results of flow measurements, visual observations of flow levels and predictive flow modeling as needed to complete the report such that the report:

1. Identifies areas, sources and quantities of significant inflow to the sanitary sewer Collection System;

2. Identifies areas, sources, and quantities of significant infiltration to the Collection System;

3. Identifies any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. Provides a plan for using these results to identify and target high priority areas for repair and rehabilitation work.

D. If the work described in Subsections B and C of this Paragraph has been completed within the past ten years, the City may, by **September 30, 2010**, submit a summary of the work and recommendations to EPA in lieu of the requirements of Subsections B and C of this Paragraph.

63. Inflow Identification and Reduction

A. On **September 30, 2010**, the City of Oakland submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Oakland shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

64. SSO Response, Recordkeeping, Notification and Reporting

A. On **March 1, 2010**, the City of Oakland submitted, and EPA has reviewed and approved, a Sanitary Sewer Overflow Response Plan that describes the following: (1) emergency response and contingency procedures to address SSOs from its Collection System; (2) recordkeeping procedures for maintaining SSO reports, including a procedure for linking the SSOs to the MMS; (3) procedures for notifying members of the public who may be impacted by the SSOs; and (4) procedures for reporting to and notifying appropriate regulatory agencies. The

City of Oakland shall ensure that agency staff and responders are adequately trained to perform the procedures outlined in the SSO Response Plan, and shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved. The City shall retain appropriate records and evaluate on an annual basis agency staff's and responders' adherence to the Plan as approved, and report findings of its evaluation in the Annual Report required in Section XIII.

65. <u>Pump Station and Force Main Reliability</u>

A. By July 15, 2012, the City of Oakland shall submit a plan to EPA for review and approval pursuant to Section XIV, including a schedule and financial plan, for completing the necessary repairs, renovations, and upgrades on each pump station and force main. The improvements shall be designed to ensure adequate capacity for peak weather flows, and to provide an automatic alarm system with SCADA communications and backup or redundant equipment (pumps and power supply) so that pump station operations can be restored in a timely manner in the event of electrical failure, mechanical failure, or power outage. The schedule and financial plan shall be sufficient to ensure completion of the upgrades by October 15, 2022.

B. Beginning in 2013, as part of the Annual Report provided for in Section XIII, the City of Oakland shall submit information to EPA documenting pump station and force main renovations and upgrades during the previous year, and describing projects to be completed in the next year.

66. <u>Data Management – Maintenance Management System</u>

A. By January 15, 2011, the City of Oakland shall submit to EPA for review and approval pursuant to Section XIV a plan for obtaining and implementing computerized sewer maintenance management systems (MMS) capable of scheduling work assignments and tracking completion of sewer cleaning, maintenance, repairs and SSOs. The City shall record information on Collection System inspections, condition ratings, and sewers repaired, rehabilitated, and replaced. The MMS shall have the capability to be used to generate reports summarizing SSOs and to identify hot spots.

B. By October 15, 2011, the City of Oakland shall certify to EPA that the City's MMS is being fully implemented, and has been linked to a Geographic Information System (GIS) map of the Collection Systems, which is linked to an inventory of Collection System assets that includes information on asset age, material, dimensions and capacities, where available, along with information on inspection history, condition ratings and sewers repaired, rehabilitated, or replaced, where available.

67. Sewer Cleaning and Root Control Program

A. By July 15, 2011 the City of Oakland shall submit a plan to implement a Sewer Cleaning and Root Control Plan to ensure regular cleaning of sewer pipes. The Sewer Cleaning and Root Control Plan shall include a schedule for routine cleaning which ensures that the highest priority Collection System locations are cleaned at least once every 10 years, except that hot spot locations must be cleaned on a more frequent basis. The frequency of hot spot cleaning shall be based on a rationale, and supported by data. Records of pipe mileage cleaned shall be based on the unique length of each pipe section that was cleaned, and shall not include multiple passes through that same length of pipe. The Plan must be sufficient to eliminate or reduce blockage-related SSOs. EPA review of this Plan shall consider whether it meets or exceeds the requirements of subparagraph 60.B.2. If EPA determines that the Plan meets or exceeds the requirements of subparagraph 60.B.2, the Plan shall be deemed to satisfy the requirements of subparagraph 60.B.2. To the extent practical, EPA's review of this Plan will take into consideration any EPA comments provided pursuant to subparagraph 60.A. with regard to these criteria so that the City has the opportunity to tailor this Plan to the pertinent provisions required to be included in the AMIP.

B. Beginning in 2012, as part of its Annual Report provided for in Section XIII, the City of Oakland shall document the activities conducted under its Sewer Cleaning and Root Control Program during the previous year, including miles of pipe cleaned as part of the routine and hot spot cleaning programs, and miles of pipe treated by each method for controlling roots. The City of Oakland shall include a description of the success of the Sewer Cleaning and Root Control Program at preventing blockages and SSOs as well as any changes to be made to the Program to further reduce SSOs. If EPA determines that the Sewer Cleaning and Root Control Plan meets or exceeds the requirements of subparagraph 60.B.2, the reporting required under this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the AMIP provided for in subparagraph 60.C.

68. Sewer Pipe and Maintenance Hole Inspection

A. By July 15, 2011, the City of Oakland shall submit a Sewer Pipe and Maintenance Hole Inspection Plan to EPA for review and approval pursuant to Section XIV for periodic inspection and assessment of the condition of gravity sewers and maintenance holes throughout the City's Collection System. The Plan shall be sufficient to evaluate the condition of pipes and maintenance holes following blockage related SSOs, identify pipes and maintenance holes in need of emergency repair, and shall contain a schedule which initiates the inspection of the high priority Collection System locations at a rate of no less than 10 percent per year. The universe of high priority locations and the rate of inspection shall be based on a rationale, and supported by data. EPA's review of this Plan shall consider whether it meets or exceeds the requirements of subparagraph 60.B.1. If EPA determines that this Plan meets or exceeds the requirements of subparagraph 60.B.1, the Plan shall be deemed to satisfy the requirements of subparagraph 60.B.1. To the extent practical, EPA's review of this Plan will take into consideration any EPA comments provided pursuant to subparagraph 60.A. with regard to these criteria so that the City has the opportunity to tailor this Plan to the pertinent provisions required to be included in the AMIP.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Oakland shall submit information to EPA summarizing inspection methods and findings of the sewer pipe and maintenance hole condition assessment conducted during the previous year and the estimated miles of sewer pipe and number of maintenance holes to be inspected during the current year, along with a description of how the findings are being used to prioritize rehabilitation projects. If EPA determines that the Sewer Pipe and Maintenance Hole Inspection Program meets or exceeds the requirements of subparagraph 60.B.1, the reporting required under this subparagraph may be incorporated into the section of the Annual Report pertaining to implementation of the AMIP provided for in subparagraph 60.C.

69. Sewer Repair, Rehabilitation and Replacement Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Oakland shall submit information to EPA documenting sewer repair, rehabilitation, and/or replacement activities completed in the previous year; describing projects to be completed in the coming year; and discussing the reductions in flows and/or SSOs that have been achieved. Beginning in 2013, the reporting required under this Paragraph may be incorporated into the section of the Annual Report pertaining to implementation of the Asset Management Plan provided for in subparagraph 60.C.

70. Annual SSO Reports. Beginning in 2011, as part of the Annual Report submitted pursuant to Section XIII, the City of Oakland shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows required by the Regional Water Board ("Annual Overflow Report"). To the extent that the information is not included in the Annual Overflow Report, the City shall provide a listing of the number and location of any repeat SSOs, a list of SSOs in any areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

XI. WORK – CITY OF PIEDMONT

71. Maintain Current Program. The City of Piedmont shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

72. Implement Improvements. The City of Piedmont shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the City of Piedmont may submit a description of its program for review and approval by EPA pursuant to Section XIV.

73. Asset Management Program

A. The City of Piedmont shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The City of Piedmont and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the City as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the City shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The City may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the City. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 72.B.3. At a minimum, the AMIP shall include a description of the City of Piedmont's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection system maintenance protocols, including**:

a) A schedule for routine cleaning of the City of Piedmont's Collection System using standardized responses developed by the City to typical local problems that cause blockages such as debris, grease and roots. The City shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods; and

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the City of Piedmont shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10 year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The City shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the City to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System and reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII, the City of Piedmont shall submit information to EPA summarizing the City's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the City shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

74. Private Sewer Lateral Inspection and Repair or Replacement Program

A. Consistent with the requirements at Section V.C., Paragraph 29 of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The City of Piedmont has the option of submitting an application to EBMUD for a determination that the City has a private sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application"), but has elected to be covered under the EBMUD Regional Ordinance.

B. On **October 15, 2010**, the City of Piedmont submitted the following to EPA for review and comment (these documents do not require EPA approval):

1. A description of how the City of Piedmont will cooperate with EBMUD in the implementation of its private sewer lateral program within its service area, including a description of the responsibilities that will be assigned to each City agency or department involved in the implementation of this program;

2. A statement that the City will include, as part of the application process for permits and approvals described in subparagraph 74.A, a requirement that the applicant submit a valid EBMUD Compliance Certificate; and

3. A copy of an agreement, if any, between the City and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the City building permit process that requires permittees to submit compliance certificates prior to the City inspector's completion of the final inspection.

C. The City of Piedmont shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program. If the City implements a building permit process that requires permittees to submit compliance certificates before being issued certificates of occupancy, the City, to satisfy the requirements of this subparagraph, shall annually document, in spreadsheet format, the building permits issued, the certificates of occupancy issued, and whether a compliance certificate was submitted prior to issuance of the certificate of occupancy.

D. <u>Lower Laterals</u>

1. The City of Piedmont shall continue its existing practice of, when replacing sewer mains, evaluating the condition of lower laterals connected to those sewer mains and replacing or requiring replacement of defective lower laterals. The City of Piedmont may issue a Compliance Certificate to the owner of any private sewer lateral whose lower lateral is replaced pursuant to this practice covering the replaced portion of the private sewer lateral.

2. By February 25, 2011, the City of Piedmont shall enact an ordinance which requires that each owner of a private sewer lateral show proof that the lower lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. This ordinance shall be designed to extend the application of the Regional Ordinance to lower laterals and Compliance Certificates for lower laterals shall have the same duration as Compliance Certificates provided for in the Regional Ordinance.

75. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The City of Piedmont shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **August 31, 2010**, the City of Piedmont submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the City of Piedmont shall submit a report to EPA for review and approval pursuant to Section XIV on the activities undertaken pursuant to the Sub-Basin Flow Monitoring/I&I Assessment Plan to provide the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

76. Inflow Identification and Reduction

A. On **August 31, 2010**, the City of Piedmont submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the City will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the City of Piedmont shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner which did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

77. Computerized Maintenance Management System (MMS)

A. On **August 31, 2010**, the City of Piedmont submitted, and EPA has reviewed and approved, a Plan for improving its computerized sewer maintenance management system so that it is capable of scheduling work assignments and tracking completion of sewer cleaning, maintenance, repairs, and SSOs ("MMS Plan"). The City shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. By October 15, 2011, the City of Piedmont shall certify to EPA that the City's MMS is being fully implemented and has been linked to a Geographic Information System (GIS) map of the Collection Systems, which is linked to an inventory of sewer Collection System assets that includes the information on asset age, material, dimensions, and capacities, along with information on inspection history, condition ratings and sewers repaired, rehabilitated, or replaced.

78. Sewer Repair, Rehabilitation and Replacement Beginning in 2011, as part of the Annual Report provided for in Section XIII, the City of Piedmont shall submit information to EPA documenting sewer repair, rehabilitation, or replacement activities completed in the previous year; describing projects to be completed in the next year; and discussing the reductions in flows and/or SSOs that have been achieved. Beginning in 2013, the reporting required under this Paragraph may be incorporated into the section of the Annual Report pertaining to implementation of the Asset Management Plan provided for in subparagraph 69.C.

79. Annual Overflow Reports. Beginning in 2010, as part of the Annual Report provided for in Section XIII, the City of Piedmont shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows ("Annual Overflow Report") required by the Regional Water Board. To the extent that the information is not included in the Annual Overflow Report, the City of Piedmont shall provide a listing of the number and location(s) of repeat SSOs, a list of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future. The City shall also review the Annual Spill Report to determine whether the utilization of a vactor truck could have helped to mitigate the impact of the SSOs and include a summary of the review and provide a summary of the evaluation results.

XII. WORK – STEGE SANITARY DISTRICT

80. Maintain Current Program. The Stege Sanitary District shall implement the programs for controlling SSOs and reducing I&I set forth in its SSMP.

81. Implement Improvements. The Stege Sanitary District shall implement any improvements to its current programs needed to meet the requirements set out below in this Section. To the extent that an existing program satisfies the requirements of this Section, the Stege Sanitary District may submit a description of its program for review and approval by EPA pursuant to Section XIV.

82. Asset Management Program

A. The Stege Sanitary District shall participate and cooperate with EBMUD in the development of the EBMUD Template in accordance with the provisions of Section V.D., Paragraph 39 of the EBMUD SO. The District and Baykeeper reserve the right to comment on the EBMUD Template, and/or to submit an Alternative Template to EBMUD, EPA and the Regional Water Board, before the end of the ninety-day comment period set forth in the EBMUD SO. Upon completion of the EBMUD Template, following review of it and any other Alternative Template(s), EPA may provide comments for use as guidance by the District as the basis for the Asset Management Implementation Plan ("AMIP").

B. By July 15, 2012, the District shall submit to EPA for review and approval pursuant to Section XIV an AMIP that uses the EPA comments provided pursuant to subparagraph A above. The District may tailor the EPA comments, and may omit portions of the EPA comments that do not apply to the District. The AMIP shall be updated as necessary to incorporate any revisions to the initial inspection and maintenance schedules, and to ensure that repair, renovation and replacement projects continue to be adequately identified and planned beyond the initial time frames specified in subparagraph 81.B.3. At a minimum, the AMIP shall include a description of the District's programs for:

1. **Routine inspection of the Collection System** according to a specified schedule, and that includes the following:

a) Inspection methods to be used, including direct visual inspection and CCTV inspection, and whether CCTV equipment is owned, purchased, leased, or a combination;

b) An inspection schedule, and protocol for determining the regular time interval on which repeat inspections will be performed; and

c) A system for timely evaluation of inspection findings and documentation of the assessed condition.

2. **Collection system maintenance protocols, including**:

a) A schedule for routine cleaning of the Stege Sanitary District's Collection System using standardized responses developed by the District to typical local problems that cause blockages such as debris, grease and roots. The District shall develop its routine cleaning schedule after evaluating the cleaning needs of the Collection System;

b) A list of locations where pipe blockages and SSOs have frequently occurred (hot spots), a hot spot cleaning schedule, and procedures for adjusting the hot spot cleaning schedule based on changing conditions;

c) Preventive measures to address blockage of sewer pipes by roots, including a description of root control methods; locations where root control methods may be used within the Collection System; and a schedule for application of root control methods; and

d) A plan for staffing the sewer system cleaning and root control programs, indicating whether staffing duties will be carried out by agency staff, by staff from other agencies, or by private contractor(s). To the extent that any sewer cleaning or root control duties conducted under this program will be carried out by private contractor(s), the Stege Sanitary District shall retain on file and make available for inspection for a period of three years after the completion of work a description of each contractor and a copy of each contract, or a description of the procurement process.

e) A Quality Assurance and Quality Control Program ("QA/QC Program") to ensure proper sewer cleaning. The QA/QC Program shall include a plan for inspecting the cleaning quality, which specifies a minimum percentage of cleaned pipe to be inspected at regular intervals and a schedule for inspections, the procedures for conducting the inspections, the time interval for any necessary re-cleaning, and criteria for increasing and decreasing the frequency of inspection.

3. **Condition based repair and replacement of sewer pipe plan.** This plan shall include elimination of known improper flow connections, according to a schedule informed by the inspection results, and address both short-term (repairs of Acute Defects to occur within one year of completion of inspection and assessment) and long term repair, rehabilitation and replacement of sewer pipes. The plan shall include the following:

a) A schedule and 10 year financial plan for repair, rehabilitation, and replacement of sewer pipes. This schedule shall identify pipe reaches presently planned as priorities for rehabilitation or replacement over the next three years, with the understanding that the identified priorities are likely to be further developed and revised through the inspection and assessment process, and as a result of changed conditions. The District shall develop its schedule for repair, rehabilitation and replacement of sewer pipes using standardized responses developed by the District to observed defects, taking into account available peak flow rate data;

b) Measures to control the inflow and infiltration as needed to reduce flows in the Collection System, and to reduce the frequency of SSOs; and

c) The budget allocated for emergency repair and replacement of sewer pipe, the length of sewer pipe which underwent emergency repair and replacement during the previous year, and the cost thereof.

C. Beginning in 2013, as part of its Annual Report provided for in Section XIII , the Stege Sanitary District shall submit information to EPA summarizing the District's progress in implementing each element of the AMIP, and must include any proposed revisions to the maintenance and construction schedules along with any accompanying changes to the financial plan. If any Acute Defect has not been addressed within one year of the inspection and assessment identifying it, the District shall explain what new information or changed circumstances warrant not addressing the Acute Defect.

83. Private Sewer Lateral Inspection and Repair or Replacement Program

A. Consistent with the requirements at Section V.C., Paragraph 29 of the EBMUD SO, EBMUD adopted a Regional Private Sewer Lateral Ordinance (the "Regional Ordinance") setting standards for the performance of sewer pipes that extend from privately-owned structures to the Satellites' Collection Systems ("private sewer laterals"). The Regional Ordinance requires that each owner of a private sewer lateral show proof that the lateral meets the performance standards by obtaining (or already holding) a valid Compliance Certificate upon transfer of title of the structure, prior to obtaining a permit or other approval authorizing construction or significant modification of such structure at a cost in excess of $100,000, and prior to obtaining approval from EBMUD for a change in the size of the owner's water service. The Regional Ordinance applies only to the portion of private sewer laterals that are on the property of the owner of the privately-owned structure (the "upper lateral"). Portions of the private sewer lateral connecting the upper lateral to the sewer main on public property, including public streets, (the "lower lateral") are not addressed by the Regional Ordinance. The District has the option of submitting an application to EBMUD for a determination that the District has a private sewer lateral ordinance that is no less stringent than the Regional Ordinance ("No Less Stringent Application"), but has elected to be covered by the EBMUD Regional Ordinance.

B. On **October 15, 2010**, the Stege Sanitary District submitted the following to EPA for review and comment (these documents do not require EPA approval):

1. Procedures for cooperating with EBMUD in the implementation of its private sewer lateral program within the District's service area, including a description of the responsibilities that will be assigned to each District department involved in the implementation of this program;

2. A statement that the District will coordinate with the entities who are responsible for issuing the permits and approvals described above in subparagraph 83.A to the District's customers to insure that such permits and approvals are issued only upon presentation by the District's customers of a valid EBMUD Compliance Certificate; and

3. A copy of an agreement, if any, between the District and EBMUD regarding cooperation in the implementation of the private sewer lateral program, which may include a description of the building permit processes that require the District's customers to submit compliance certificates prior to the City inspector's completion of the final inspection.

C. The District shall provide to EBMUD the information required by and at the frequency determined necessary by EPA for implementation of the Regional Ordinance program.

D. Lower Laterals. The District's Ordinances provide that the property owner is the owner of the lower lateral and has full responsibility for its maintenance. By June 20, 2011, the District shall enact an ordinance which extends EBMUD's Regional Ordinance to apply to lower sewer laterals. Unless the property owner already has a valid Compliance Certificate, the property owner shall be required to obtain a Compliance Certificate from EBMUD (a) prior to transferring title to the residential, commercial, or industrial structure, (b) prior to obtaining any permit or other approval needed for the construction or significant modification of such structure at a cost in excess of $100,000, or (c) prior to obtaining approval from EBMUD for an increase or decrease in size of the owner's water service. It is anticipated that, in January 2012 (after a District ordinance is passed as described above), EBMUD will extend the administration of the Regional Ordinance to lower laterals in the same way as upper laterals, under its Stipulated Order with the United States, and that EBMUD's Compliance Certificates shall cover lower laterals as well as upper laterals.

84. Sub-Basin Flow Monitoring/I&I Assessment Plan

A. The Stege Sanitary District shall cooperate with EBMUD in the development of the Regional Flow Monitoring/Data Assessment Program described in Section V.A. of the EBMUD SO, and the Flow Modeling and Limits Report described in Section V.B. of the EBMUD SO.

B. On **July 15, 2010**, the Stege Sanitary District submitted, and EPA has reviewed and approved, a Sub-Basin Flow Monitoring/I&I Assessment Plan. The District shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

C. By December 1, 2012, the Stege Sanitary District shall submit a report to EPA for review and approval pursuant to Section XIV on the activities undertaken pursuant to the Sub-Basin Flow Monitoring/I&I Assessment Plan to provide the following:

1. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant infiltration to the Collection System;

2. Classification of Sub-Basins as high, medium, or low priority with regard to the relative quantities of significant inflow to the Collection System;

3. Identification of any bottlenecks in the Collection System which lack sufficient capacity to convey sewage flows through the Collection System and to the EBMUD interceptor during wet weather; and

4. A plan for using these results to identify and target high priority areas for repair and rehabilitation work.

85. <u>Inflow Identification and Reduction</u>

A. On **July 15, 2010**, the Stege Sanitary District submitted, and EPA has reviewed and approved, an Inflow Identification and Reduction Plan that describes how the Stege Sanitary District will implement a program to identify and reduce sources of direct storm water inflow, including roof leaders and drains directly connected to the Collection System, leaking manhole covers, and cross connections with storm drains. The District shall take the actions required by the Plan, in accordance with the schedules and requirements of the Plan as approved.

B. Beginning in 2012, as part of the Annual Report provided for in Section XIII, the Stege Sanitary District shall submit the following information as it becomes available on implementation of the Inflow Identification and Reduction Program:

1. Locations and results of inflow testing done the previous year including the total number of illicit connections discovered;

2. Description of follow-up actions that were conducted, including the number of illicit connections which were disconnected;

3. Description of enforcement actions taken against any property owner who did not comply with disconnection requirements;

4. Description of methods used to seal manhole covers in Collection System areas prone to flooding, and list of locations at which this work was done; and

5. A schedule for locations to be tested in the next year.

86. Documentation of SSO Response Procedures

A. On **April 15, 2010**, Stege Sanitary District submitted, and EPA has reviewed and approved, written procedures for the following:

1. Procedures to notify those who respond to SSOs during normal business hours and after business hours. The responders shall have a response goal of 60 minutes.

2. Procedures to estimate SSO volume that include more than one estimation method to be used for different SSO scenarios.

3. Procedures to determine the SSO start time. The start time shall be no later than the time at which the initial report of the SSO is made.

These procedures are enforceable under this Stipulated Order as if set forth herein.

B. Stege Sanitary District shall ensure that agency staff and responders are adequately trained to perform the SSO response procedures, and shall maintain records of training. The District shall retain appropriate records and evaluate on an annual basis agency staff's and responders' adherence to the Plan as approved, and report findings of its evaluation in the Annual Report required in Section XIII.

87. Annual SSO Reports. Beginning in 2011, as part of the Annual Report provided for in Section XIII, the Stege Sanitary District shall submit a copy to EPA of the Annual Report of Sanitary Sewer Overflows ("Annual Overflow Report") required by the Regional Water Board. To the extent that the information is not included in the Annual Overflow Report, the Stege Sanitary District shall provide a listing of the number and location(s) of repeat SSOs, a list

of any SSOs in areas in which the sewer pipes have been rehabilitated, and a description of measures that will be taken to help prevent these SSOs in the future.

XIII. ANNUAL REPORTING REQUIREMENTS

88. Timing. By March 31 of each year between the Effective Date and the Termination Date, each Defendant shall submit to Plaintiffs, with a copy to Intervenor, an annual progress report ("Annual Report").

89. Contents. Each Defendant's Annual Report shall include a summary discussion of each of the following for the period from January 1 to December 31 of the prior year:

(a) Information required to be reported in the Annual Report by the Defendant, as applicable, as set forth in Sections VI through XII, as set forth below:

i) For each Defendant, beginning in 2011: Copy of Annual Report of Sanitary Sewer Overflows, annotated as necessary.

ii) For the City of Oakland, beginning in 2011: Sewer Repair, Rehabilitation, and Replacement Program.

iii) For the City of Alameda, beginning in 2012: Sewer Cleaning and Root Control Program.

iv) For the Cities of Albany and Berkeley, beginning in 2011: Sewer Cleaning and Inspection Program.

v) For the City of Emeryville, beginning in 2011: Sewer Pipe and Maintenance Hole Inspection Program.

vi) For the Cities of Berkeley and Piedmont, beginning in 2011: Sewer Pipe Repair, and Rehabilitation Program.

vii) For each Defendant, beginning in 2012: Inflow Identification and Reduction Program.

viii) For Defendants who implement their own Private Sewer Lateral Ordinance, beginning in 2012: Private Sewer Lateral Repair and Replacement Program.

ix) For the City of Oakland, beginning in 2012: Sewer Cleaning and Root Control Program.

x) For the City of Oakland, beginning in 2012: Sewer Pipe and Maintenance Hole Inspection Program.

xi) For each Defendant, beginning in 2013: Asset Management Implementation Program.

xii) For the Cities of Alameda and Oakland, beginning in 2013: Pump Station Improvement Program Progress Report.

(b) A list of all Deliverables submitted to Plaintiffs during the reporting period, and actions taken on those Deliverables,

(c) A description of any known noncompliance with this Stipulated Order during the reporting period; and

(d) Any recommended or required changes to the work required of the Defendant by the applicable provisions of Sections VI - XII, including any proposed material modifications to any Deliverable, for the following year.

If the Annual Report documents that any of the obligations subject to stipulated penalties may not have been complied with, and the Defendant submitting the Annual Report takes the position that potentially applicable stipulated penalties should not be assessed or, pursuant to Paragraph 99, should be reduced or waived, the Defendant may include in the Annual Report an explanation as to why Plaintiffs should forego collecting such penalties; provided however that not including such information does not prejudice the Defendant from providing such or additional information to Plaintiffs or the Court in Dispute Resolution under Section XVII.

90. Each Annual Report shall be signed by an official of the Defendant and include the following certification:

> I certify under penalty of law that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gathered and presented the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that to the best of my knowledge and belief the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing and willful submission of a materially false statement.

91. The reporting requirements of this Stipulated Order do not relieve any Defendant of any reporting obligations required by the CWA or the California Water Code or their implementing regulations, or by any other federal, State, or local law, regulation, permit, or other requirement.

XIV. REVIEW AND APPROVAL OF DELIVERABLES

92. Within 90 days of submission to EPA of any Deliverable, EPA, following consultation with the Regional Water Board, shall, in writing: (a) approve the Deliverable, (b) approve the Deliverable with conditions, (c) approve part of the Deliverable and disapprove the remainder, or (d) disapprove the Deliverable. If EPA does not do one of these four things within the 90-day period, a Defendant shall have the right to invoke the procedures set forth in Section XVII (Dispute Resolution). EPA shall use its best efforts to timely respond to any Deliverable as provided for by this Paragraph and promptly communicate with an affected Defendant at such time as it becomes aware of any constraint on timely response to a Deliverable. Consistent with the requirements of Section XXI (Notices), when a Defendant submits a Deliverable to EPA for review and approval, the Defendant shall concurrently provide the Regional Water Board and Baykeeper with a copy of the Deliverable. Baykeeper shall have no more than 21 days from receipt of any Deliverable to provide written comments on the Deliverable to EPA and the Regional Water Board. If Baykeeper provides timely comments on a Deliverable, EPA will consult with Baykeeper before making a decision as to whether and/or how to approve the Deliverable. If Baykeeper does not intend to comment on a Deliverable, it will provide notice to EPA and the Regional Water Board as soon as practicable after receipt of the Deliverable.

93. If a Deliverable is approved pursuant to this Section, the Defendant shall take all actions required by the Deliverable, in accordance with the schedules and requirements of the Deliverable as approved. If the Deliverable is conditionally approved or approved only in part, the Defendant shall, upon written direction of EPA, following EPA's consultation with the Regional Water Board, take all actions required by the approved Deliverable that EPA determines are technically severable from any disapproved portions, subject to the Defendant's

right to dispute only the specified conditions or the disapproved portions, under Section XVII (Dispute Resolution).

94. If the Deliverable is disapproved in whole or in part pursuant to this Section, the Defendant shall, within 60 days or such other time as the Parties agree to in writing, correct all deficiencies and resubmit the Deliverable, or disapproved portion thereof, for approval in accordance with the preceding Paragraphs. Alternatively, the Defendant may invoke the Dispute Resolution Section of this Stipulated Order.

95. If a resubmitted Deliverable, or portion thereof, is disapproved in whole or in part, EPA, following consultation with the Regional Water Board, may again require the Defendant to correct any deficiencies in accordance with the preceding Paragraphs, subject to the Defendant's right to invoke Dispute Resolution.

XV. STIPULATED PENALTIES

96. Each Defendant shall be liable for stipulated penalties to Plaintiffs for the following violations of this Stipulated Order as specified below:

97. Delays in Submission of Deliverables and Annual Reports. Each Defendant shall be subject to the following stipulated penalties for each failure to timely submit to Plaintiffs a Deliverable or Annual Report under this Stipulated Order:

Period of Noncompliance	Penalty Per Day for Failure to Timely Submit
Days 1-15	$100
Days 16-30	$300
Days 31-60	$500
Days over 61	$2,000

98. Private Sewer Lateral Inspection and Repair or Replacement Program.

A. Each Defendant shall be subject to the following stipulated penalties for failure to timely submit either a No Less Stringent Application or a description of the Defendant's cooperation with EBMUD in implementing its private sewer lateral program consistent with the requirements of Section V.C., Paragraphs 29-30 of the EBMUD SO:

Period of Noncompliance	Penalty Per Day for Failure to Timely Submit
Days 1-30	$500
Days 31-60	$1,000
Days over 61	$1,500

B. Each Defendant shall be subject to the following stipulated penalties for failing to timely complete installation of flow meters required by its approved flow monitoring/I&I assessment plan:

Period of Noncompliance	Penalty Per Day for Failure to Timely Install
Days 1-30	$1,000
Days 31-60	$1,500
Days over 61	$2,000

C. Each Defendant shall be subject to the following stipulated penalties for failing to test the number of miles of sewers and laterals scheduled for routine inflow testing as set forth in the Defendant's approved Inflow Identification and Reduction Program in any year:

Number of Miles Not Tested	Penalty Per Mile Not Tested
Miles 1-5	$500
Miles over 5	$1,500

D. Each Defendant with an approved "No Less Stringent" application to administer its private lateral program shall be subject to the following stipulated penalties for failing to take action to require property owners to obtain a Compliance Certificate upon transfer of title of the structure, or prior to construction or significant modification of such structure as required by its approved program:

Certificates Not Obtained and No Compliance Action	Penalty Per Certificate Each Year
25 – 50 Certificates	$100

Over 50 Certificates	$200

E. Each Defendant (other than Stege Sanitary District) without an approved "No Less Stringent" application to administer its private lateral program shall be subject to the following stipulated penalties for failing to provide notice to EBMUD of property owners required to obtain a Compliance Certificate prior to construction or significant modification of such structure, unless the Defendant has in place a city building permitting process that requires a Compliance Certificate prior to receiving a final permit, and has provided EPA with a description of such process:

Notices Not Provided	Penalty Per Notice Each Year
25-50 Notices	$100 per notice over 24
Over 50 Notices	$200 per notice over 50

F. If a Defendant without an approved "No Less Stringent" application to administer its private lateral program has in place a city building permitting process that requires a Compliance Certificate prior to receiving a final inspection and has provided EPA with a description of such process, such a Defendant shall be subject to the following stipulated penalties for conducting final inspections without first requiring a Compliance Certificate:

Final Inspections Conducted Without First Requiring Compliance Certificate	Penalty Per Inspection Each Year
25-50 inspections	$100 per inspection over 24
Over 50 inspections	$200 per inspection over 50

G. The City of Alameda shall be subject to the following stipulated penalties for failing to timely Complete Renovation of each pump station as required by its Pump Station Renovation Plan:

Period of Noncompliance	Penalty Per Day Per Pump Station
Days 1-15	$0

Days 16-90	$500
Days over 90	$1,500

H. The City of Oakland shall be subject to the following stipulated penalties for failing to timely Complete Renovation of each pump station and force main as required by its approved Pump Station and Force Main Renovation Plan:

Period of Noncompliance	Penalty Per Day Per Pump Station
Days 1-15	$0
Days 16-90	$500
Days over 90	$1,500

I. The City of Albany and the City of Berkeley shall be subject to the following stipulated penalties for each percentage point below 20% of its Collection System it fails to clean or inspect in any year:

Percent Below 20%	Penalty Per % Per Year
1%-5%	$1,000
5%-10%	$2,500
10%-20%	$7,500

J. The City of Alameda shall be subject to the following stipulated penalties for failing in any year to clean the pipe mileage required by its approved Sewer Cleaning and Root Control Program:

Required Mileage Not Cleaned	Penalty Per Mile Not Cleaned
5 miles to 50 miles	$500
Over 50 miles	$2,000

K. The City of Oakland shall be subject to the following stipulated penalties for failing in any year to clean the pipe mileage required by its approved Sewer Cleaning and Root Control Program:

Required Mileage Not Cleaned	Penalty Per Mile Not Cleaned
5 miles to 50 miles	$500
Over 50 miles	$2,000

99. Stipulated penalties under this Section shall begin to accrue on the day after performance is due or on the day a violation subject to stipulated penalties occurs, whichever is applicable, and shall continue to accrue until performance is satisfactorily completed or until the violation ceases. Either Plaintiff may, in the un-reviewable exercise of its discretion, reduce or waive stipulated penalties otherwise due to it under this Stipulated Order. Any Defendant may provide information for consideration as to whether a violation resulted from events outside the control of the Defendant on whom the penalty may be imposed, and the effect of the amount of the penalty on that Defendant's ability to comply with the requirements of this Stipulated Order.

100. A Defendant shall pay stipulated penalties to the United States and the Regional Water Board within 30 days of receiving a written demand from either Plaintiff, or both jointly; only one demand shall be made. The Defendant shall pay fifty percent (50%) of the total stipulated penalty amount due to the United States, and fifty percent (50%) to the Regional Water Board, using the penalty payment procedures set forth in the following Paragraph. Plaintiffs may modify these payment procedures through written notice to Defendants. Any demand for payment of a stipulated penalty shall be simultaneously sent to all other parties.

101. Defendants shall pay stipulated penalties owing to the United States by FedWire Electronic Funds Transfer ("EFT") to the U.S. Department of Justice, in accordance with written instructions to be provided to Defendants by the Financial Litigation Unit of the U.S. Attorney's Office for the Northern District of California, 450 Golden Gate Avenue, 11th Floor, San Francisco, CA 94102. At the time of payment, Defendants shall send a copy of the EFT authorization form and the EFT transaction record, together with a transmittal letter, which shall

state that the payment is for stipulated penalties owed pursuant to the Stipulated Order in *United States et al. v. City of Alameda, et al.*, and shall reference the civil action number and DOJ Case No. 90-5-1-1-09361/1, to the United States in accordance with Section XXI of this Stipulated Order (Notices); by email to acctsreceivable.CINWD@epa.gov; and by mail to:

EPA Cincinnati Finance Office
26 Martin Luther King Drive
Cincinnati, OH 45268

Defendants shall pay stipulated penalties owing to the Regional Water Board by sending a certified check or warrant payable to "California Regional Water Quality Control Board, San Francisco Bay Region." At the time of payment, Defendant shall state in its transmittal letter that the payment is for stipulated penalties owed pursuant to the Stipulated Order in *United States et al. v. City of Alameda, et al.*, and shall address it to:

Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

102. If any Defendant fails to pay stipulated penalties according to the terms of this Stipulated Order, that Defendant shall be liable for interest on such penalties, as provided for in 28 U.S.C. § 1961, accruing as of the date payment became due, subject to Paragraph 103 below. Nothing in this Paragraph shall be construed to limit the United States or the Regional Water Board from seeking any remedy otherwise provided by law for a Defendant's failure to pay any stipulated penalties.

103. Upon receipt of a written demand for payment of a stipulated penalty, a Defendant may dispute its liability for such stipulated penalty pursuant to the Dispute Resolution Section of this Stipulated Order. Pending resolution of any such dispute, stipulated penalties continue to accrue if the obligation at issue has not been met and interest on any unpaid penalties accrues pursuant to the terms of the preceding Paragraph; provided that Defendants may argue to the Court that stipulated penalties shall not run after the matter has been fully briefed. Upon the completion of dispute resolution, any stipulated penalties that are ultimately determined to be due, plus interest as applicable, shall be paid within 30 days of (1) the date a motion must be

filed under Paragraph 112 if the Defendant does not initiate Judicial Dispute Resolution pursuant to Paragraph 112, or (2) any Court order directing payment.

104. The payment of stipulated penalties shall not alter in any way a Defendant's obligation to complete the performance of all activities required under this Stipulated Order. Payment of stipulated penalties pursuant to this Section shall be in addition to any other rights or remedies that shall be available to Plaintiffs by reason of a Defendant's failure to comply with the requirements of this Stipulated Order, or any other applicable federal, State or local laws, regulations, NPDES permits, and all other applicable permits. Where a violation of this Order is also a violation of the Clean Water Act, or comparable State law, the Defendant shall be allowed a credit for any stipulated penalties paid against any statutory penalties imposed for such violation. The payment of stipulated penalties under this Stipulated Order shall not be deemed an admission of a violation of any law, regulation, or any Defendant's NPDES permit.

XVI. FORCE MAJEURE

105. A "force majeure event" is any event beyond the control of a Defendant, its contractors, or any entity controlled by a Defendant that delays the performance of any obligation under this Stipulated Order despite the Defendant's best efforts to fulfill the obligation. "Best efforts" includes anticipating reasonably foreseeable force majeure events and taking appropriate preventive actions before a force majeure event occurs. "Best efforts" also includes addressing the effects of any force majeure event (a) as it is occurring and (b) after it has occurred, to prevent or minimize any resulting delay to the extent reasonably practicable. "Force Majeure" does not include a Defendant's financial inability to perform any obligation under this Stipulated Order.

106. A Defendant shall provide written notice, as provided in Section XXI of this Stipulated Order (Notices), within 30 days of the time a Defendant first knew of, or by the exercise of due diligence, should have known of, a claimed force majeure event. The notice shall state the anticipated duration of any delay, its cause(s), the Defendant's past and proposed actions to prevent or minimize any delay, a schedule for carrying out those actions, and the Defendant's rationale for attributing any delay to a force majeure event. Failure to provide

written notice as required by this Paragraph shall preclude the Defendant from asserting any claim of force majeure.

107. If EPA, following consultation with the Regional Water Board, agrees that a force majeure event has occurred, it may agree to extend the time for a Defendant to perform the affected requirements for the time necessary to complete those obligations. An extension of time to perform the obligations affected by a force majeure event shall not, by itself, extend the time to perform any other obligation. Where EPA, following consultation with the Regional Water Board, agrees to an extension of time, the appropriate modification shall be made pursuant to Section XXIV of this Stipulated Order (Modification).

108. If EPA, following consultation with the Regional Water Board, does not agree that a force majeure event has occurred, or does not agree to the extension of time sought by a Defendant, EPA's position shall be binding, unless the Defendant invokes Dispute Resolution under Section XVII of this Stipulated Order. In any such dispute, the Defendant bears the burden of proving, by a preponderance of the evidence, that each claimed force majeure event is a force majeure event, that the Defendant gave the notice required hereunder, that the force majeure event caused any delay the Defendant claims was attributable to that event, and that the Defendant exercised best efforts to prevent or minimize any delay caused by the event.

XVII. DISPUTE RESOLUTION

109. Unless otherwise expressly provided for in this Stipulated Order, all disputes under this Stipulated Order are subject to dispute resolution, and the dispute resolution procedures of this Section shall be the exclusive mechanism to resolve disputes arising under or with respect to this Stipulated Order. However, such procedures shall not apply to actions by the United States and the Regional Water Board to enforce obligations of the Satellites that have not been disputed in accordance with this Section.

110. Informal Dispute Resolution. Any dispute subject to dispute resolution under this Stipulated Order shall first be the subject of informal negotiations. The dispute shall be considered to have arisen when a Defendant or Baykeeper sends Plaintiffs a written notice of dispute ("Notice of Dispute"). Such Notice of Dispute shall state clearly the matter in dispute.

The period of informal negotiations shall not exceed 20 days from the date the Notice of Dispute was sent, unless that period is modified by written agreement. If the Parties cannot resolve a dispute by informal negotiations, then the position advanced by the United States; or, in the case of a demand for stipulated penalties made solely by the Regional Water Board, the position advanced by the Regional Water Board, shall be considered binding unless, within 30 days after the conclusion of the informal negotiation period, the Defendant or Baykeeper invokes the dispute resolution procedures as set forth in the following Paragraph.

111. Formal Dispute Resolution. A Defendant or Baykeeper shall invoke the dispute resolution procedures of this Paragraph within the time period provided in the preceding Paragraph by serving on Plaintiffs (with a copy to the other Parties) a written statement of position ("Statement of Position") regarding the matter in dispute. The Statement of Position shall include, but may not necessarily be limited to, any factual data, analysis, or opinion supporting the position and any supporting documentation relied upon by the Defendant or Baykeeper. The Defendant may argue that no stipulated penalties or interest should be imposed.

A. As to all disputes other than disputes concerning demand for stipulated penalties made solely by the Regional Water Board, EPA, following consultation with the Regional Water Board, shall serve the United States' Statement of Position within 45 days after service of a Defendant's Statement of Position. Any Defendant may also serve a Statement of Position responsive to Baykeeper or to another Defendant during this period. The United States' Statement of Position shall include, but may not necessarily be limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by the United States and the Regional Water Board. The United States' Statement of Position shall be binding unless the Defendant or Baykeeper files a motion for judicial review of the dispute in accordance with the following Paragraphs. If the United States does not serve a Statement of Position within the specified time period, the Party invoking dispute resolution may initiate Judicial Dispute Resolution under Paragraph 112.

B. As to a dispute concerning a demand for stipulated penalties made solely by the Regional Water Board, the Regional Water Board shall serve its Statement of Position within 45 days after service of a Defendant's Statement of Position. The Regional Water Board's Statement of Position shall include, but may not necessarily be limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by the Regional Water Board. The Regional Water Board's Statement of Position shall be binding unless the Defendant files a motion for judicial review of the dispute in accordance with the following Paragraphs. If the Regional Water Board does not serve a Statement of Position within the specified time period, the Party invoking dispute resolution may initiate judicial dispute resolution under Paragraph 112.

112. Judicial Dispute Resolution. A Defendant or Baykeeper may seek judicial review of the dispute against Plaintiffs by filing with the Court and serving on Plaintiffs (with copies to the other Parties in accordance with Section XXI - Notices), a motion requesting judicial resolution of the dispute. The motion must be filed within 60 days after service of the Statement of Position by the United States or the Regional Water Board pursuant to the preceding Paragraph or within 60 days after the Statement of Position was due. The motion shall contain a written statement of the Defendant's or Baykeeper's position on the matter in dispute, as set forth in its Statement of Position, including any supporting factual data, analysis, opinion, or documentation, and shall set forth the relief requested and any schedule within which the dispute must be resolved for orderly implementation of this Stipulated Order. The United States, the Water Boards, and any other non-moving party participating in the dispute shall have at least 60 days in which to respond to Defendant's or Baykeeper's motion. The Defendant or Baykeeper may file a reply memorandum to the extent permitted by the Local Rules.

113. In any dispute in District Court under this Section XVII, the Court shall first rule on the dispute (if any) between the Defendant and the United States (or the Regional Water Board in the case of a dispute under Paragraph 111(B)). If the Defendant's position prevails over the United States' or the Regional Water Board's position as to any issue, the dispute resolution as to that issue shall end. If the position of the United States or the Regional Water Board prevails over the position of the Defendant, the Court shall then consider any remaining dispute between the United States or the Regional Water Board and Baykeeper.

114. Except as otherwise provided in this Stipulated Order, in any dispute in District Court under this Section XVII, a Defendant shall bear the burden of demonstrating by a preponderance of the evidence that the Defendant's position on the issues in dispute best complies with this Stipulated Order and better furthers the Objectives of this Stipulated Order. In any dispute in District Court under this Section XVII, Baykeeper shall bear the burden of demonstrating that the United States' position is arbitrary and capricious.

115. Effect on Stipulated Order Obligations. The invocation of dispute resolution procedures under this Section shall not, by itself, extend, postpone, or affect in any way any obligation of a Defendant under this Stipulated Order, unless and until the final resolution of the dispute so provides. Stipulated penalties with respect to the disputed matter shall continue to accrue from the first day of noncompliance, but payment shall be stayed pending resolution of the dispute as provided in Section XV. If a Defendant does not prevail on the disputed issue, stipulated penalties shall be assessed and paid as provided in Section XV.

XVIII. INFORMATION COLLECTION AND RETENTION

116. Plaintiffs and their representatives, including attorneys, contractors, and consultants, shall have the right of entry on Defendants' property at all reasonable times, upon presentation of credentials, to:

A. monitor the progress of activities required under this Stipulated Order;

B. verify any data or information submitted to Plaintiffs in accordance with the terms of this Stipulated Order;

C. obtain documentary evidence, including photographs and similar data; and

D. assess a Defendant's compliance with this Stipulated Order.

117. Until the termination of this Stipulated Order and any subsequent order or decree entered in this matter, Defendants shall retain, and shall instruct its contractors and agents to preserve, unless prohibited by law, all final versions of records and documents (including records or documents in electronic form) in its or its contractors' or agents' possession or control, or that come into its or its contractors' or agents' possession or control, that document a Defendant's performance of its obligations under this Stipulated Order. This record retention requirement

shall apply regardless of any Defendant, corporate, or institutional document-retention policy to the contrary. At any time during this record-retention period, Plaintiffs may request copies of any documents or records required to be maintained under this Paragraph.

118. This Stipulated Order in no way limits or affects any right of entry and inspection, or any right to obtain information, held by Plaintiffs pursuant to applicable federal or State laws, regulations, or permits, nor does it limit or affect any duty or obligation of Defendants to maintain records or information imposed by applicable federal or State laws, regulations, or permits.

XIX. EFFECT OF SETTLEMENT/RESERVATION OF RIGHTS

119. This Stipulated Order is a partial remedy for the civil claims of the United States, the Water Boards and Baykeeper for the violations alleged in the Complaints filed in this action. Therefore, this Stipulated Order does not resolve these civil claims and is without prejudice to the rights of the United States, the Water Boards and Baykeeper to seek further relief to address these claims or any future claims, including, but not limited to, further injunctive relief, and civil penalties, and the right of the United States and the Water Boards to seek further administrative relief to address these claims. The Parties intend to negotiate a subsequent agreement to resolve the civil claims of the United States, the Water Boards and Baykeeper for the violations alleged in the Complaints. However, the Parties recognize that such negotiations may not result in agreement and that the United States, the Water Boards and Baykeeper reserve the right to take such actions as they deem appropriate and necessary to resolve these claims and any future claims. In this and any subsequent administrative or judicial proceeding initiated by the United States, the Water Boards and/or Baykeeper for injunctive relief, civil penalties, or other appropriate relief relating to Defendants' compliance with the Clean Water Act and/or the California Water Code, the Parties shall not assert that another Party's claims or defenses in such subsequent administrative or judicial proceeding are barred or waived solely because the Party entered into this Stipulated Order and did not raise such claims or defenses in the instant case.

120. The Parties have concurrently filed, with this Stipulated Order, a Stipulation and Proposed Order for Stay of Proceedings ("Proposed Stay Order"). Upon entry of the Proposed

Stay Order, further proceedings on the claims in the Complaints will be stayed until this Stipulated Order is terminated as to any Defendant under Section XXV (Termination) and the Court issues an order lifting the stay as to that Defendant, except for motions filed with this Court by Baykeeper for interim attorneys' fees and costs, and any opposition filed by Defendants in response to such motions. This Stipulated Order will not take effect unless the Proposed Stay Order is granted in substantially the form filed with the Court.

121. This Stipulated Order also does not resolve the claims of the Water Boards for litigation costs (including attorneys fees) pursuant to Cal. Code Civ. Proc. § 1021.8.

122. The United States, the Water Boards, and Baykeeper reserve all legal and equitable remedies available to enforce the provisions of this Stipulated Order. This Stipulated Order shall not be construed to prevent or limit the rights of the United States, the Water Boards, or Baykeeper to obtain penalties or injunctive relief under the CWA or implementing regulations, or under other federal or State laws, regulations, or permit conditions. Defendants reserve all legal and equitable defenses to the allegations in the Complaints, except to the extent they are waived for purposes of entering into and implementing this Stipulated Order.

123. This Stipulated Order is not a permit, or a modification of any permit, under any federal, State, or local laws or regulations. Defendants are responsible for achieving and maintaining complete compliance with all applicable federal, State, and local laws, regulations, and permits. The United States, the Water Boards and Baykeeper do not, by their consent to the entry of this Stipulated Order, warrant or aver in any manner that Defendants' compliance with any aspect of this Stipulated Order will result in compliance with provisions of the CWA or the California Water Code.

124. Nothing in this Stipulated Order shall constitute an admission of any fact or of any liability or a waiver of any right unless explicitly set forth herein. EPA, the Water Boards and Defendants agree that, from the commencement of this action through the termination of this Stipulated Order, Plaintiffs are "diligently prosecuting" this action as that term is used in CWA § 505(b)(1)(B), 33 U.S.C. §1365(b)(1)(B). Baykeeper contends that whether Plaintiffs are diligently prosecuting this action will remain a question of fact dependent on future

circumstances. Baykeeper agrees that it will not file any collateral action under CWA Section 505 until after termination of this Stipulated Order, and after the stay imposed by the Court under the Proposed Stay Order is lifted.

125. This Stipulated Order does not limit or affect the rights of Defendants, Baykeeper, or the Plaintiffs against any third parties not party to this Stipulated Order, nor does it limit the rights of third parties not party to this Stipulated Order against Defendants, except as otherwise provided by law.

126. This Stipulated Order shall not be construed to create rights in, or grant any cause of action to, any third party not party to this Stipulated Order.

127. Nothing in this Stipulated Order shall limit Defendants' ability to modify its program for the design, planning, construction, operation, and maintenance of its facilities in any fashion not inconsistent with this Stipulated Order.

128. Upon entry of this Stipulated Order, EPA Administrative Orders Docket Nos. CWA 309(a)-10-005 through CWA 309(a)-10-011, issued to Defendants on November 18, 2009, are terminated without any further action on the part of EPA. Any submission by a Defendant pursuant to the terms of its above-referenced Administrative Order that has not yet been approved, or has been approved subject to conditions by EPA, shall be treated as a Deliverable pursuant to the terms of this Stipulated Order.

XX. COSTS

129. The Parties (except Baykeeper) shall bear their own costs of this action, including attorneys' fees, except Plaintiffs shall be entitled to collect the costs (including attorneys' fees) incurred in any action necessary to collect any stipulated penalties due but not paid by a Defendant (for the purposes of this Paragraph, stipulated penalties are not "due" until after the conclusion of dispute resolution proceedings regarding the stipulated penalties pursuant to the Dispute Resolution Section of this Stipulated Order, if any). Baykeeper's right, if any, to attorneys' fees and costs under 33 U.S.C. §1365(d) related to this Action will be resolved by motion in this Action.

XXI. NOTICES

130. A Defendant shall provide Baykeeper and the Water Boards with a copy of any report, notice, or Deliverable submitted to EPA under this Stipulated Order at the time it submits the document to EPA. Unless otherwise specified herein, whenever notifications, submissions, or communications are required by this Stipulated Order they shall be made in writing and addressed as follows:

A. To EPA:

Chief, Clean Water Act Compliance Office (WTR-7), Water Division
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

B. To the Regional Water Board:

Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

and

John Davidson
Supervising Deputy Attorney General
455 Golden Gate Avenue, Suite 11000
San Francisco, CA 94102

C. To the United States:

Chief, Clean Water Act Compliance Office (WTR-7), Water Division
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

and

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
Box 7611 Ben Franklin Station
Washington, D.C. 20044-7611
Re: DOJ No. 90-5-1-1-09361/1

D. To the State Water Board:

Executive Director
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

E. To Plaintiffs:

To the United States and the Water Boards as indicated in "B," "C" and "D" above.

F. To City of Alameda

Donna Mooney, Acting City Attorney
City of Alameda
2263 Santa Clara Avenue, Room 280
Alameda, CA 94501
(510) 747-4750
DMOONEY@ci.alameda.ca.us

and

Matthew T. Naclerio, Director of Public Works
City of Alameda
City Hall West
950 W. Mall Square, Room 110
Alameda, CA 94501
(510) 749-5840
mnaclerio@ci.alameda.ca.us

G. To City of Albany

Robert Zweben
Law Offices of
1730 Solano Avenue
Berkeley, CA 94707
(510) 528-5858
rjzlaw@aol.com

and

Richard Cunningham, Public Works Manager
City of Albany
1000 San Pablo Avenue
Albany, CA 947006
(510) 524-9543
rcunningham@albanyca.org

H. To City of Berkeley

Claudette Ford

Director of Public Works
2180 Milvia Street
Third Floor
Berkeley, CA 94704

and

Zach Cowan
City Attorney
2180 Milvia Street
Fourth Floor
Berkeley, CA 94704

I. To City of Emeryville

Michael G. Biddle, City Attorney
City of Emeryville
1333 Park Avenue
Emeryville, CA 94608
mbiddle@emeryville.org

J. To City of Oakland

John Russo, City Attorney
Celso Dolores Ortiz, Deputy City Attorney
City of Oakland
One Frank Ogawa Plaza, 6th Floor
Oakland, CA 94612
(510) 510-238-6236
COrtiz@oaklandcityattorney.org

and

Marilee J. Allan
Bingham McCutchen LLP
Three Embarcadero Center
San Francisco, CA 94111-4067
(415) 393-2364
marilee.allan@bingham.com

K. To City of Piedmont

Thomas R. Curry, Esq.
Burke, Williams & Sorensen LLP
1901 Harrison Street, Suite 900
Oakland, CA 94612-3501

(510) 273-8780
tcurry@bwslaw.com

and

Geoffrey Grote
City Administrator
City of Piedmont
120 Vista Avenue
Piedmont, CA 94611
(510) 420-3042
ggrote@ci.piedmont.ca.us

and

Chester Nakahara
Acting Public Works Director
City of Piedmont
120 Vista Avenue
Piedmont, CA 94611
(510) 420-3062
cnakahara@ci.piedmont.ca.us

L. To Stege Sanitary District

Doug Humphrey, District Manager
7500 Schmidt Lane
El Cerrito, CA 94530-0537
(510) 524-4668
doug@stegesd.dst.ca.us

and

Kenton L. Alm
Meyers, Nave, Riback, Silver & Wilson
555 12th Street, Suite 1500
Oakland, CA 94607
(510) 808-2081
kalm@meyersnave.com

M. Baykeeper

Jason Flanders, Staff Attorney
San Francisco Baykeeper
785 Market St., Ste. 850
San Francisco, CA 94103
Jason@Baykeeper.org (email delivery only preferred)

and

Christopher A. Sproul

Environmental Advocates
5135 Anza Street
San Francisco, CA 94121
csproul@enviroadvocates.com (email delivery only preferred)

131. Any Party may, by written notice to the other Parties, change its designated notice recipient(s) or notice address(es) provided above.

132. Notices submitted pursuant to this Section shall be deemed submitted upon mailing or emailing, unless otherwise provided in this Stipulated Order or by mutual agreement of the Parties in writing.

XXII. EFFECTIVE DATE

133. The Effective Date of this Stipulated Order shall be the date upon which this Stipulated Order is entered by the Court or a motion to enter is granted, whichever occurs first, as recorded on the Court's docket; provided however, that this Stipulated Order will not take effect unless the Proposed Stay Order is granted in substantially the form filed with the Court, as provided in Paragraph 120. Defendants hereby agree that they shall be bound to perform duties scheduled to occur prior to the Effective Date. In the event that the United States withdraws or withholds consent to this Stipulated Order prior to entry, or the Court declines to enter the Stipulated Order, then the preceding requirement to perform duties scheduled to occur before the Effective Date shall terminate.

XXIII. RETENTION OF JURISDICTION

134. The Court shall retain jurisdiction over this case for the purpose of resolving disputes arising under this Stipulated Order pursuant to the Dispute Resolution Section of this Stipulated Order, entering orders modifying this Stipulated Order pursuant to the Modification Section of this Stipulated Order, or effectuating or enforcing compliance with the terms of this Stipulated Order.

XXIV. MODIFICATION

135. The terms of this Stipulated Order may be modified by a subsequent written agreement signed by all the Parties. Where the modification would constitute a material change to any term of this Stipulated Order, the modification shall be effective only upon approval by

the Court. Extensions of time and modifications to Deliverables shall not be construed as material changes to this Stipulated Order. Any disputes concerning modification shall be resolved pursuant to Section XVII of this Stipulated Order (Dispute Resolution); provided, however, that instead of the burden of proof provided by Paragraph 114, the Party seeking the modification bears the burden of demonstrating that it is entitled to the requested modification in accordance with Federal Rule of Civil Procedure 60(b).

XXV. TERMINATION

136. EPA, following consultation with the Regional Water Board, may seek to terminate this Stipulated Order at any time after January 1, 2013, should EPA determine in writing that this Stipulated Order cannot be effectively implemented to accomplish the objectives of this Stipulated Order, as set forth in Section III and Paragraph 19. If a Defendant or Baykeeper objects to termination of this Stipulated Order pursuant to this Paragraph, it may invoke Section XVII (Dispute Resolution).

137. A Defendant may move the Court to terminate its own obligations under this Stipulated Order. However, no Defendant shall seek to terminate its obligations under this Stipulated Order prior to approval of its AMIP (either directly by Plaintiffs or indirectly as a result of a Dispute Resolution process pursuant to Section XVII). If, following the approval of a Defendant's AMIP, Plaintiffs and that Defendant cannot agree as to whether this Stipulated Order should be terminated as to that Defendant, the Defendant may move the Court for relief from this Stipulated Order. Any Defendant seeking to terminate its obligations under this Stipulated Order shall provide a report on the status of its compliance with this Stipulated Order to accompany such motion to terminate. The Court shall decide the motion to terminate under the standard of review articulated in Paragraph 114. If the Court grants a Defendant's motion to terminate its obligations under this Stipulated Order, this Stipulated Order shall remain in full effect with respect to the other Defendants.

138. Notwithstanding Paragraphs 136 and 137, the Parties may jointly move to terminate this Stipulated Order with the approval of the Court. Each Defendant shall provide a

report on the status of its compliance with this Stipulated Order to accompany any such motion to terminate.

139. No Defendant shall seek relief from this Stipulated Order unless it certifies to Plaintiffs and the Court that there are no outstanding stipulated penalty assessments pending pursuant to this Stipulated Order. This shall in no way constrain the ability of the Parties to enter into a subsequent agreement regarding the Defendants' Collection Systems.

XXVI. PUBLIC PARTICIPATION

140. This Stipulated Order shall be lodged with the Court for a period of not less than 30 days for public notice and comment in accordance with 28 C.F.R. § 50.7. Plaintiffs reserve the right to withdraw or withhold their consent if comments regarding this Stipulated Order disclose facts or considerations indicating that this Stipulated Order is inappropriate, improper, or inadequate. Each Defendant consents to entry of this Stipulated Order without further notice.

XXVII. SIGNATORIES/SERVICE

141. Each undersigned representative of each Defendant, the Water Boards, Baykeeper, and the Assistant Attorney General for the Environment and Natural Resources Division of the Department of Justice certifies that he or she is fully authorized to enter into the terms and conditions of this Stipulated Order and to execute and legally bind the Party he or she represents to this document.

142. This Stipulated Order may be signed in counterparts, and its validity shall not be challenged on that basis.

XXVIII. INTEGRATION

143. This Stipulated Order constitutes the final, complete, and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Stipulated Order, and this Stipulated Order supersedes all prior agreements and understandings, whether oral or written, concerning the settlement embodied herein. Other than Deliverables that are subsequently submitted pursuant to this Stipulated Order, and the concurrently-filed Proposed Stay Order, no other document and no other representation, inducement, agreement,

understanding, or promise constitutes any part of this Stipulated Order or the settlement it represents, nor shall they be used in construing the terms of this Stipulated Order.

XXIX. HEADINGS

144. Headings to the sections and subsections of this Stipulated Order are provided for convenience and do not affect the meaning or interpretation of the provisions of this Stipulated Order.

XXX. PARTIAL JUDGMENT

145. Upon approval and entry of this Stipulated Order by the Court, this Stipulated Order shall constitute a partial judgment of the Court as to the Parties. The Parties recognize that final resolution of the claims set forth in the Complaints will require further remedial action, and this Stipulated Order is without prejudice to the Parties' positions as to the merits of any such further relief.

Dated and entered this ___ day of ____________________, 2011.

____
UNITED STATES DISTRICT JUDGE
Northern District of California

WE HEREBY CONSENT to the entry of this Stipulated Order, subject to the public notice and comment provisions of 28 C.F.R. § 50.7:

For Plaintiff the United States of America:

Dated: 3/6/11

Ignacia S. Moreno

IGNACIA S. MORENO
Assistant Attorney General
Environment and Natural Resources Division
U.S. Department of Justice

PATRICIA L. HURST
Trial Attorney
Environmental Enforcement Section
U.S. Department of Justice
P.O. Box 7611
Ben Franklin Station
Washington, D.C. 20044-7611

Attorneys for Plaintiff, United States of America

WE HEREBY CONSENT to the entry of this Stipulated Order, subject to the public notice and comment provisions of 28 C.F.R. § 50.7:

For Plaintiff the United States of America (cont'd):

Dated: 2-28-11

MARK POLLINS, Director
Water Enforcement Division
Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency

JARED BLUMENFELD
Regional Administrator
U.S. Environmental Protection Agency, Region 9

Of Counsel:
HUGH BARROLL
Assistant Regional Counsel
U.S. Environmental Protection Agency, Region 9

WE HEREBY CONSENT to the entry of this Stipulated Order, subject to the public notice and comment provisions of 28 C.F.R. § 50.7:

For Plaintiff the United States of America (cont'd):

Dated: ______________________

____
MARK POLLINS, Director
Water Enforcement Division
Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency

____
JARED BLUMENFELD 3/8/11
Regional Administrator
U.S. Environmental Protection Agency, Region 9

Of Counsel:
HUGH BARROLL
Assistant Regional Counsel
U.S. Environmental Protection Agency, Region 9

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region:

KAMALA D. HARRIS
Attorney General of the State of California

Dated: 2/4/11

JOHN DAVIDSON
Supervising Deputy Attorney General
455 Golden Gate Avenue, Suite 11000
San Francisco, CA 94102

Attorneys for Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region

Dated: ____________________

BRUCE H. WOLFE
Executive Officer
California Regional Water Quality Control Board, San Francisco Bay Region

Dated: ____________________

THOMAS HOWARD
Executive Director
California State Water Resources Control Board

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region:

KAMALA D. HARRIS
Attorney General of the State of California

Dated: ______________________

____
JOHN DAVIDSON
Supervising Deputy Attorney General
455 Golden Gate Avenue, Suite 11000
San Francisco, CA 94102

Attorneys for Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region

Dated: 3/2/11

Bruce H. Wolfe
BRUCE H. WOLFE
Executive Officer
California Regional Water Quality Control Board, San Francisco Bay Region

Dated: ______________________

____
THOMAS HOWARD
Executive Director
California State Water Resources Control Board

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region:

KAMALA D. HARRIS
Attorney General of the State of California

Dated: ____________________

____
JOHN DAVIDSON
Supervising Deputy Attorney General
455 Golden Gate Avenue, Suite 11000
San Francisco, CA 94102

Attorneys for Plaintiff People of the State of California ex rel. California State Water Resources Control Board and California Regional Water Quality Control Board, San Francisco Bay Region

Dated: ____________________

____
BRUCE H. WOLFE
Executive Officer
California Regional Water Quality Control Board, San Francisco Bay Region

Dated: 3/3/2011

Thomas Howard
THOMAS HOWARD
Executive Director
California State Water Resources Control Board

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: 1/26/11 ______________________ By: Donna Mooney
Acting City Attorney

For Defendant City of Albany:

Dated: ______________________ By: Robert Zweben
City Attorney

For Defendant City of Berkeley:

Dated: ______________________ By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: ______________________ By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: ______________________ By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: ______________________ By: Geoffrey Grote
City Administrator

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: ____________________

By: Donna Mooney
Acting City Attorney

For Defendant City of Albany:

Dated: 2-28-11

By: Kenton L. Alm
Special Counsel

For Defendant City of Albany:

Dated: 3/1/2011

By: Richard Cunningham
City of Albany

For Defendant City of Berkeley:

Dated: ____________________

By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: ____________________

By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: ____________________

By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: ____________________

By: Geoffrey Grote
City Administrator

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: ______________________ ______________________________
By: Teresa L. Highsmith
City Attorney

For Defendant City of Albany:

Dated: ______________________ ______________________________
By: Robert Zweben
City Attorney

For Defendant City of Berkeley:

Dated: 1/5/11 ______________________________
By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: ______________________ ______________________________
By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: ______________________ ______________________________
By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: ______________________ ______________________________
By: Geoffrey Grote
City Administrator

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: ____________________ ____________________________________
By: Teresa L. Highsmith
City Attorney

For Defendant City of Albany:

Dated: ____________________ ____________________________________
By: Robert Zweben
City Attorney

For Defendant City of Berkeley:

Dated: ____________________ ____________________________________
By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: 1/5/2011 Michael G. Biddle
By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: ____________________ ____________________________________
By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: ____________________ ____________________________________
By: Geoffrey Grote
City Administrator

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: ____________________ ____________________

By: Donna Mooney
Acting City Attorney

For Defendant City of Albany:

Dated: ____________________ ____________________

By: Robert Zweben
City Attorney

For Defendant City of Berkeley:

Dated: ____________________ ____________________

By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: ____________________ ____________________

By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: 3/1/11 ____________________

By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: ____________________ ____________________

By: Geoffrey Grote
City Administrator

WE HEREBY CONSENT to the entry of this Stipulated Order:

For Defendant City of Alameda:

Dated: ____________________

By: Donna Mooney
Acting City Attorney

For Defendant City of Albany:

Dated: ____________________

By: Robert Zweben
City Attorney

For Defendant City of Berkeley:

Dated: ____________________

By: Zach Cowan
City Attorney

For Defendant City of Emeryville:

Dated: ____________________

By: Michael G. Biddle
City Attorney

For Defendant City of Oakland:

Dated: ____________________

By: Dan Lindheim
City Administrator

For Defendant City of Piedmont:

Dated: 1/21/11

By: Geoffrey Grote
City Administrator

For San Francisco Baykeeper:

Dated: 2/23/2011

By: Jason Flanders
Staff Attorney, San Francisco Baykeeper

For San Francisco Baykeeper:

Dated: ______________________

By: Deb Self
Executive Director

For Defendant Stege Sanitary District:

Dated: 2/9/11

By: Douglas Humphrey
District Manager

APPENDIX B – SWRCB GENERAL WASTE DISCHARGE REQUIREMENTS ORDER NO. 2006-0003

STATE WATER RESOURCES CONTROL BOARD
ORDER NO. 2006-0003-DWQ

STATEWIDE GENERAL WASTE DISCHARGE REQUIREMENTS
FOR
SANITARY SEWER SYSTEMS

The State Water Resources Control Board, hereinafter referred to as "State Water Board", finds that:

1. All federal and state agencies, municipalities, counties, districts, and other public entities that own or operate sanitary sewer systems greater than one mile in length that collect and/or convey untreated or partially treated wastewater to a publicly owned treatment facility in the State of California are required to comply with the terms of this Order. Such entities are hereinafter referred to as "Enrollees".

2. Sanitary sewer overflows (SSOs) are overflows from sanitary sewer systems of domestic wastewater, as well as industrial and commercial wastewater, depending on the pattern of land uses in the area served by the sanitary sewer system. SSOs often contain high levels of suspended solids, pathogenic organisms, toxic pollutants, nutrients, oxygen-demanding organic compounds, oil and grease and other pollutants. SSOs may cause a public nuisance, particularly when raw untreated wastewater is discharged to areas with high public exposure, such as streets or surface waters used for drinking, fishing, or body contact recreation. SSOs may pollute surface or ground waters, threaten public health, adversely affect aquatic life, and impair the recreational use and aesthetic enjoyment of surface waters.

3. Sanitary sewer systems experience periodic failures resulting in discharges that may affect waters of the state. There are many factors (including factors related to geology, design, construction methods and materials, age of the system, population growth, and system operation and maintenance), which affect the likelihood of an SSO. A proactive approach that requires Enrollees to ensure a system-wide operation, maintenance, and management plan is in place will reduce the number and frequency of SSOs within the state. This approach will in turn decrease the risk to human health and the environment caused by SSOs.

4. Major causes of SSOs include: grease blockages, root blockages, sewer line flood damage, manhole structure failures, vandalism, pump station mechanical failures, power outages, excessive storm or ground water inflow/infiltration, debris blockages, sanitary sewer system age and construction material failures, lack of proper operation and maintenance, insufficient capacity and contractor-caused damages. Many SSOs are preventable with adequate and appropriate facilities, source control measures and operation and maintenance of the sanitary sewer system.

SEWER SYSTEM MANAGEMENT PLANS

5. To facilitate proper funding and management of sanitary sewer systems, each Enrollee must develop and implement a system-specific Sewer System Management Plan (SSMP). To be effective, SSMPs must include provisions to provide proper and efficient management, operation, and maintenance of sanitary sewer systems, while taking into consideration risk management and cost benefit analysis. Additionally, an SSMP must contain a spill response plan that establishes standard procedures for immediate response to an SSO in a manner designed to minimize water quality impacts and potential nuisance conditions.

6. Many local public agencies in California have already developed SSMPs and implemented measures to reduce SSOs. These entities can build upon their existing efforts to establish a comprehensive SSMP consistent with this Order. Others, however, still require technical assistance and, in some cases, funding to improve sanitary sewer system operation and maintenance in order to reduce SSOs.

7. SSMP certification by technically qualified and experienced persons can provide a useful and cost-effective means for ensuring that SSMPs are developed and implemented appropriately.

8. It is the State Water Board's intent to gather additional information on the causes and sources of SSOs to augment existing information and to determine the full extent of SSOs and consequent public health and/or environmental impacts occurring in the State.

9. Both uniform SSO reporting and a centralized statewide electronic database are needed to collect information to allow the State Water Board and Regional Water Quality Control Boards (Regional Water Boards) to effectively analyze the extent of SSOs statewide and their potential impacts on beneficial uses and public health. The monitoring and reporting program required by this Order and the attached Monitoring and Reporting Program No. 2006-0003-DWQ, are necessary to assure compliance with these waste discharge requirements (WDRs).

10. Information regarding SSOs must be provided to Regional Water Boards and other regulatory agencies in a timely manner and be made available to the public in a complete, concise, and timely fashion.

11. Some Regional Water Boards have issued WDRs or WDRs that serve as National Pollution Discharge Elimination System (NPDES) permits to sanitary sewer system owners/operators within their jurisdictions. This Order establishes minimum requirements to prevent SSOs. Although it is the State Water Board's intent that this Order be the primary regulatory mechanism for sanitary sewer systems statewide, Regional Water Boards may issue more stringent or more

prescriptive WDRs for sanitary sewer systems. Upon issuance or reissuance of a Regional Water Board's WDRs for a system subject to this Order, the Regional Water Board shall coordinate its requirements with stated requirements within this Order, to identify requirements that are more stringent, to remove requirements that are less stringent than this Order, and to provide consistency in reporting.

REGULATORY CONSIDERATIONS

12. California Water Code section 13263 provides that the State Water Board may prescribe general WDRs for a category of discharges if the State Water Board finds or determines that:

    - The discharges are produced by the same or similar operations;
    - The discharges involve the same or similar types of waste;
    - The discharges require the same or similar treatment standards; and
    - The discharges are more appropriately regulated under general discharge requirements than individual discharge requirements.

    This Order establishes requirements for a class of operations, facilities, and discharges that are similar throughout the state.

13. The issuance of general WDRs to the Enrollees will:
    a) Reduce the administrative burden of issuing individual WDRs to each Enrollee;
    b) Provide for a unified statewide approach for the reporting and database tracking of SSOs;
    c) Establish consistent and uniform requirements for SSMP development and implementation;
    d) Provide statewide consistency in reporting; and
    e) Facilitate consistent enforcement for violations.

14. The beneficial uses of surface waters that can be impaired by SSOs include, but are not limited to, aquatic life, drinking water supply, body contact and non-contact recreation, and aesthetics. The beneficial uses of ground water that can be impaired include, but are not limited to, drinking water and agricultural supply. Surface and ground waters throughout the state support these uses to varying degrees.

15. The implementation of requirements set forth in this Order will ensure the reasonable protection of past, present, and probable future beneficial uses of water and the prevention of nuisance. The requirements implement the water quality control plans (Basin Plans) for each region and take into account the environmental characteristics of hydrographic units within the state. Additionally, the State Water Board has considered water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect

water quality in the area, costs associated with compliance with these requirements, the need for developing housing within California, and the need to develop and use recycled water.

16. The Federal Clean Water Act largely prohibits any discharge of pollutants from a point source to waters of the United States except as authorized under an NPDES permit. In general, any point source discharge of sewage effluent to waters of the United States must comply with technology-based, secondary treatment standards, at a minimum, and any more stringent requirements necessary to meet applicable water quality standards and other requirements. Hence, the unpermitted discharge of wastewater from a sanitary sewer system to waters of the United States is illegal under the Clean Water Act. In addition, many Basin Plans adopted by the Regional Water Boards contain discharge prohibitions that apply to the discharge of untreated or partially treated wastewater. Finally, the California Water Code generally prohibits the discharge of waste to land prior to the filing of any required report of waste discharge and the subsequent issuance of either WDRs or a waiver of WDRs.

17. California Water Code section 13263 requires a water board to, after any necessary hearing, prescribe requirements as to the nature of any proposed discharge, existing discharge, or material change in an existing discharge. The requirements shall, among other things, take into consideration the need to prevent nuisance.

18. California Water Code section 13050, subdivision (m), defines nuisance as anything which meets all of the following requirements:
    a. Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
    b. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.
    c. Occurs during, or as a result of, the treatment or disposal of wastes.

19. This Order is consistent with State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality of Waters in California) in that the Order imposes conditions to prevent impacts to water quality, does not allow the degradation of water quality, will not unreasonably affect beneficial uses of water, and will not result in water quality less than prescribed in State Water Board or Regional Water Board plans and policies.

20. The action to adopt this General Order is exempt from the California Environmental Quality Act (Public Resources Code §21000 et seq.) because it is an action taken by a regulatory agency to assure the protection of the environment and the regulatory process involves procedures for protection of the environment. (Cal. Code Regs., tit. 14, §15308). In addition, the action to adopt

this Order is exempt from CEQA pursuant to Cal.Code Regs., title 14, §15301 to the extent that it applies to existing sanitary sewer collection systems that constitute "existing facilities" as that term is used in Section 15301, and §15302, to the extent that it results in the repair or replacement of existing systems involving negligible or no expansion of capacity.

21. The Fact Sheet, which is incorporated by reference in the Order, contains supplemental information that was also considered in establishing these requirements.

22. The State Water Board has notified all affected public agencies and all known interested persons of the intent to prescribe general WDRs that require Enrollees to develop SSMPs and to report all SSOs.

23. The State Water Board conducted a public hearing on February 8, 2006, to receive oral and written comments on the draft order. The State Water Board received and considered, at its May 2, 2006, meeting, additional public comments on substantial changes made to the proposed general WDRs following the February 8, 2006, public hearing. The State Water Board has considered all comments pertaining to the proposed general WDRs.

IT IS HEREBY ORDERED, that pursuant to California Water Code section 13263, the Enrollees, their agents, successors, and assigns, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted hereunder, shall comply with the following:

A. DEFINITIONS

1. **Sanitary sewer overflow (SSO)** - Any overflow, spill, release, discharge or diversion of untreated or partially treated wastewater from a sanitary sewer system. SSOs include:
   (i) Overflows or releases of untreated or partially treated wastewater that reach waters of the United States;
   (ii) Overflows or releases of untreated or partially treated wastewater that do not reach waters of the United States; and
   (iii) Wastewater backups into buildings and on private property that are caused by blockages or flow conditions within the publicly owned portion of a sanitary sewer system.

2. **Sanitary sewer system** – Any system of pipes, pump stations, sewer lines, or other conveyances, upstream of a wastewater treatment plant headworks used to collect and convey wastewater to the publicly owned treatment facility. Temporary storage and conveyance facilities (such as vaults, temporary piping, construction trenches, wet wells, impoundments, tanks, etc.) are considered to be part of the sanitary sewer system, and discharges into these temporary storage facilities are not considered to be SSOs.

For purposes of this Order, sanitary sewer systems include only those systems owned by public agencies that are comprised of more than one mile of pipes or sewer lines.

3. **Enrollee** - A federal or state agency, municipality, county, district, and other public entity that owns or operates a sanitary sewer system, as defined in the general WDRs, and that has submitted a complete and approved application for coverage under this Order.

4. **SSO Reporting System** – Online spill reporting system that is hosted, controlled, and maintained by the State Water Board. The web address for this site is http://ciwqs.waterboards.ca.gov. This online database is maintained on a secure site and is controlled by unique usernames and passwords.

5. **Untreated or partially treated wastewater** – Any volume of waste discharged from the sanitary sewer system upstream of a wastewater treatment plant headworks.

6. **Satellite collection system** – The portion, if any, of a sanitary sewer system owned or operated by a different public agency than the agency that owns and operates the wastewater treatment facility to which the sanitary sewer system is tributary.

7. **Nuisance** - California Water Code section 13050, subdivision (m), defines nuisance as anything which meets all of the following requirements:
   a. Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
   b. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.
   c. Occurs during, or as a result of, the treatment or disposal of wastes.

B. APPLICATION REQUIREMENTS

1. Deadlines for Application – All public agencies that currently own or operate sanitary sewer systems within the State of California must apply for coverage under the general WDRs within six (6) months of the date of adoption of the general WDRs. Additionally, public agencies that acquire or assume responsibility for operating sanitary sewer systems after the date of adoption of this Order must apply for coverage under the general WDRs at least three (3) months prior to operation of those facilities.

2. Applications under the general WDRs – In order to apply for coverage pursuant to the general WDRs, a legally authorized representative for each agency must submit a complete application package. Within sixty (60) days of adoption of the general WDRs, State Water Board staff will send specific instructions on how to

apply for coverage under the general WDRs to all known public agencies that own sanitary sewer systems. Agencies that do not receive notice may obtain applications and instructions online on the Water Board's website.

3. Coverage under the general WDRs – Permit coverage will be in effect once a complete application package has been submitted and approved by the State Water Board's Division of Water Quality.

C. PROHIBITIONS

1. Any SSO that results in a discharge of untreated or partially treated wastewater to waters of the United States is prohibited.

2. Any SSO that results in a discharge of untreated or partially treated wastewater that creates a nuisance as defined in California Water Code Section 13050(m) is prohibited.

D. PROVISIONS

1. The Enrollee must comply with all conditions of this Order. Any noncompliance with this Order constitutes a violation of the California Water Code and is grounds for enforcement action.

2. It is the intent of the State Water Board that sanitary sewer systems be regulated in a manner consistent with the general WDRs. Nothing in the general WDRs shall be:

   (i) Interpreted or applied in a manner inconsistent with the Federal Clean Water Act, or supersede a more specific or more stringent state or federal requirement in an existing permit, regulation, or administrative/judicial order or Consent Decree;
   (ii) Interpreted or applied to authorize an SSO that is illegal under either the Clean Water Act, an applicable Basin Plan prohibition or water quality standard, or the California Water Code;
   (iii) Interpreted or applied to prohibit a Regional Water Board from issuing an individual NPDES permit or WDR, superseding this general WDR, for a sanitary sewer system, authorized under the Clean Water Act or California Water Code; or
   (iv) Interpreted or applied to supersede any more specific or more stringent WDRs or enforcement order issued by a Regional Water Board.

3. The Enrollee shall take all feasible steps to eliminate SSOs. In the event that an SSO does occur, the Enrollee shall take all feasible steps to contain and mitigate the impacts of an SSO.

4. In the event of an SSO, the Enrollee shall take all feasible steps to prevent untreated or partially treated wastewater from discharging from storm drains into

flood control channels or waters of the United States by blocking the storm drainage system and by removing the wastewater from the storm drains.

5. All SSOs must be reported in accordance with Section G of the general WDRs.

6. In any enforcement action, the State and/or Regional Water Boards will consider the appropriate factors under the duly adopted State Water Board Enforcement Policy. And, consistent with the Enforcement Policy, the State and/or Regional Water Boards must consider the Enrollee's efforts to contain, control, and mitigate SSOs when considering the California Water Code Section 13327 factors. In assessing these factors, the State and/or Regional Water Boards will also consider whether:

   (i) The Enrollee has complied with the requirements of this Order, including requirements for reporting and developing and implementing a SSMP;

   (ii) The Enrollee can identify the cause or likely cause of the discharge event;

   (iii) There were no feasible alternatives to the discharge, such as temporary storage or retention of untreated wastewater, reduction of inflow and infiltration, use of adequate backup equipment, collecting and hauling of untreated wastewater to a treatment facility, or an increase in the capacity of the system as necessary to contain the design storm event identified in the SSMP. It is inappropriate to consider the lack of feasible alternatives, if the Enrollee does not implement a periodic or continuing process to identify and correct problems.

   (iv) The discharge was exceptional, unintentional, temporary, and caused by factors beyond the reasonable control of the Enrollee;

   (v) The discharge could have been prevented by the exercise of reasonable control described in a certified SSMP for:
   - Proper management, operation and maintenance;
   - Adequate treatment facilities, sanitary sewer system facilities, and/or components with an appropriate design capacity, to reasonably prevent SSOs (e.g., adequately enlarging treatment or collection facilities to accommodate growth, infiltration and inflow (I/I), etc.);
   - Preventive maintenance (including cleaning and fats, oils, and grease (FOG) control);
   - Installation of adequate backup equipment; and
   - Inflow and infiltration prevention and control to the extent practicable.

   (vi) The sanitary sewer system design capacity is appropriate to reasonably prevent SSOs.

(vii) The Enrollee took all reasonable steps to stop and mitigate the impact of the discharge as soon as possible.

7. When a sanitary sewer overflow occurs, the Enrollee shall take all feasible steps and necessary remedial actions to 1) control or limit the volume of untreated or partially treated wastewater discharged, 2) terminate the discharge, and 3) recover as much of the wastewater discharged as possible for proper disposal, including any wash down water.

   The Enrollee shall implement all remedial actions to the extent they may be applicable to the discharge and not inconsistent with an emergency response plan, including the following:

   (i) Interception and rerouting of untreated or partially treated wastewater flows around the wastewater line failure;
   (ii) Vacuum truck recovery of sanitary sewer overflows and wash down water;
   (iii) Cleanup of debris at the overflow site;
   (iv) System modifications to prevent another SSO at the same location;
   (v) Adequate sampling to determine the nature and impact of the release; and
   (vi) Adequate public notification to protect the public from exposure to the SSO.

8. The Enrollee shall properly, manage, operate, and maintain all parts of the sanitary sewer system owned or operated by the Enrollee, and shall ensure that the system operators (including employees, contractors, or other agents) are adequately trained and possess adequate knowledge, skills, and abilities.

9. The Enrollee shall allocate adequate resources for the operation, maintenance, and repair of its sanitary sewer system, by establishing a proper rate structure, accounting mechanisms, and auditing procedures to ensure an adequate measure of revenues and expenditures. These procedures must be in compliance with applicable laws and regulations and comply with generally acceptable accounting practices.

10. The Enrollee shall provide adequate capacity to convey base flows and peak flows, including flows related to wet weather events. Capacity shall meet or exceed the design criteria as defined in the Enrollee's System Evaluation and Capacity Assurance Plan for all parts of the sanitary sewer system owned or operated by the Enrollee.

11. The Enrollee shall develop and implement a written Sewer System Management Plan (SSMP) and make it available to the State and/or Regional Water Board upon request. A copy of this document must be publicly available at the Enrollee's office and/or available on the Internet. This SSMP must be approved by the Enrollee's governing board at a public meeting.

12. In accordance with the California Business and Professions Code sections 6735, 7835, and 7835.1, all engineering and geologic evaluations and judgments shall be performed by or under the direction of registered professionals competent and proficient in the fields pertinent to the required activities. Specific elements of the SSMP that require professional evaluation and judgments shall be prepared by or under the direction of appropriately qualified professionals, and shall bear the professional(s)' signature and stamp.

13. The mandatory elements of the SSMP are specified below. However, if the Enrollee believes that any element of this section is not appropriate or applicable to the Enrollee's sanitary sewer system, the SSMP program does not need to address that element. The Enrollee must justify why that element is not applicable. The SSMP must be approved by the deadlines listed in the SSMP Time Schedule below.

Sewer System Management Plan (SSMP)

(i) **Goal**: The goal of the SSMP is to provide a plan and schedule to properly manage, operate, and maintain all parts of the sanitary sewer system. This will help reduce and prevent SSOs, as well as mitigate any SSOs that do occur.

(ii) **Organization**: The SSMP must identify:

(a) The name of the responsible or authorized representative as described in Section J of this Order.

(b) The names and telephone numbers for management, administrative, and maintenance positions responsible for implementing specific measures in the SSMP program. The SSMP must identify lines of authority through an organization chart or similar document with a narrative explanation; and

(c) The chain of communication for reporting SSOs, from receipt of a complaint or other information, including the person responsible for reporting SSOs to the State and Regional Water Board and other agencies if applicable (such as County Health Officer, County Environmental Health Agency, Regional Water Board, and/or State Office of Emergency Services (OES)).

(iii) **Legal Authority:** Each Enrollee must demonstrate, through sanitary sewer system use ordinances, service agreements, or other legally binding procedures, that it possesses the necessary legal authority to:

(a) Prevent illicit discharges into its sanitary sewer system (examples may include I/I, stormwater, chemical dumping, unauthorized debris and cut roots, etc.);

(b) Require that sewers and connections be properly designed and constructed;

(c) Ensure access for maintenance, inspection, or repairs for portions of the lateral owned or maintained by the Public Agency;

(d) Limit the discharge of fats, oils, and grease and other debris that may cause blockages, and

(e) Enforce any violation of its sewer ordinances.

(iv) **Operation and Maintenance Program**. The SSMP must include those elements listed below that are appropriate and applicable to the Enrollee's system:

(a) Maintain an up-to-date map of the sanitary sewer system, showing all gravity line segments and manholes, pumping facilities, pressure pipes and valves, and applicable stormwater conveyance facilities;

(b) Describe routine preventive operation and maintenance activities by staff and contractors, including a system for scheduling regular maintenance and cleaning of the sanitary sewer system with more frequent cleaning and maintenance targeted at known problem areas. The Preventative Maintenance (PM) program should have a system to document scheduled and conducted activities, such as work orders;

(c) Develop a rehabilitation and replacement plan to identify and prioritize system deficiencies and implement short-term and long-term rehabilitation actions to address each deficiency. The program should include regular visual and TV inspections of manholes and sewer pipes, and a system for ranking the condition of sewer pipes and scheduling rehabilitation. Rehabilitation and replacement should focus on sewer pipes that are at risk of collapse or prone to more frequent blockages due to pipe defects. Finally, the rehabilitation and replacement plan should include a capital improvement plan that addresses proper management and protection of the infrastructure assets. The plan shall include a time schedule for implementing the short- and long-term plans plus a schedule for developing the funds needed for the capital improvement plan;

(d) Provide training on a regular basis for staff in sanitary sewer system operations and maintenance, and require contractors to be appropriately trained; and

(e) Provide equipment and replacement part inventories, including identification of critical replacement parts.

(v) **Design and Performance Provisions**:

(a) Design and construction standards and specifications for the installation of new sanitary sewer systems, pump stations and other appurtenances; and for the rehabilitation and repair of existing sanitary sewer systems; and

(b) Procedures and standards for inspecting and testing the installation of new sewers, pumps, and other appurtenances and for rehabilitation and repair projects.

(vi) **Overflow Emergency Response Plan -** Each Enrollee shall develop and implement an overflow emergency response plan that identifies measures to protect public health and the environment. At a minimum, this plan must include the following:

(a) Proper notification procedures so that the primary responders and regulatory agencies are informed of all SSOs in a timely manner;

(b) A program to ensure an appropriate response to all overflows;

(c) Procedures to ensure prompt notification to appropriate regulatory agencies and other potentially affected entities (e.g. health agencies, Regional Water Boards, water suppliers, etc.) of all SSOs that potentially affect public health or reach the waters of the State in accordance with the MRP. All SSOs shall be reported in accordance with this MRP, the California Water Code, other State Law, and other applicable Regional Water Board WDRs or NPDES permit requirements. The SSMP should identify the officials who will receive immediate notification;

(d) Procedures to ensure that appropriate staff and contractor personnel are aware of and follow the Emergency Response Plan and are appropriately trained;

(e) Procedures to address emergency operations, such as traffic and crowd control and other necessary response activities; and

(f) A program to ensure that all reasonable steps are taken to contain and prevent the discharge of untreated and partially treated wastewater to waters of the United States and to minimize or correct any adverse impact on the environment resulting from the SSOs, including such accelerated or additional monitoring as may be necessary to determine the nature and impact of the discharge.

(vii) **FOG Control Program:** Each Enrollee shall evaluate its service area to determine whether a FOG control program is needed. If an Enrollee determines that a FOG program is not needed, the Enrollee must provide justification for why it is not needed. If FOG is found to be a problem, the Enrollee must prepare and implement a FOG source control program to reduce the amount of these substances discharged to the sanitary sewer system. This plan shall include the following as appropriate:

(a) An implementation plan and schedule for a public education outreach program that promotes proper disposal of FOG;

(b) A plan and schedule for the disposal of FOG generated within the sanitary sewer system service area. This may include a list of acceptable disposal facilities and/or additional facilities needed to adequately dispose of FOG generated within a sanitary sewer system service area;

(c) The legal authority to prohibit discharges to the system and identify measures to prevent SSOs and blockages caused by FOG;

(d) Requirements to install grease removal devices (such as traps or interceptors), design standards for the removal devices, maintenance requirements, BMP requirements, record keeping and reporting requirements;

(e) Authority to inspect grease producing facilities, enforcement authorities, and whether the Enrollee has sufficient staff to inspect and enforce the FOG ordinance;

(f) An identification of sanitary sewer system sections subject to FOG blockages and establishment of a cleaning maintenance schedule for each section; and

(g) Development and implementation of source control measures for all sources of FOG discharged to the sanitary sewer system for each section identified in (f) above.

(viii) **System Evaluation and Capacity Assurance Plan**: The Enrollee shall prepare and implement a capital improvement plan (CIP) that will provide hydraulic capacity of key sanitary sewer system elements for dry weather peak flow conditions, as well as the appropriate design storm or wet weather event. At a minimum, the plan must include:

(a) **Evaluation**: Actions needed to evaluate those portions of the sanitary sewer system that are experiencing or contributing to an SSO discharge caused by hydraulic deficiency. The evaluation must provide estimates of peak flows (including flows from SSOs that escape from the system) associated with conditions similar to those causing overflow events, estimates of the capacity of key system components, hydraulic deficiencies (including components of the system with limiting capacity) and the major sources that contribute to the peak flows associated with overflow events;

(b) **Design Criteria:** Where design criteria do not exist or are deficient, undertake the evaluation identified in (a) above to establish appropriate design criteria; and

(c) **Capacity Enhancement Measures:** The steps needed to establish a short- and long-term CIP to address identified hydraulic deficiencies, including prioritization, alternatives analysis, and schedules. The CIP may include increases in pipe size, I/I reduction programs, increases and redundancy in pumping capacity, and storage facilities. The CIP shall include an implementation schedule and shall identify sources of funding.

(d) **Schedule:** The Enrollee shall develop a schedule of completion dates for all portions of the capital improvement program developed in (a)-(c) above. This schedule shall be reviewed and updated consistent with the SSMP review and update requirements as described in Section D. 14.

(ix) **Monitoring, Measurement, and Program Modifications:** The Enrollee shall:

(a) Maintain relevant information that can be used to establish and prioritize appropriate SSMP activities;

(b) Monitor the implementation and, where appropriate, measure the effectiveness of each element of the SSMP;

(c) Assess the success of the preventative maintenance program;

(d) Update program elements, as appropriate, based on monitoring or performance evaluations; and

(e) Identify and illustrate SSO trends, including: frequency, location, and volume.

(x) **SSMP Program Audits** - As part of the SSMP, the Enrollee shall conduct periodic internal audits, appropriate to the size of the system and the number of SSOs. At a minimum, these audits must occur every two years and a report must be prepared and kept on file. This audit shall focus on evaluating the effectiveness of the SSMP and the

Enrollee's compliance with the SSMP requirements identified in this subsection (D.13), including identification of any deficiencies in the SSMP and steps to correct them.

(xi) **Communication Program** – The Enrollee shall communicate on a regular basis with the public on the development, implementation, and performance of its SSMP. The communication system shall provide the public the opportunity to provide input to the Enrollee as the program is developed and implemented.

The Enrollee shall also create a plan of communication with systems that are tributary and/or satellite to the Enrollee's sanitary sewer system.

14. Both the SSMP and the Enrollee's program to implement the SSMP must be certified by the Enrollee to be in compliance with the requirements set forth above and must be presented to the Enrollee's governing board for approval at a public meeting. The Enrollee shall certify that the SSMP, and subparts thereof, are in compliance with the general WDRs within the time frames identified in the time schedule provided in subsection D.15, below.

    In order to complete this certification, the Enrollee's authorized representative must complete the certification portion in the Online SSO Database Questionnaire by checking the appropriate milestone box, printing and signing the automated form, and sending the form to:

    State Water Resources Control Board
    Division of Water Quality
    Attn: SSO Program Manager
    P.O. Box 100
    Sacramento, CA 95812

    The SSMP must be updated every five (5) years, and must include any significant program changes. Re-certification by the governing board of the Enrollee is required in accordance with D.14 when significant updates to the SSMP are made. To complete the re-certification process, the Enrollee shall enter the data in the Online SSO Database and mail the form to the State Water Board, as described above.

15. The Enrollee shall comply with these requirements according to the following schedule. This time schedule does not supersede existing requirements or time schedules associated with other permits or regulatory requirements.

Sewer System Management Plan Time Schedule

Task and Associated Section	Completion Date			
	Population > 100,000	Population between 100,000 and 10,000	Population between 10,000 and 2,500	Population < 2,500
Application for Permit Coverage ***Section C***	6 months after WDRs Adoption			
Reporting Program ***Section G***	6 months after WDRs Adoption[1]			
SSMP Development Plan and Schedule ***No specific Section***	9 months after WDRs Adoption[2]	12 months after WDRs Adoption[2]	15 months after WDRs Adoption[2]	18 months after WDRs Adoption[2]
Goals and Organization Structure ***Section D 13 (i) & (ii)***	12 months after WDRs Adoption[2]		18 months after WDRs Adoption[2]	
Overflow Emergency Response Program ***Section D 13 (vi)***	24 months after WDRs Adoption[2]	30 months after WDRs Adoption[2]	36 months after WDRs Adoption[2]	39 months after WDRs Adoption[2]
Legal Authority ***Section D 13 (iii)***				
Operation and Maintenance Program ***Section D 13 (iv)***				
Grease Control Program ***Section D 13 (vii)***				
Design and Performance ***Section D 13 (v)***	36 months after WDRs Adoption	39 months after WDRs Adoption	48 months after WDRs Adoption	51 months after WDRs Adoption
System Evaluation and Capacity Assurance Plan ***Section D 13 (viii)***				
Final SSMP, incorporating all of the SSMP requirements ***Section D 13***				

1. In the event that by July 1, 2006 the Executive Director is able to execute a memorandum of agreement (MOA) with the California Water Environment Association (CWEA) or discharger representatives outlining a strategy and time schedule for CWEA or another entity to provide statewide training on the adopted monitoring program, SSO database electronic reporting, and SSMP development, consistent with this Order, then the schedule of Reporting Program Section G shall be replaced with the following schedule:

Reporting Program ***Section G***	
Regional Boards 4, 8, and 9	8 months after WDRs Adoption
Regional Boards 1, 2, and 3	12 months after WDRs Adoption
Regional Boards 5, 6, and 7	16 months after WDRs Adoption

If this MOU is not executed by July 1, 2006, the reporting program time schedule will remain six (6) months for all regions and agency size categories.

2. In the event that the Executive Director executes the MOA identified in note 1 by July 1, 2006, then the deadline for this task shall be extended by six (6) months. The time schedule identified in the MOA must be consistent with the extended time schedule provided by this note. If the MOA is not executed by July 1, 2006, the six (6) month time extension will not be granted.

E. WDRs and SSMP AVAILABILITY

1. A copy of the general WDRs and the certified SSMP shall be maintained at appropriate locations (such as the Enrollee's offices, facilities, and/or Internet homepage) and shall be available to sanitary sewer system operating and maintenance personnel at all times.

F. ENTRY AND INSPECTION

1. The Enrollee shall allow the State or Regional Water Boards or their authorized representative, upon presentation of credentials and other documents as may be required by law, to:

    a. Enter upon the Enrollee's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order;

    b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and

d. Sample or monitor at reasonable times, for the purposes of assuring compliance with this Order or as otherwise authorized by the California Water Code, any substances or parameters at any location.

G. GENERAL MONITORING AND REPORTING REQUIREMENTS

1. The Enrollee shall furnish to the State or Regional Water Board, within a reasonable time, any information that the State or Regional Water Board may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order. The Enrollee shall also furnish to the Executive Director of the State Water Board or Executive Officer of the applicable Regional Water Board, upon request, copies of records required to be kept by this Order.

2. The Enrollee shall comply with the attached Monitoring and Reporting Program No. 2006-0003 and future revisions thereto, as specified by the Executive Director. Monitoring results shall be reported at the intervals specified in Monitoring and Reporting Program No. 2006-0003. Unless superseded by a specific enforcement Order for a specific Enrollee, these reporting requirements are intended to replace other mandatory routine written reports associated with SSOs.

3. All Enrollees must obtain SSO Database accounts and receive a “Username” and “Password” by registering through the California Integrated Water Quality System (CIWQS). These accounts will allow controlled and secure entry into the SSO Database. Additionally, within 30days of receiving an account and prior to recording spills into the SSO Database, all Enrollees must complete the “Collection System Questionnaire”, which collects pertinent information regarding a Enrollee’s collection system. The “Collection System Questionnaire” must be updated at least every 12 months.

4. Pursuant to Health and Safety Code section 5411.5, any person who, without regard to intent or negligence, causes or permits any untreated wastewater or other waste to be discharged in or on any waters of the State, or discharged in or deposited where it is, or probably will be, discharged in or on any surface waters of the State, as soon as that person has knowledge of the discharge, shall immediately notify the local health officer of the discharge. Discharges of untreated or partially treated wastewater to storm drains and drainage channels, whether man-made or natural or concrete-lined, shall be reported as required above.

   Any SSO greater than 1,000 gallons discharged in or on any waters of the State, or discharged in or deposited where it is, or probably will be, discharged in or on any surface waters of the State shall also be reported to the Office of Emergency Services pursuant to California Water Code section 13271.

H. CHANGE IN OWNERSHIP

1. This Order is not transferable to any person or party, except after notice to the Executive Director. The Enrollee shall submit this notice in writing at least 30 days in advance of any proposed transfer. The notice must include a written agreement between the existing and new Enrollee containing a specific date for the transfer of this Order's responsibility and coverage between the existing Enrollee and the new Enrollee. This agreement shall include an acknowledgement that the existing Enrollee is liable for violations up to the transfer date and that the new Enrollee is liable from the transfer date forward.

I. INCOMPLETE REPORTS

1. If an Enrollee becomes aware that it failed to submit any relevant facts in any report required under this Order, the Enrollee shall promptly submit such facts or information by formally amending the report in the Online SSO Database.

J. REPORT DECLARATION

1. All applications, reports, or information shall be signed and certified as follows:

   (i) All reports required by this Order and other information required by the State or Regional Water Board shall be signed and certified by a person designated, for a municipality, state, federal or other public agency, as either a principal executive officer or ranking elected official, or by a duly authorized representative of that person, as described in paragraph (ii) of this provision. (For purposes of electronic reporting, an electronic signature and accompanying certification, which is in compliance with the Online SSO database procedures, meet this certification requirement.)

   (ii) An individual is a duly authorized representative only if:

      (a) The authorization is made in writing by a person described in paragraph (i) of this provision; and

      (b) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity.

K. CIVIL MONETARY REMEDIES FOR DISCHARGE VIOLATIONS

1. The California Water Code provides various enforcement options, including civil monetary remedies, for violations of this Order.

2. The California Water Code also provides that any person failing or refusing to furnish technical or monitoring program reports, as required under this Order, or

falsifying any information provided in the technical or monitoring reports is subject to civil monetary penalties.

L. SEVERABILITY

1. The provisions of this Order are severable, and if any provision of this Order, or the application of any provision of this Order to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Order, shall not be affected thereby.

2. This order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, nor protect the Enrollee from liability under federal, state or local laws, nor create a vested right for the Enrollee to continue the waste discharge.

CERTIFICATION

The undersigned Clerk to the State Water Board does hereby certify that the foregoing is a full, true, and correct copy of general WDRs duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 2, 2006.

AYE: Tam M. Doduc
Gerald D. Secundy

NO: Arthur G. Baggett

ABSENT: None

ABSTAIN: None

Song Her
Clerk to the Board

STATE WATER RESOURCES CONTROL BOARD

MONITORING AND REPORTING PROGRAM NO. 2006-0003-DWQ
STATEWIDE GENERAL WASTE DISCHARGE REQUIREMENTS
FOR
SANITARY SEWER SYSTEMS

This Monitoring and Reporting Program (MRP) establishes monitoring, record keeping, reporting and public notification requirements for Order No. 2006-2003-DWQ, "Statewide General Waste Discharge Requirements for Sanitary Sewer Systems." Revisions to this MRP may be made at any time by the Executive Director, and may include a reduction or increase in the monitoring and reporting.

A. SANITARY SEWER OVERFLOW REPORTING

SSO Categories

1. Category 1 - All discharges of sewage resulting from a failure in the Enrollee's sanitary sewer system that:
   A. Equal or exceed 1000 gallons, or
   B. Result in a discharge to a drainage channel and/or surface water; or
   C. Discharge to a storm drainpipe that was not fully captured and returned to the sanitary sewer system.

2. Category 2 – All other discharges of sewage resulting from a failure in the Enrollee's sanitary sewer system.

3. Private Lateral Sewage Discharges – Sewage discharges that are caused by blockages or other problems within a privately owned lateral.

SSO Reporting Timeframes

4. Category 1 SSOs – All SSOs that meet the above criteria for Category 1 SSOs must be reported as soon as: (1) the Enrollee has knowledge of the discharge, (2) reporting is possible, and (3) reporting can be provided without substantially impeding cleanup or other emergency measures. Initial reporting of Category 1 SSOs must be reported to the Online SSO System as soon as possible but no later than 3 business days after the Enrollee is made aware of the SSO. Minimum information that must be contained in the 3-day report must include all information identified in section 9 below, except for item 9.K. A final certified report must be completed through the Online SSO System, within 15 calendar days of the conclusion of SSO response and remediation. Additional information may be added to the certified report, in the form of an attachment, at any time.

   The above reporting requirements do not preclude other emergency notification requirements and timeframes mandated by other regulatory agencies (local

County Health Officers, local Director of Environmental Health, Regional Water Boards, or Office of Emergency Services (OES)) or State law.

5. Category 2 SSOs – All SSOs that meet the above criteria for Category 2 SSOs must be reported to the Online SSO Database within 30 days after the end of the calendar month in which the SSO occurs (e.g. all SSOs occurring in the month of January must be entered into the database by March 1st).

6. Private Lateral Sewage Discharges – All sewage discharges that meet the above criteria for Private Lateral sewage discharges may be reported to the Online SSO Database based upon the Enrollee's discretion. If a Private Lateral sewage discharge is recorded in the SSO Database, the Enrollee must identify the sewage discharge as occurring and caused by a private lateral, and a responsible party (other than the Enrollee) should be identified, if known.

7. If there are no SSOs during the calendar month, the Enrollee will provide, within 30 days after the end of each calendar month, a statement through the Online SSO Database certifying that there were no SSOs for the designated month.

8. In the event that the SSO Online Database is not available, the enrollee must fax all required information to the appropriate Regional Water Board office in accordance with the time schedules identified above. In such event, the Enrollee must also enter all required information into the Online SSO Database as soon as practical.

Mandatory Information to be Included in SSO Online Reporting

All Enrollees must obtain SSO Database accounts and receive a "Username" and "Password" by registering through the California Integrated Water Quality System (CIWQS). These accounts will allow controlled and secure entry into the SSO Database. Additionally, within thirty (30) days of receiving an account and prior to recording SSOs into the SSO Database, all Enrollees must complete the "Collection System Questionnaire", which collects pertinent information regarding an Enrollee's collection system. The "Collection System Questionnaire" must be updated at least every 12 months.

At a minimum, the following mandatory information must be included prior to finalizing and certifying an SSO report for each category of SSO:

9. Category 2 SSOs:

   A. Location of SSO by entering GPS coordinates;
   B. Applicable Regional Water Board, i.e. identify the region in which the SSO occurred;
   C. County where SSO occurred;
   D. Whether or not the SSO entered a drainage channel and/or surface water;
   E. Whether or not the SSO was discharged to a storm drain pipe that was not fully captured and returned to the sanitary sewer system;

F. Estimated SSO volume in gallons;
G. SSO source (manhole, cleanout, etc.);
H. SSO cause (mainline blockage, roots, etc.);
I. Time of SSO notification or discovery;
J. Estimated operator arrival time;
K. SSO destination;
L. Estimated SSO end time; and
M. SSO Certification. Upon SSO Certification, the SSO Database will issue a Final SSO Identification (ID) Number.

10. Private Lateral Sewage Discharges:

A. All information listed above (if applicable and known), as well as;
B. Identification of sewage discharge as a private lateral sewage discharge; and
C. Responsible party contact information (if known).

11. Category 1 SSOs:

A. All information listed for Category 2 SSOs, as well as;
B. Estimated SSO volume that reached surface water, drainage channel, or not recovered from a storm drain;
C. Estimated SSO amount recovered;
D. Response and corrective action taken;
E. If samples were taken, identify which regulatory agencies received sample results (if applicable). If no samples were taken, NA must be selected.
F. Parameters that samples were analyzed for (if applicable);
G. Identification of whether or not health warnings were posted;
H. Beaches impacted (if applicable). If no beach was impacted, NA must be selected;
I. Whether or not there is an ongoing investigation;
J. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the overflow and a schedule of major milestones for those steps;
K. OES control number (if applicable);
L. Date OES was called (if applicable);
M. Time OES was called (if applicable);
N. Identification of whether or not County Health Officers were called;
O. Date County Health Officer was called (if applicable); and
P. Time County Health Officer was called (if applicable).

Reporting to Other Regulatory Agencies

These reporting requirements do not preclude an Enrollee from reporting SSOs to other regulatory agencies pursuant to California state law. These reporting requirements do not replace other Regional Water Board telephone reporting requirements for SSOs.

1. The Enrollee shall report SSOs to OES, in accordance with California Water Code Section 13271.

Office of Emergency Services
Phone (800) 852-7550

2. The Enrollee shall report SSOs to County Health officials in accordance with California Health and Safety Code Section 5410 et seq.

3. The SSO database will automatically generate an e-mail notification with customized information about the SSO upon initial reporting of the SSO and final certification for all Category 1 SSOs. E-mails will be sent to the appropriate County Health Officer and/or Environmental Health Department if the county desires this information, and the appropriate Regional Water Board.

B. Record Keeping

1. Individual SSO records shall be maintained by the Enrollee for a minimum of five years from the date of the SSO. This period may be extended when requested by a Regional Water Board Executive Officer.

3. All records shall be made available for review upon State or Regional Water Board staff's request.

4. All monitoring instruments and devices that are used by the Enrollee to fulfill the prescribed monitoring and reporting program shall be properly maintained and calibrated as necessary to ensure their continued accuracy;

5. The Enrollee shall retain records of all SSOs, such as, but not limited to and when applicable:

   a. Record of Certified report, as submitted to the online SSO database;
   b. All original recordings for continuous monitoring instrumentation;
   c. Service call records and complaint logs of calls received by the Enrollee;
   d. SSO calls;
   e. SSO records;
   f. Steps that have been and will be taken to prevent the SSO from recurring and a schedule to implement those steps.
   g. Work orders, work completed, and any other maintenance records from the previous 5 years which are associated with responses and investigations of system problems related to SSOs;
   h. A list and description of complaints from customers or others from the previous 5 years; and
   i. Documentation of performance and implementation measures for the previous 5 years.

6. If water quality samples are required by an environmental or health regulatory agency or State law, or if voluntary monitoring is conducted by the Enrollee or its agent(s), as a result of any SSO, records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical technique or method used; and,
f. The results of such analyses.

C. Certification

1. All final reports must be certified by an authorized person as required by Provision J of the Order.
2. Registration of authorized individuals, who may certify reports, will be in accordance with the CIWQS' protocols for reporting.

Monitoring and Reporting Program No. 2006-0003 will become effective on the date of adoption by the State Water Board.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Board held on May 2, 2006.

Song Her
Clerk to the Board

APPENDIX C – SANITARY SEWER FLOW MONITORING AND INFLOW/INFILTRATION STUDY

This report is provided on the V&A CD deliverable.

SANITARY SEWER FLOW MONITORING AND INFLOW / INFILTRATION STUDY

Prepared for

City of Oakland
250 Frank H. Ogawa Plaza
Oakland, CA 94612

Prepared by

V&A

November 2012

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ABBREVIATIONS, TERMS AND DEFINITIONS USED IN THIS REPORT

Table i.
Abbreviations

Abbreviation	Term
ADWF	average dry weather flow
CCTV	closed-circuit television
CIP	capital improvement plan
CO	carbon monoxide
d/D	depth/diameter ratio
FM	flow monitor
gpd	gallons per day
gpm	gallons per minute
GWI	groundwater infiltration
H_2S	hydrogen sulfide
I/I	inflow and infiltration
IDM	inch-diameter-mile (miles of pipeline multiplied by the diameter of the pipeline in inches)
IDW	inverse distance weighting
LEL	lower explosive limit
mgd	million gallons per day
NOAA	National Oceanic and Atmospheric Administration
Q	flow rate
RDI	rainfall-dependent infiltration
RRI	rainfall-responsive infiltration
RG	rain gauge
SSO	sanitary sewer overflow
WEF	Water Environment Federation
WRCC	Western Regional Climate Center

Table ii.

Terms and Definitions

Term	Definition
Attenuation	Flow attenuation in a sewer collection system is the natural process of the reduction of the peak flow rate through redistribution of the same volume of flow over a longer period of time. This occurs as a result of friction (resistance), along the sewer pipes. As the flows from the basins combine within the trunk sewer lines, the peaks from each basin will (a) not necessarily coincide at the same time, and (b) due to the length and time of travel through the trunk sewers, peak flows will ***attenuate*** as the peak flows move downstream. The sum of the peak flows of individual basins upstream will generally be greater than the measured peak flows observed at points downstream. Additional information on this concept is presented on page 45.
Average dry weather flow (ADWF)	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 can be expressed as a numeric average or as a curve showing the variation in flow over a day. ADWF includes the influence of normal groundwater infiltration (not related to a rain event).
Basin	Sanitary sewer collection system upstream of a given location (often a flow meter), including all pipelines, inlets, and appurtenances. Also refers 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	Depth of water in a pipe as a fraction of the pipe's diameter. A measure of fullness of the pipe used in capacity analysis.
Design storm	A theoretical storm event of a given duration and intensity that aligns with historical frequency records of rainfall events. For example, a 10-year, 24-hour design storm is a storm event wherein the volume of rain that falls in a 24-hour period would historically occur once every 10 years. Design storm events are used to predict I/I response and are useful for modeling how a collection system will react to a given set of storm event scenarios.
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. **Total 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 is 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 storm water. The storm water 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.
Infiltration, *rainfall-responsive*	Rainfall-responsive infiltration (**RRI**) is storm water that enters the collection system through pipe defects, but normally in sewers constructed close to the ground surface such as private laterals. RRI is independent of the groundwater

Term	Definition
	table and reaches defective sewers via the pipe trench in which the sewer is constructed, particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system.
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.
Normalization	To run an "apples-to-apples" comparison amongst different basins, calculated metrics must be **normalized**. Individual basins will have different runoff areas, pipe lengths and sanitary flows. There are three common methods of normalization. Depending on the information available, one or all methods can be applied to a given project: ❖ Pipe Length: The metric is divided by the length of pipe in the upstream basin expressed in units of inch-diameter-mile (IDM). ❖ Basin Area: The metric is divided by the estimated drainage area of the basin in acres. ❖ ADWF: The metric is divided by the average dry weather sanitary flow (ADWF).
Normalization, *inflow*	The peak I/I flow rate is used to quantify inflow. Although the instantaneous flow monitoring data will typically show an inflow peak, the inflow response is measured from the I/I flow rate (in excess of baseline flow). This removes the effect of sanitary flow variations and measures only the I/I response: ❖ Pipe Length: The peak I/I flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). ❖ Basin Area: The peak I/I flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. ❖ ADWF: The peak I/I flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.
Normalization, *GWI*	The estimated GWI rates are compared to acceptable GWI rates, as defined by the Water Environment Federation, and are used to identify basins with high GWI: ❖ Pipe Length: The GWI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM). ❖ Basin Area: The GWI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre. ❖ ADWF: The GWI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Normalization,
RDI</td><td>The estimated RDI rates at a period 24 hours or more after the conclusion of a storm event are used to identify basins with high RDI:

❖ <u>Pipe Length:</u> The RDI flow rate is divided by the length of pipe (IDM) in the upstream basin. The result is expressed in gallons per day (gpd) per IDM (gpd/IDM).
❖ <u>Basin Area:</u> The RDI flow rate is divided by the geographic area of the upstream basin. The result is expressed in gpd per acre.
❖ <u>ADWF:</u> The RDI flow rate is divided by the average dry weather flow (ADWF). This is a ratio and is expressed without units.</td></tr>
<tr><td>Normalization,
total I/I</td><td>The estimated totalized I/I in gallons attributable to a particular storm event is used to identify basins with high total I/I. Because this is a totalized value rather than a rate and can be attributable solely to an individual storm event, the volume of the storm event is also taken into consideration. This allows for a comparison not only between basins but also between storm events:

❖ <u>Pipe Length:</u> Total gallons of I/I is divided by the length of pipe (IDM) in the upstream basin and the rainfall total (inches) of the storm event. The result is expressed in gallons per IDM per inch-rain.
❖ <u>Basin Area (R-Value):</u> Total gallons of I/I is divided by total gallons of rainfall water that fell within the acreage of the basin area. This is a ratio and is expressed as a percentage. R-Value is described as “the percentage of rainfall that enters the collection system.” Systems with R-Values less than 5%[1] are often considered to be performing well.
❖ <u>ADWF:</u> Total gallons of I/I is divided by the ADWF and the rainfall total of the storm event. The result is expressed in million gallons per MGD of ADWF per inch of rain.</td></tr>
<tr><td>Peaking factor</td><td>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 capacity analysis.</td></tr>
<tr><td>Surcharge</td><td>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.</td></tr>
<tr><td>Synthetic I/I hydrograph</td><td>A set of algorithms has been developed to approximate the actual I/I hydrograph. The synthetic hydrograph is developed strictly using rainfall data and response parameters representing response time, recession coefficient and soil saturation.</td></tr>
<tr><td>Weekend/weekday ratio</td><td>The ratio of weekend ADWFs to weekday ADWFs. In residential areas, this ratio is typically slightly higher than 1.0. In business districts, depending on the type of service, this ratio can be significantly less than 1.0.</td></tr>
</table>

[1] Keefe, P.N. “Test Basins for I/I Reduction and SSO Elimination.” 1998 WEF Wet Weather Specialty Conference, Cleveland.

INTRODUCTION

Preface

The City of Oakland (City) is the principal city of the eastern mainland side of the San Francisco Bay Area Region known as the East Bay. Oakland has a population of approximately 400,000, has the busiest port in the San Francisco Bay, as well as all of Northern California, and serves as a major transportation hub and trade center for the entire region. The City owns, maintains, and operates gravity sewer pipelines, as well as sewage pump stations and associated force mains collecting wastewater flow from residential, commercial, industrial, and institutional customers within the City service area. Figure 1 presents a location map of the City.

The City operates one of seven wastewater collection satellite agencies (Satellites) in the East Bay that route sewage to the East Bay Municipal Utility District (EBMUD) wastewater treatment facilities. The other collection systems include the Cities of Alameda, Albany, Berkeley, Emeryville, Piedmont, and the Stege Sanitary District. All wastewater flows from the Satellite collection systems flow to an interceptor system, which is owned and operated by EBMUD. The interceptor system conveys flows from the Satellites to the EBMUD Main Wastewater Treatment Plant (MWWTP).

Figure 1. Vicinity Map

Background

On November 28, 2009, the United States Environmental Protection Agency (EPA) issued an Administrative Order Docket No. CWA 309(a)-10-009 requiring the City of Oakland to take specific actions related to its wastewater collection system. The goal of the Administrative Order, which has since become a Stipulated Order (SO), is focused on eliminating discharges from the EBMUD wet weather facilities as part of a regional solution involving EBMUD and its Satellite dischargers. The SO required the development of a number of administrative requirements, including the development of a basin flow monitoring program.

Scope and Purpose

V&A was retained by the City to complete sanitary sewer flow monitoring and rainfall monitoring with inflow and infiltration (I/I) analysis within the City of Oakland, California (City). Flow and rainfall monitoring occurred over the course of two wet weather seasons that are described as follows:

- **Season 1:** Seventy flow monitors and eight rain gauges were installed from December 1, 2010 to March 31, 2011 to capture flow from 19 large sanitary basins within the City.
- **Season 2:** Sixty-one flow monitors and seven rain gauges were installed from December 1, 2011 to March 31, 2012 to capture flow from the basins with the highest I/I rates and to help with the model calibration effort.

The purpose of the two-year study was to measure sanitary sewer flows over two wet-weather seasons and conduct analyses to define capacity and I/I occurring within the sanitary sewer basins within the City of Oakland collection system.

Season 1 / Season 2 Strategy

Season 1: The 2010/2011 flow monitoring effort was coordinated with the concurrent EBMUD flow monitoring effort to avoid duplication or conflict of metering locations. Additionally, the sewer basins with a known history of large rainfall I/I response were targeted for a more intensive flow monitoring effort. The overall intent was to have a generally good distribution of flow monitors throughout the entire collection system, but with a higher density of flow monitors in the basins believed to have the highest levels of I/I.

Season 2: There was greater than average rainfall during the 2010/2011 flow monitoring, and there was no need to duplicate the flow monitoring sites for a second season. The 2011/2012 flow monitoring effort chose locations with two items in mind:

a) The model that Carollo was building required some additional flow monitoring data at key locations. Fifteen sites were selected by Carollo for model calibration.

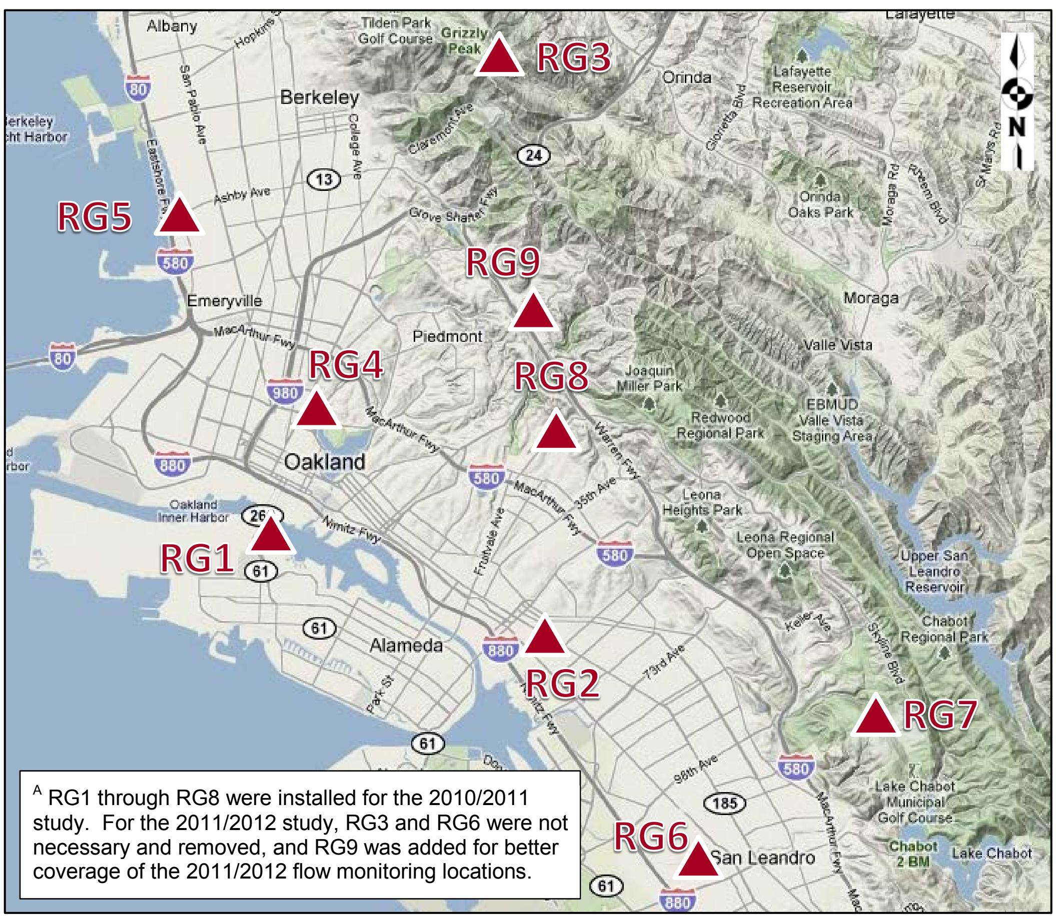
b) The remaining 46 flow monitoring sites were distributed within the flow monitoring basins with the highest I/I rates, based on the data from Season 1. The intent was to subdivide these basins into smaller catchment areas to better determine where the highest levels of I/I were located.

Rainfall Monitoring Sites

V&A installed nine rain gauges for this project[A]. Rain gauges were distributed in an attempt to capture as many of the unique topographical regions of the City as possible. The locations are detailed in Table 1 and shown in Figure 2. Additional information and data concerning the rain gauge sites are included in *Appendix A*.

Table 1. Rain Gauge Site Information

ID	Address	Latitude	Longitude	Elev. (ft)
RG1	2394 Mariner Square Drive (Alameda)	37.7898°	-122.2762°	6
RG2	East 12th St, between 53rd and 54th Ave (Oakland)	37.7658°	-122.2084°	14
RG3	Tilden Park (Berkeley)	37.8823°	-122.2251°	1,588
RG4	155 Grand Avenue (Oakland)	37.8108°	-122.2637°	26
RG5	67th and Shellmound (Oakland)	37.8481°	-122.2963°	20
RG6	San Leandro and Cherrywood (Oakland)	37.7297°	-122.1668°	47
RG7	Golf Links Road (Oakland)	37.7529°	-122.1255°	429
RG8	Head-Royce School (Oakland)	37.8087°	-122.2051°	355
RG9	Montclair Elementary School (Oakland)	37.8304°	-122.2120°	630



[A] RG1 through RG8 were installed for the 2010/2011 study. For the 2011/2012 study, RG3 and RG6 were not necessary and removed, and RG9 was added for better coverage of the 2011/2012 flow monitoring locations.

Figure 2. Rain Gauge Site Map

GARR Rainfall Data Distribution

For the 2010/2011 flow monitoring period, EBMUD retained Vieux & Associates, Inc. (Vieux) to provide gauge adjusted radar rainfall (GARR) as a part of the EBMUD flow monitoring program. V&A provided the rainfall data collected for the City project to Vieux in order to help Vieux calibrate the GARR data. In return, the final GARR data was provided back to V&A for the City service area. The GARR data is broken up into "pixels," each with an area of roughly one square kilometer. Figure 3 shows the GARR pixels with an overlay of the sewer basins that were used for this project.

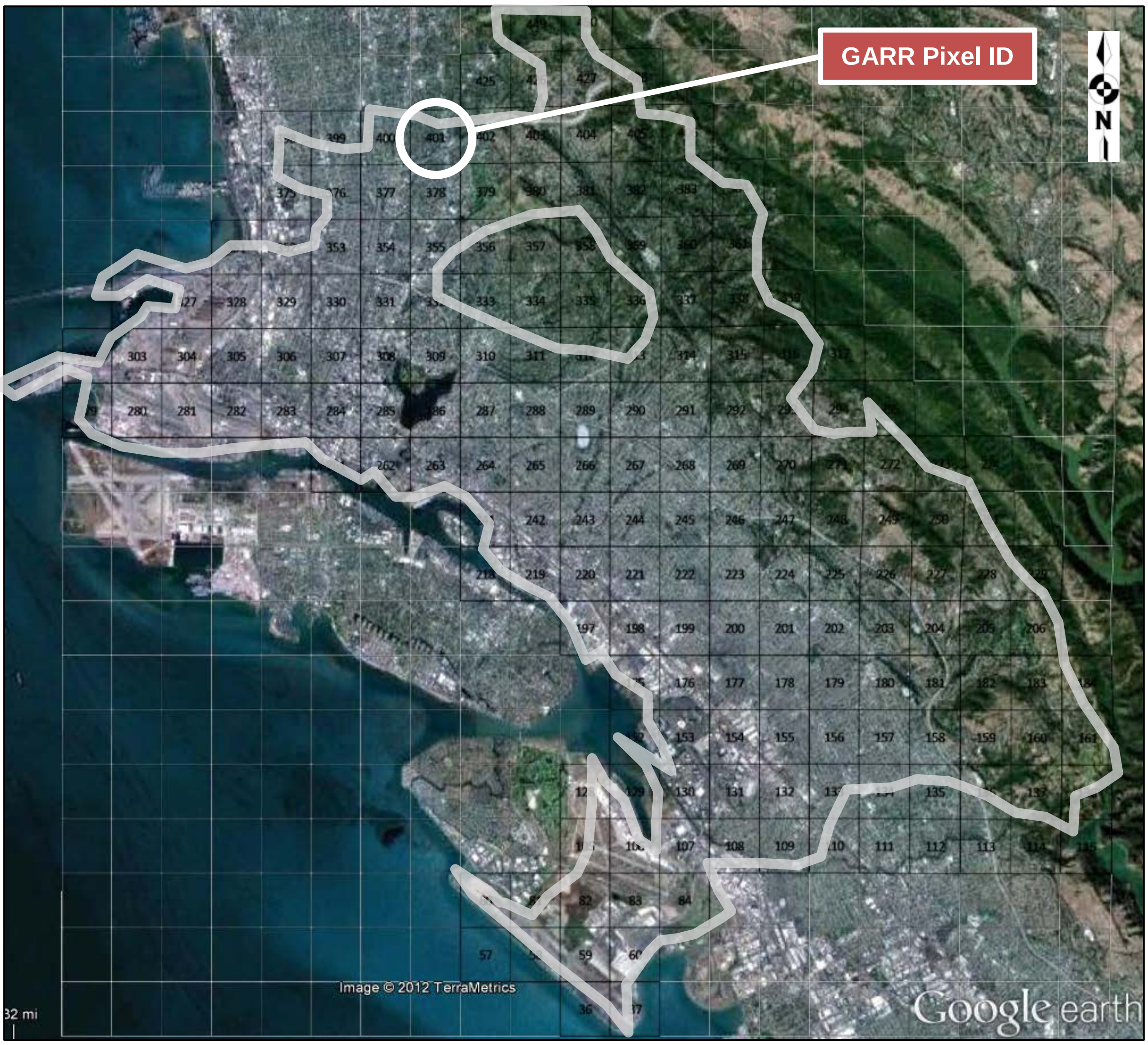


Figure 3. City of Oakland Pixel Distribution

The rainfall affecting a particular sanitary sewer basin was calculated based on the proximity to the GARR pixels. Figure 4 shows the pixels associated with Flow Monitoring Basin 83E.

For example, the rain that fell within Basin 83E is characterized by Pixels 247, 270, 271, 272, 273, 293, 294, and 295. Each pixel's influence is proportional to the area of the basin contained within that pixel. For Basin 83E, Pixel 247, 270, 271, 272, 273, 293, 294, and 295 has 1.3 percent, 13.3 percent, 13.3 percent, 21.3 percent, 17.3 percent, 12.0 percent, 14.7 percent, and 6.7 percent influence, respectively. This methodology was used to develop the 15-minute rainfall totals for each individual flow monitoring basin during the flow monitoring period, and can be referenced in *Appendix B*.

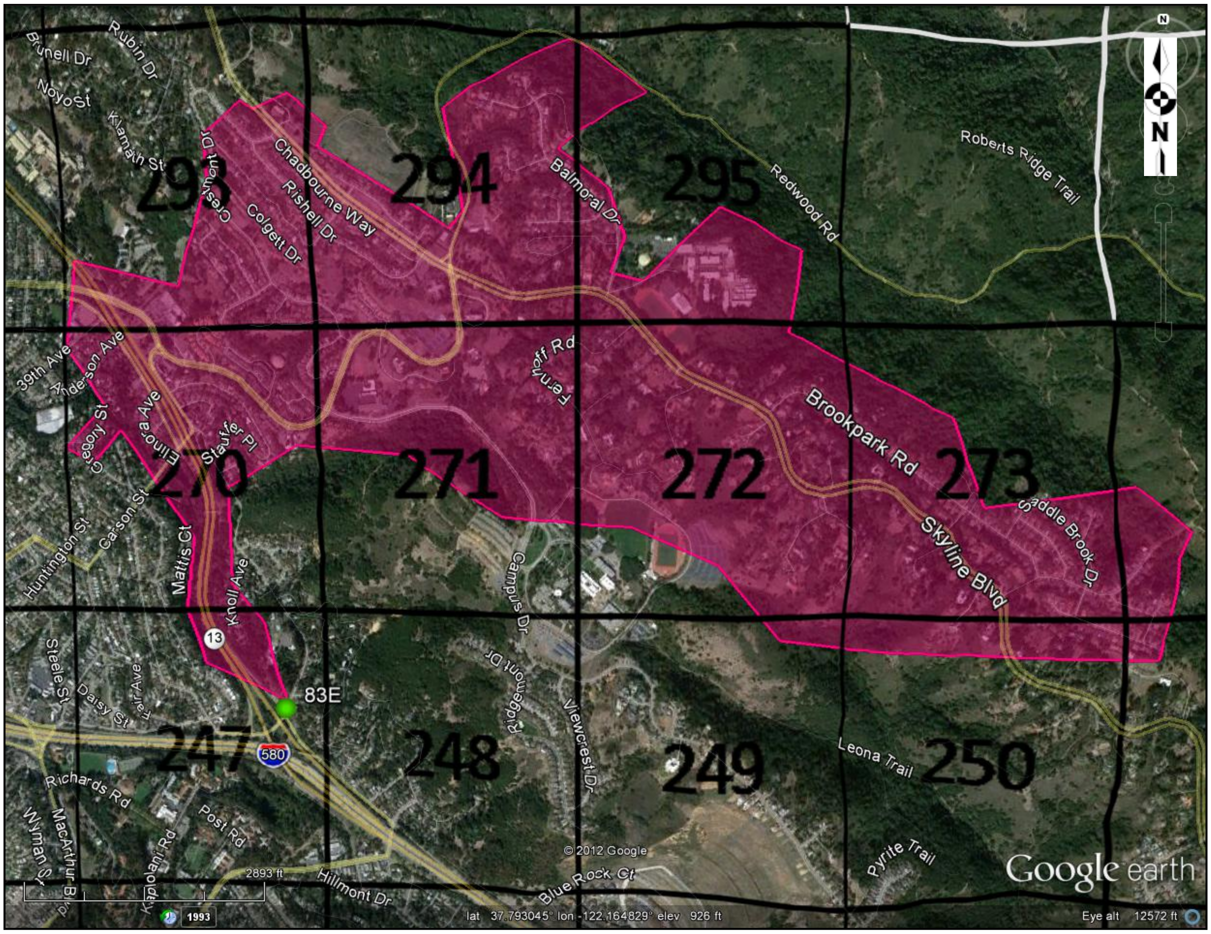


Figure 4. Basin 83E Pixel Distribution

Rain Gauge Triangulation Distribution

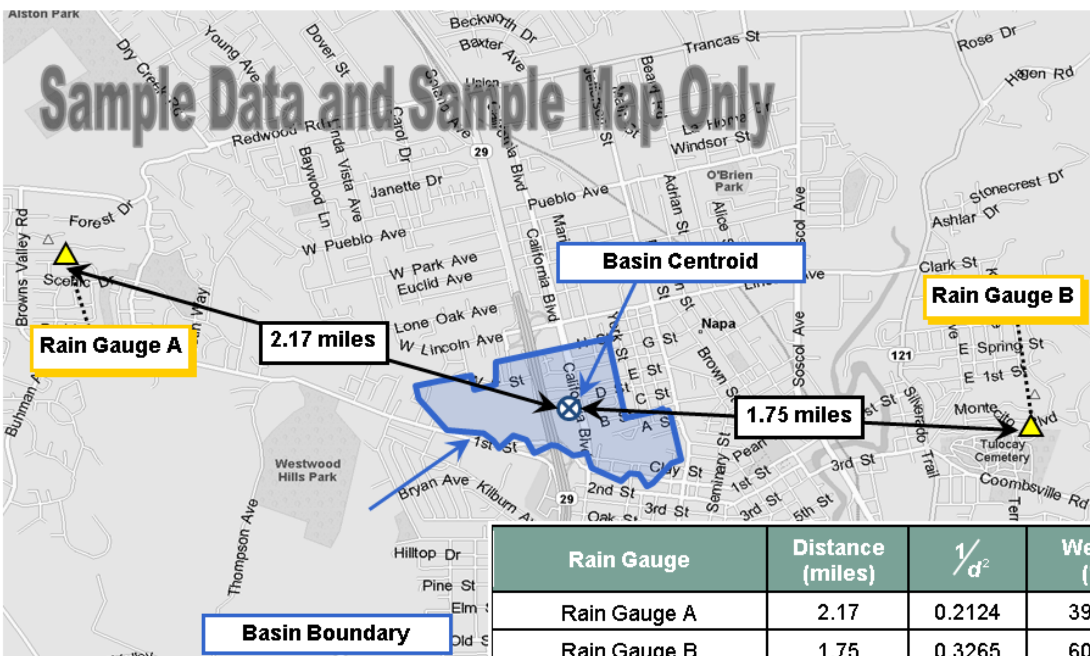
Rain gauge triangulation methods were used for the 2011/2012 flow monitoring period. The rainfall affecting the sanitary sewer collection system basins must be calculated based on the proximity to the rain gauge locations. The mean precipitation for each site was calculated by taking data from three local 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 approximate geographic coordinates of each site were determined and a weighted average was taken of the precipitation data from nearby rain gauge locations.

IDW is performed using the equation:

$$w = \frac{1/d^p}{\sum 1/d^p}$$

where the weight, *w*, depends on the distance, *d*, from the rain gauge to the monitoring site and *p*, a user-selected power (*p* > 0). The most common choice of *p* in hydrological studies of watershed areas is 2.

Figure 5 illustrates the IDW method with sample data. This calculation was used to determine rainfall distribution within the sewer basins for the 2011/2012 flow monitoring period, and can be referenced in *Appendix C*.



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 5. Rainfall Inverse Distance Weighting Method

Flow Monitoring Sites

Flow monitoring sites are the locations where the flow monitors were placed. Flow monitoring site data may include the flows from one or many drainage basins. To isolate a flow monitoring basin, an addition or subtraction of flows may be required[2]. Capacity and flow rate information is presented on a site-by-site basis. The flow monitoring sites for the 2010/2011 flow monitoring are listed in Table 2 and the flow monitoring sites for the 2011/2012 flow monitoring are listed in Table 3. Figure 6 illustrates the monitoring sites for both studies. Detailed descriptions of the individual 2010/2011 flow monitoring sites, including photographs, are included in *Appendix E*. Detailed descriptions of the individual 2011/2012 flow monitoring sites, including photographs, are included in *Appendix F*.

Flow monitoring was also performed by EBMUD within the City at 71 locations during the 2010/2011 wet weather season. These sites were generally located at most of the City's connections to the EBMUD interceptor system. EBMUD flow monitoring data was utilized in the I/I analysis portion of this study. Figure 7, Figure 8 and Figure 9 provide schematic illustrations of the V&A and EBMUD flow monitoring locations.

Note: Not every flow monitoring location listed in the tables are shown in the schematics. Repeated locations between the 2010/2011 and 2011/2012 studies are only indicated once in the schematic, and flow monitors used for model calibration are not illustrated.

Table 2. List of Flow Monitoring Sites, 2010/2011 Flow Monitoring

Monitoring Site	Pipe Diameter (in)	Location
17A	8	Alvarado Road at Gravatt Drive
17B	8	Intersection of Vicente Place and Vicente Road
20A	8	Intersection of Ocean Avenue and Vallejo Street
20B	8	Intersection of San Pablo Avenue and 61st Street
21A	9.25	Intersection of Adeline Street and 59th Street
50	36	Intersection of 34th Street and Ettie Street
50A	36	Intersection of West Street and 47th Street
50B	38 x 26 Egg	Intersection of West MacArthur Boulevard and Webster Street
50C.1	18	Intersection of College Avenue and Taft Avenue
50C.2	12	Intersection of College Avenue and Taft Avenue
50D	42 x 27 Egg	5444 Manila Avenue, west of Bryant Avenue
50E	11.5	4409 Harbord Drive, at Buckeye Avenue
50F	12	Lake Temescal Beachhouse service lot
50G	24	6766 Broadway Terrace, on north side of Highway 13
50H	15	5701 Thornhill Drive, in front of Montclair Presbyterian Church
52A	72 x 71 Thumbnail	Intersection of Magnolia Street and West Grand Avenue
52B	54	Intersection of West Grand Avenue and San Pablo Avenue

[2] There is error inherent in flow monitoring. Adding and subtracting flows increases error on an additive basis. For example, if Site A has error ±10% and Site B has error ±10%, then the resulting flow when subtracting Site A from Site B would be ±20%.

Monitoring Site	Pipe Diameter (in)	Location
52C	42	Intersection of West Grand Avenue and Martin Luther King Jr. Way
54A	18	1928 Park Boulevard, at East 20th Street
54B.1	21	Intersection of Grand Avenue and El Embarcadero
54B.2	30	Two manholes in west crosswalk at Grand Avenue and MacArthur
54B.3	30	Two manholes in west crosswalk at Grand Avenue and MacArthur
54B.4	18	Manhole in SB lanes 2/3 of MacArthur Blvd before south crosswalk
54C	18	Intersection of Trestle Glen Road and Wesley Way, near Lakeshore
54C.1	16	Trestle Glen between Grosvenor Place and Barrows Road
54D	21	3419 Lakeshore Avenue, at Longridge Road
54D.1	15	Lakeshore between Mandana and Weldon
56A	18	Intersection of Fruitvale Avenue and Montana Street
56A.1	27	Intersection of Fruitvale Avenue and Montana Street
56B	15	Montclair Golf Course, near easternmost practice putting green
56C	12	Monterey Boulevard
56D	12	Mountain Boulevard at Ascot Drive
56E	16.5	Shepherd Canyon Trail off of Bishops Court
58A	31	Intersection of 14th Avenue and East 22nd Street
58B	18	Intersection of 14th Avenue and East 30th Street
59A	24	East 8th Street, near 10th Avenue
60A	12	Intersection of 22nd Avenue and Commerce Way
60B	24	Intersection of East 17th Street and 23rd Avenue
61A	15	718 Kennedy Street
62A	15	1643 East 17th Street, at 27th Avenue
80A	10	2240 Coolidge Avenue, at East 22nd Street
80B	27	35th Avenue near the Foothill Boulevard intersection
80C	14	3107 Curran Avenue
80D	18	3010 Humboldt Avenue
80E	18	Intersection of 35th Avenue and Hageman Avenue
81A	15	Foothill Boulevard, just NW of intersection with High Street
81A.1	10	Foothill Boulevard, just NW of intersection with High Street
81B	18	High Street at Gordon
81C	10	Intersection of Quigley Place and High Street
82A	10	Intersection of 48th Avenue and Bond Street
82B	21	Intersection of 50th Avenue and Bancroft Avenue
83B	10	Intersection of 55th Avenue and Hillen Drive
83B.1	14	55th Avenue, just west of the intersection with Fleming Avenue
83C	21	Seminary Avenue between MacArthur Boulevard and Monadnock
83D	15	Seminary Avenue between MacArthur Boulevard and Monadnock
83E	18	Intersection of Mountain Boulevard and Frontage Road
84A	19.75	End of 77th Street, near BART tracks
84B	30	End of 73rd Street
84C	12	73rd Avenue at Hillside Street
84C.1	12	73rd Avenue at Hillside Street
85A	30	85th Avenue west of Blaine Street

Monitoring Site	Pipe Diameter (in)	Location
85B	33	Railroad Avenue east of 85th Avenue
85C	14.25	Intersection of 105th Avenue and Sunnyside Street
85D	18	Mountain Boulevard, near the intersection of Golf Links Road
85D.1	12	End of Barcelona St. (12-inch line from east)
85D.2	12	End of Barcelona St. (12-inch line from north)
85E	18	Intersection of Golf Links Road and Mountain Boulevard
85E.1	12	Golf Links Road northwest of Scotia Avenue
86A	21	9641 Coral Road
86B	18	End of St. Elmo Street, at Stoneford Avenue

Table 3. List of Flow Monitoring Sites, 2011/2012 Flow Monitoring

Monitoring Site	Pipe Diameter (in)	Location
21B	12	980 Aileen Street
21C	8	60th Street, just west of Shattuck Avenue
50A1	16	37th & Linden Street
50B1	42	Telegraph & 37th Street
50D1	20.5	Broadway & Kales Avenue
50F1	10	150 Caldecott Lane
50F2	10	158 Caldecott Lane
54A	18	E 20th St. & Park Blvd.
54A1	39	Athol & 18th Street
54A2	42w x 29h Box	Lakeshore Ave. & Boden Way
54A3	10	Park Blvd. & Spruce Street
54C	18	Trestle Glen & Wesley
54C1	16	Trestle Glen & Grosvener Place
54C2	16	780 Trestle Glen Road
54C3	16	Trestle Glen & Brookwood
54C4	12	Trestle Glen just east of Creed Road
54C5	10	1600 Trestle Glen Road
54C6	10	1684 Trestle Glen Road
54S5	6	294 Indian Road
54-S8	8	5527 Moraga Ave.
54-S8.1	8	Moraga Ave.
54S8.2	8	Moraga Ave. & Masonic
56A2	10	Fruitvale Ave. & Montana St.
56C	12	Monterey Blvd., 1 mile SW of Park Blvd
56C1	8	2915 Burdeck Drive
56D1	8	Ascot & Chelton
56D2	8	40 Larry Lane
56F1	30	Fruitvale Ave. & Farnham

Monitoring Site	Pipe Diameter (in)	Location
56F2	10	Fruitvale Ave. & Farnham
56G	15	3720 Fruitvale Ave.
58A	31	14th Ave. & 22nd Street
58A2	36	14th Ave. & E 18th Street
58A3	8	14th Ave. & E 27th Street
58A4	18	2744 14th Ave.
58B	18	14th Ave. & E. 30th Street
60A1	19	21st Ave. & E. 22nd Street
60A2	10	21st St. & 21st Ave.
60B1	20	23rd Ave. & 20th Street
60B2	8	2332 E. 20th Street
60C	18	E. 12th St. & 21st. Ave.
62B	18	In shopping center parking lot on E. 9th St. SE of 29th Ave.
80C1	18	Coolidge West of School Street
80C2	8	Bret Harte Middle School Playground
80C3	6.5	2901 MacArthur
80C4	12	Maple Ave. & School Street
80C5	11.25	Curran Ave. & School Street
80E1	18	Midvale & Kansas
83E1	8	4332 Atlas Ave
80E2	8	35th Avenue, SW of Kansas
83E2	8	High Street between Ygnacio & Foothill
80E3	12	1501 50th Ave.
83E3	8	E 12th St. & 50th Ave
81B1	18	Inside Mills College, south of main entrance in field
82C	12	4110 Redwood Rd.
82D	12	Redwood Rd. north of Campus Dr.
83B2	18	11900 Campus Dr.
84C2	8	MacArthur Blvd. & 66th Ave.
84C3	8	MacArthur Blvd. & 73rd Ave.
85C1	15	106th St. east of Byron
85C2	10	End of Peralta Oaks Ct.
85C3	18	207 Foothill Blvd.

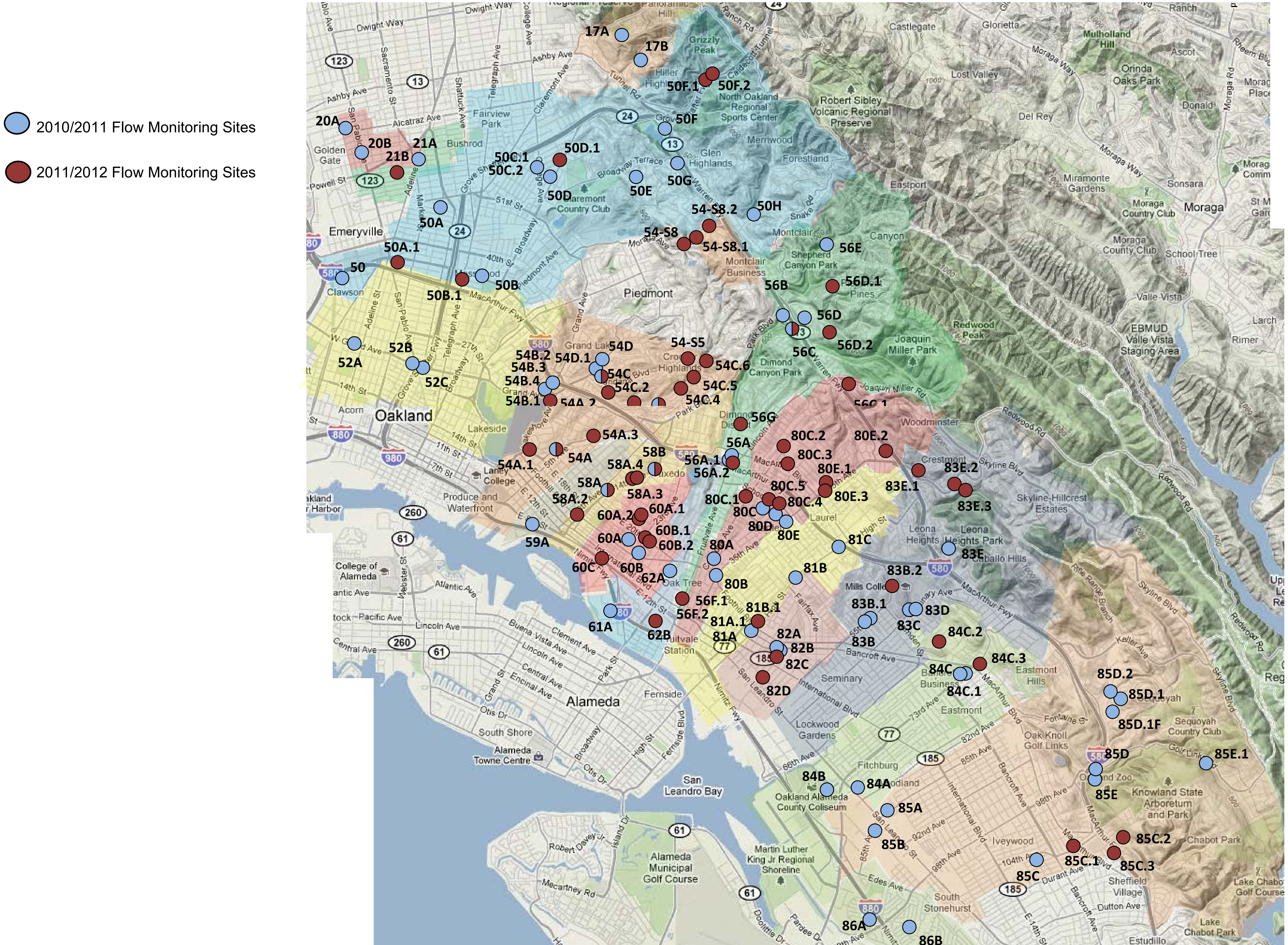


Figure 6. Flow Monitoring Site Map

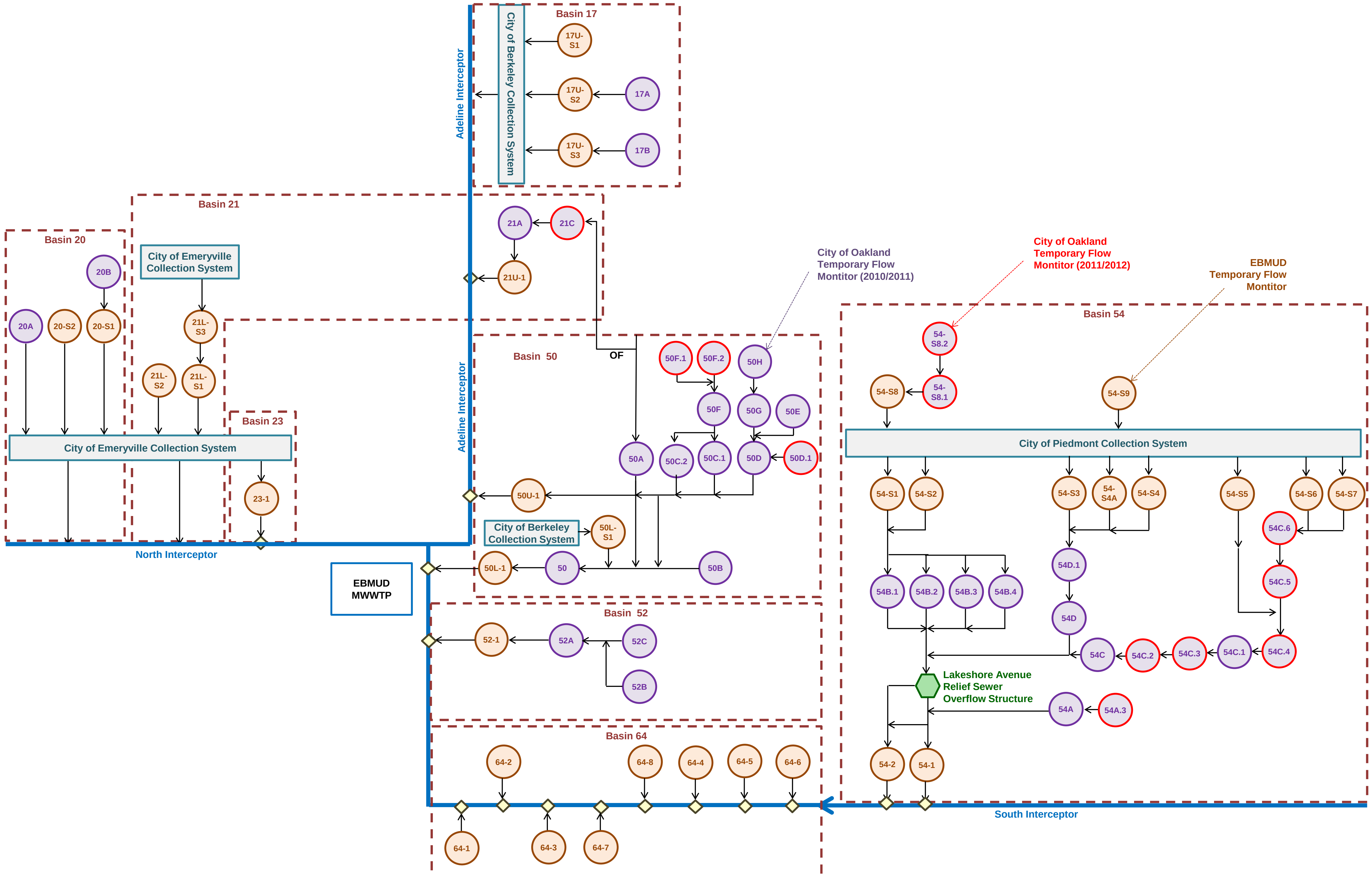


Figure 7. Flow Monitoring Locations Schematic (Page 1)

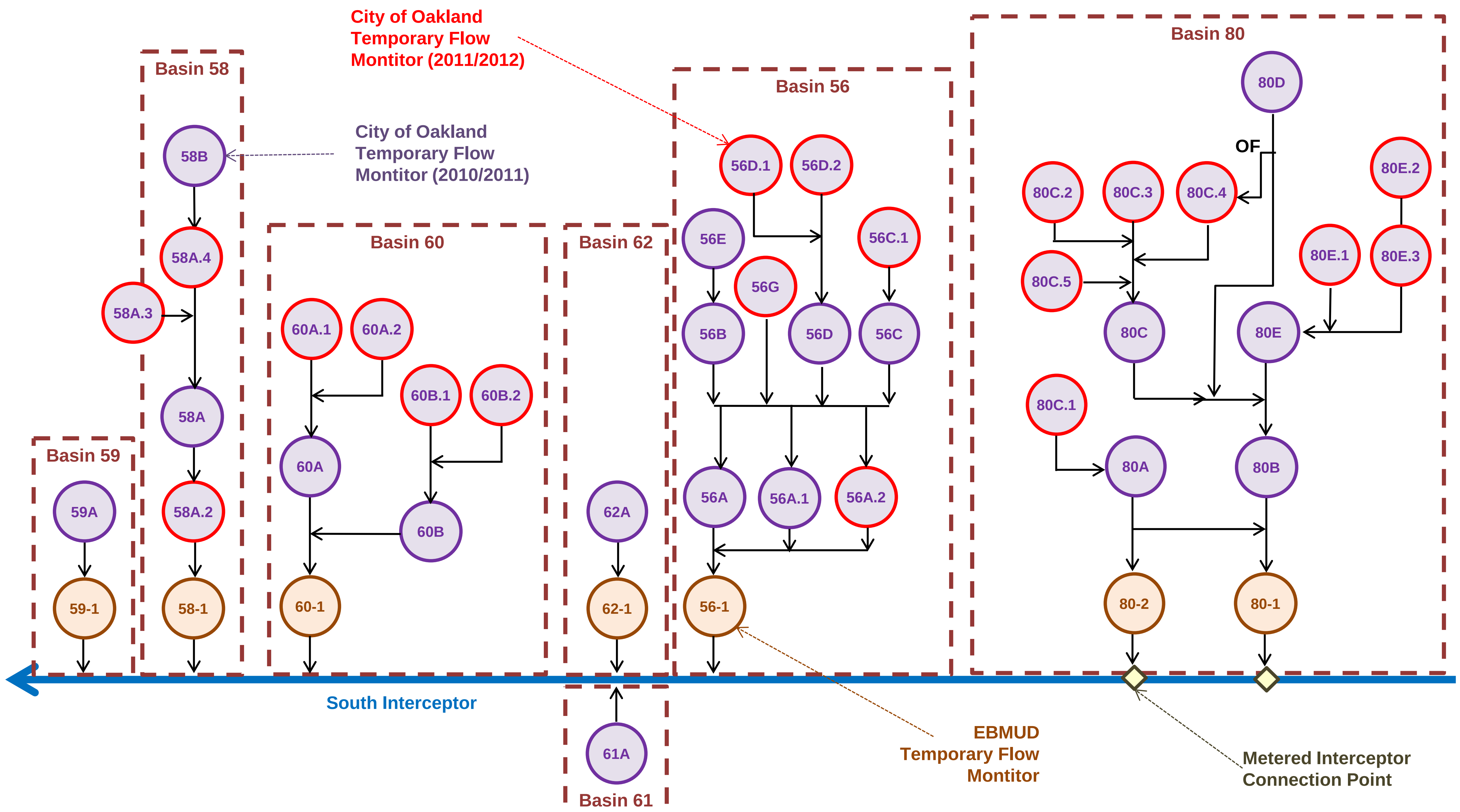


Figure 8. Flow Monitoring Locations Schematic (Page 2)

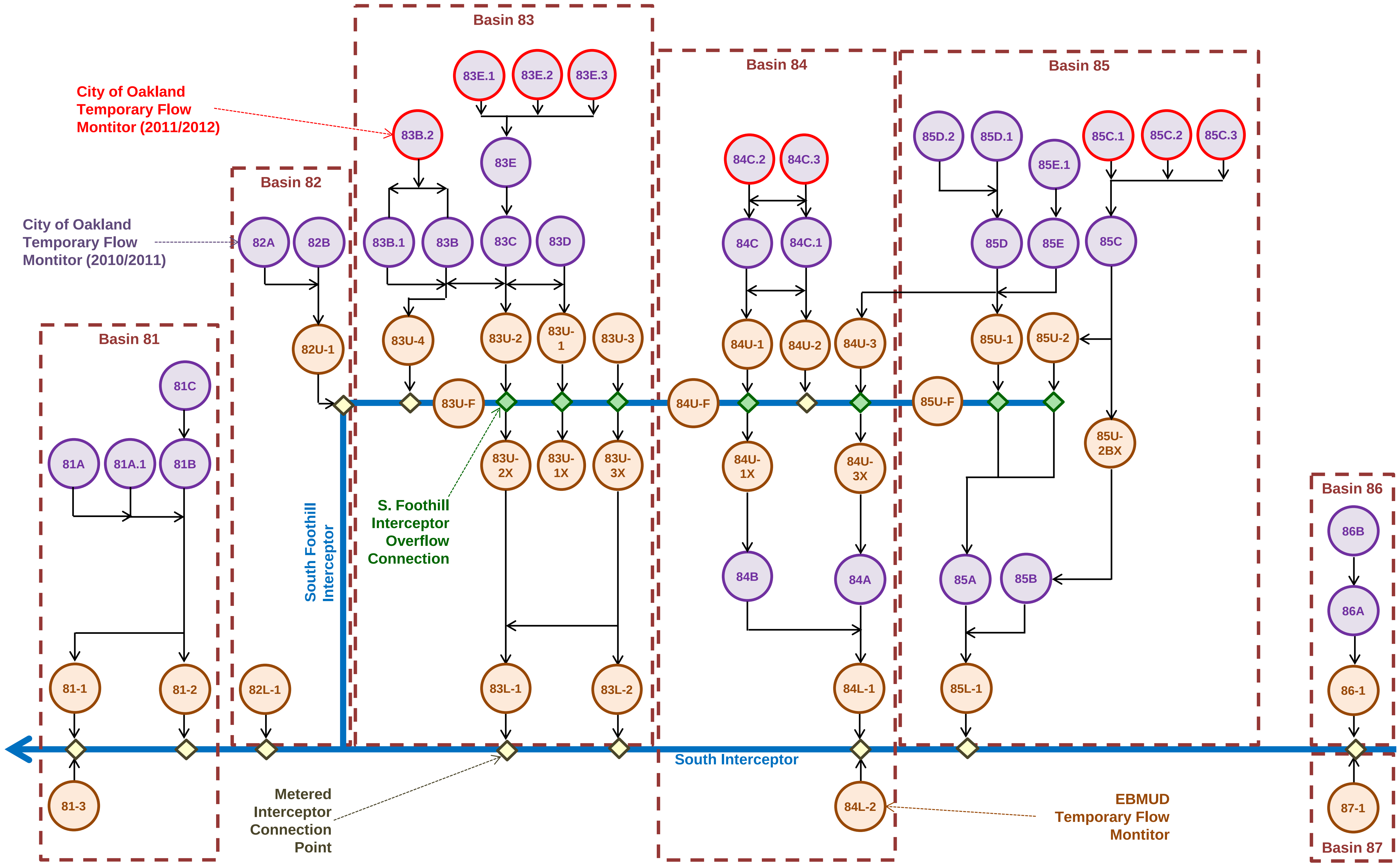


Figure 9. Flow Monitoring Locations Schematic (Page 3)

Basins

City Sewer Basins and Subbasins

The City has 22 pre-defined large sewer basins. The basins boundaries are generally defined from the drainage areas upstream from key interceptor connection points to EBMUD's North, South and Adeline Interceptors. The large City sewer basins are illustrated in Figure 10.

The City has approximately 228 pre-defined subbasins. The City sewer subbasins are illustrated in Figure 11.

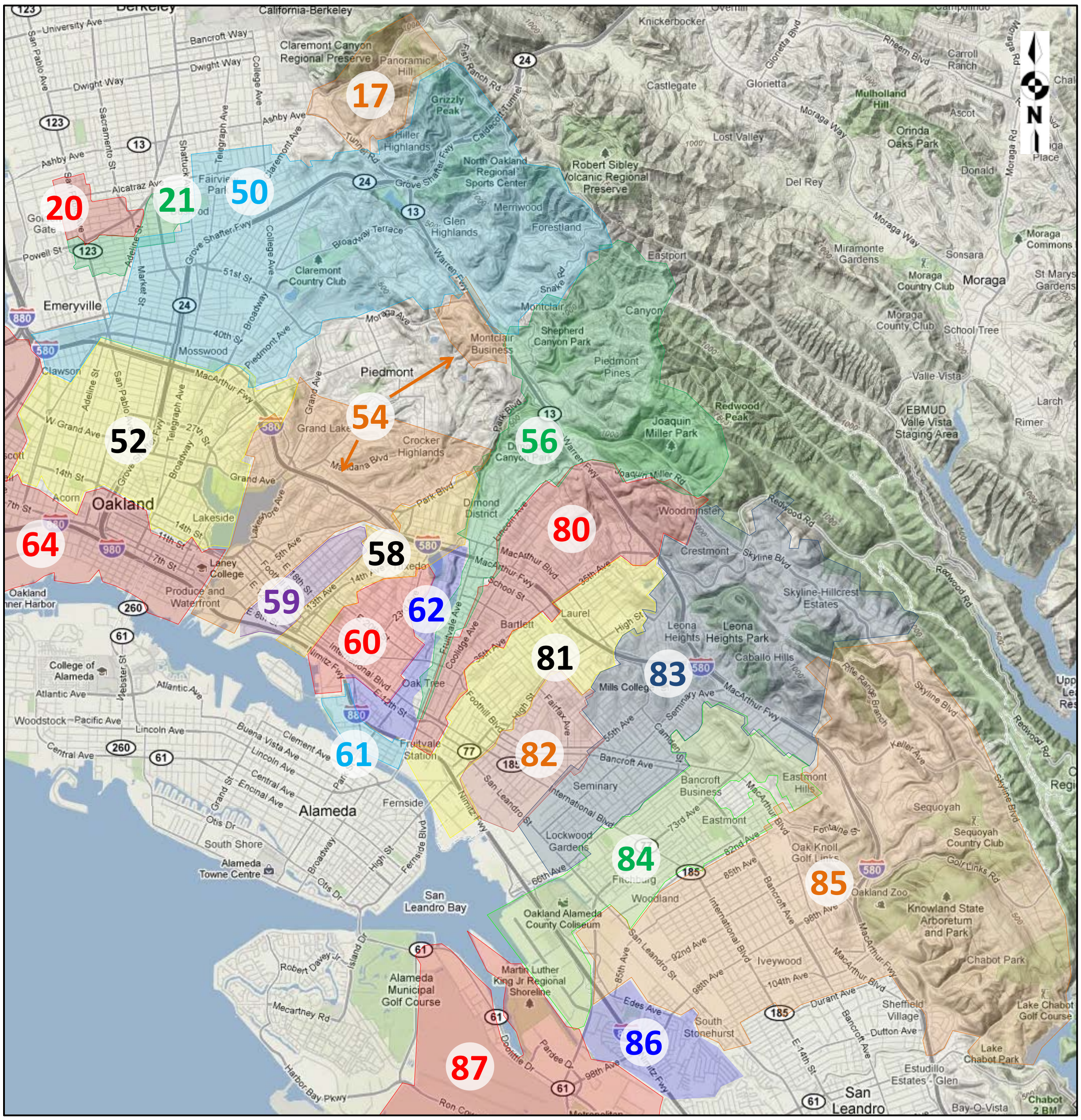


Figure 10. City Basins Map

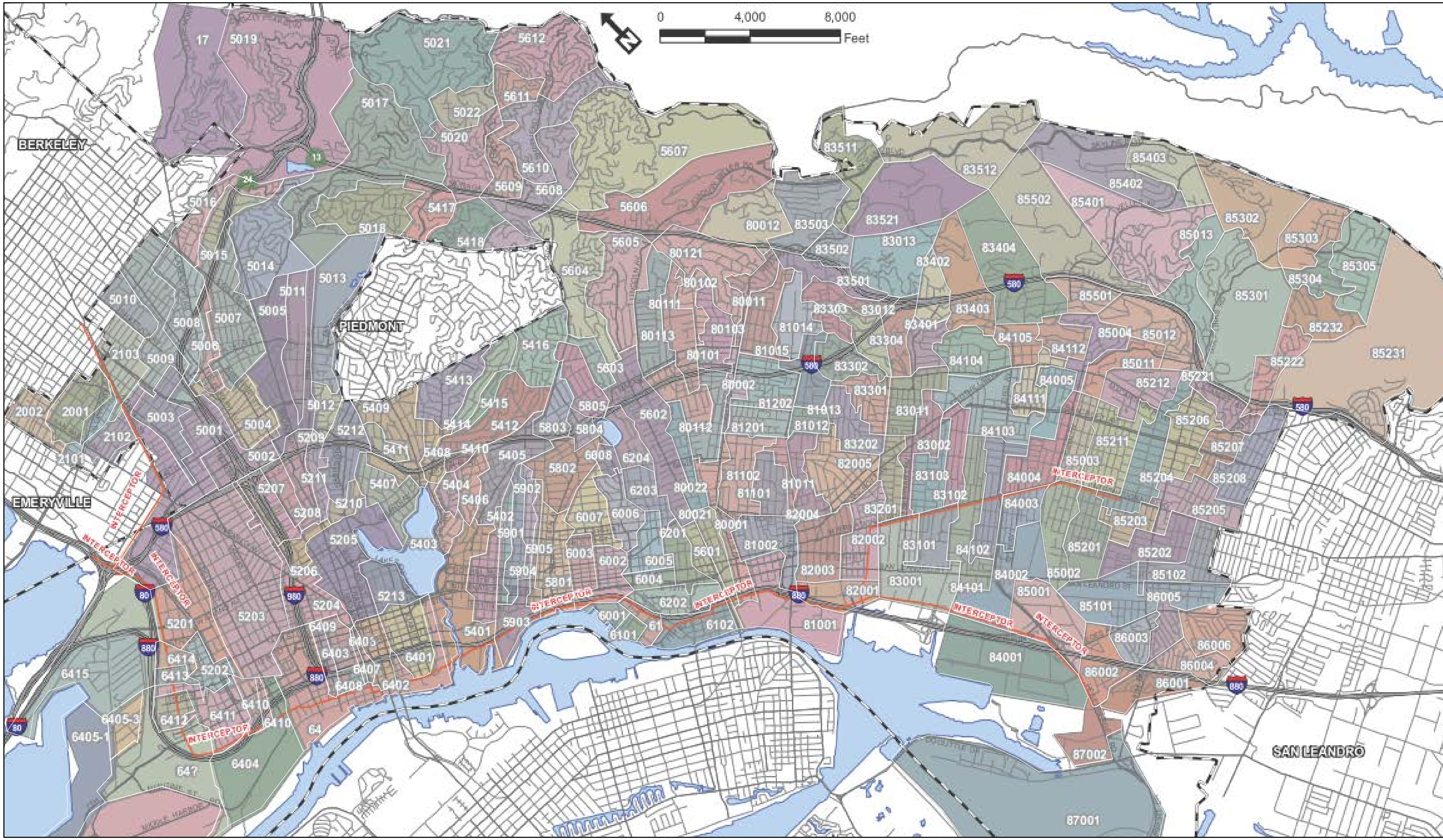


Figure 11. City Sanitary Sewer Subbasins

Flow Monitoring 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 pipelines. A basin may refer to the entire collection system upstream from a flow meter or may exclude separately monitored basins upstream. I/I analysis in this report will be conducted on a basin-by-basin basis.

Flow monitoring basins were defined by the locations of the V&A and EBMUD flow monitoring sites. The flow monitoring basins are illustrated in Figure 12.

The boundaries of the flow monitoring basins will not correspond with the City Basin and Subbasin boundaries. Throughout this report, the term "Flow Monitoring Basin" will refer to basins defined by the flow monitoring sites, "City Basin" will refer to the large basins shown in Figure 10, and "City Subbasin" will refer to the subbasins illustrated in Figure 11.

Within the City, there are several locations with cross-connections between trunk sewers or overflow bypass sewers to help equalize basins and prevent sanitary sewer overflows during peak rain events. In the course of the flow monitoring project, V&A attempted to locate and understand several of the inter-basin cross-connections; however, it is likely not all connections were found or are known. Some basins may not be definitively isolated and this may affect the behavior of flows, especially during large rainfall events.

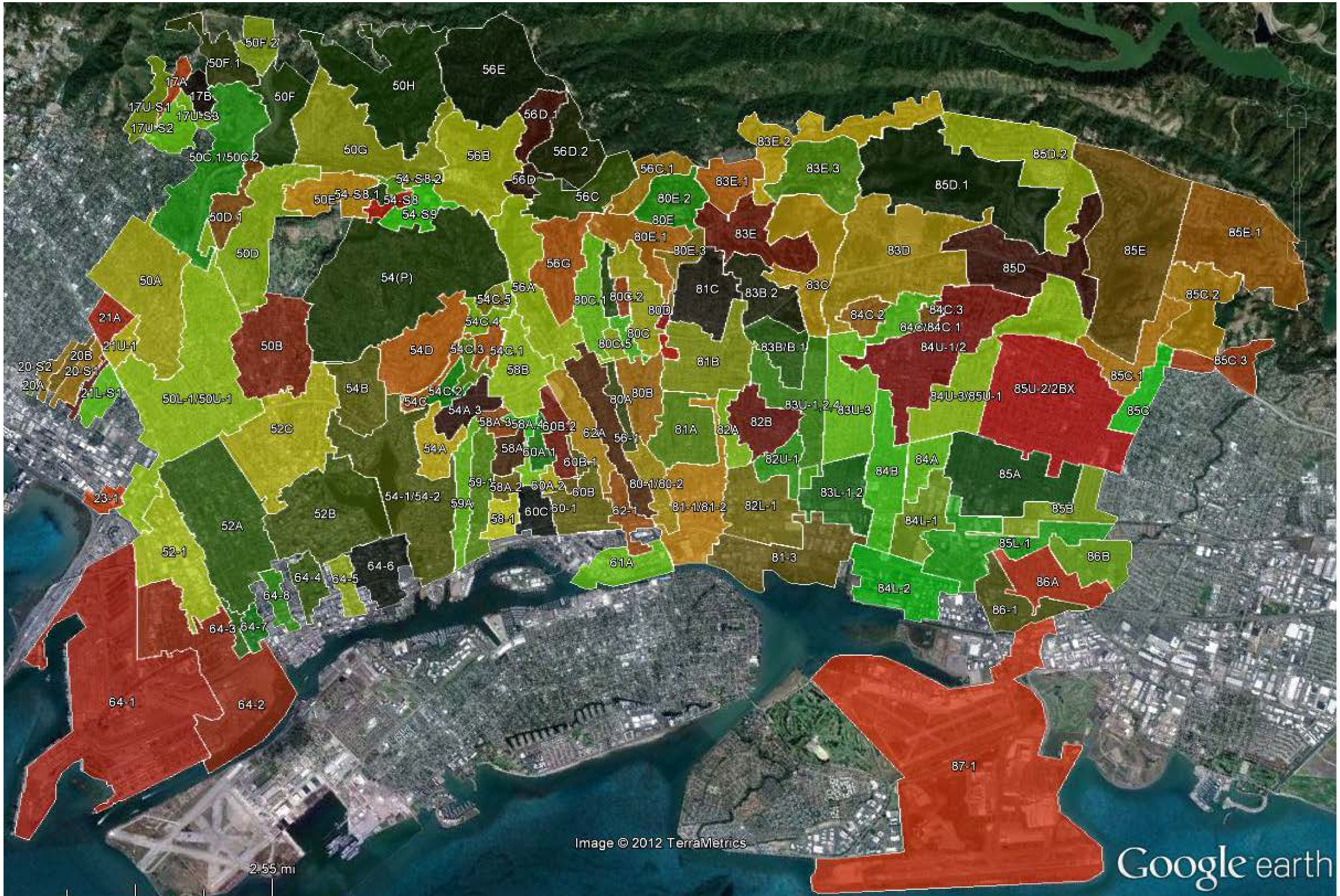


Figure 12. Flow Monitoring Basins

METHODS AND PROCEDURES

Confined Space Entry

A confined space (Photo 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 23.0%), and the absence 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. He or she is equipped with the necessary personal protective equipment to perform the job safely, including a personal four-gas monitor (Photo 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 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 prior to entering the confined space.

Photo 1. Confined Space Entry

Photo 2. Typical Personal Four-Gas Monitor

Flow Meter Installation

A combination of Teledyne Isco 2150, Hach Sigma 910, Hach Sigma 930, and Hach Marsh-McBirney Flo-Dar flow meters were installed for this project. Isco 2150 and Sigma 910 meters use a pressure transducer to collect depth readings and ultrasonic Doppler sensors on the probe to determine the average fluid velocity. Figure 13 shows a typical flow meter installation. A Flo-Dar flow meter is a non-contact flow meter that uses radar to measure velocity and a down-looking ultrasonic sensor to measure depth. Figure 14 shows a typical Flo-Dar installation.

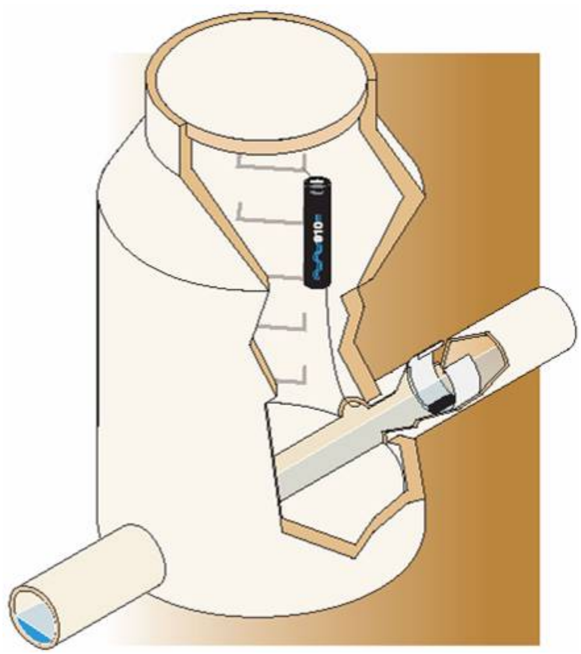


Figure 13. Typical Sigma 910 Flow Meter Installation

Figure 14. Typical Flo-Dar Flow Meter Installation

Manual level and velocity measurements were taken during installation of the flow meters and again when they were removed. These manual measurements were compared to simultaneous level and velocity readings from the flow meters to ensure proper calibration and accuracy. The pipe diameter was also verified in order to accurately calculate the flow cross-section. The continuous depth and velocity readings were recorded by the flow meters on 5-minute intervals.

Flow Calculation

Data retrieved from each flow meter was placed into a spreadsheet program for analysis. Data analysis includes data 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,

$$Q = V \cdot A$$

where Q is the volume flow rate, V is the average velocity as determined by the ultrasonic sensor, and A is the cross-sectional area of flow as determined from the depth of flow. For a circular pipe,

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

where D is the pipe diameter and d is the depth of flow.

RAINFALL MONITORING PROGRAM

2010/2011 Wet Weather Season

There were four main rainfall events that occurred over the course of the 2010/2011 flow monitoring period, summarized in Table 4 for the eight rain gauges that were installed. Detailed descriptions of the rain gauge sites, including photographs, data and graphs specific to each gauge, are included in *Appendix A*.

Table 4. 2010/2011 Rainfall Events

Rainfall Event	RG1 (in)	RG2 (in)	RG3 (in)	RG4 (in)	RG5 (in)	RG6 (in)	RG7 (in)	RG8 (in)
Individual Events								
Event 1: December 16, 2010, to December 22, 2010	2.57	3.09	4.28	2.98	2.56	2.88	2.95	3.44
Event 2: December 28, 2010, to January 2, 2011	1.91	2.09	2.77	2.14	1.87	1.93	2.23	2.52
Event 3: February 14, 2011, to February 20, 2011	3.50	2.77	4.80	3.79	3.56	3.00	3.28	4.12
Event 4: March 18, 2011, to March 26, 2011	4.57	4.81	5.96	4.53	5.39	4.77	4.84	6.09
Total Rainfall over Monitoring Period	*17.4*	*18.38*	*27.27*	*18.58*	*18.01*	*18.03*	*19.98*	*22.95*

Figure 15 graphically displays the rainfall activity recorded over the flow monitoring period. For the purposes of this section, the GARR rain data for Basin 83E was utilized. Figure 16 shows the rain accumulation plot of the period rainfall, as well as the historical average rainfall[3] in the City during this project duration. Rainfall totals were at approximately 123% of the historical normal levels during this time period. GARR-distributed rainfall for the 2010/2011 flow monitoring basins is included in *Appendix B*.

[3] Historical data taken from the WRCC: http://www.wrcc.dri.edu/summary/climsmnca.html.
Basin rainfall scaling source: hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

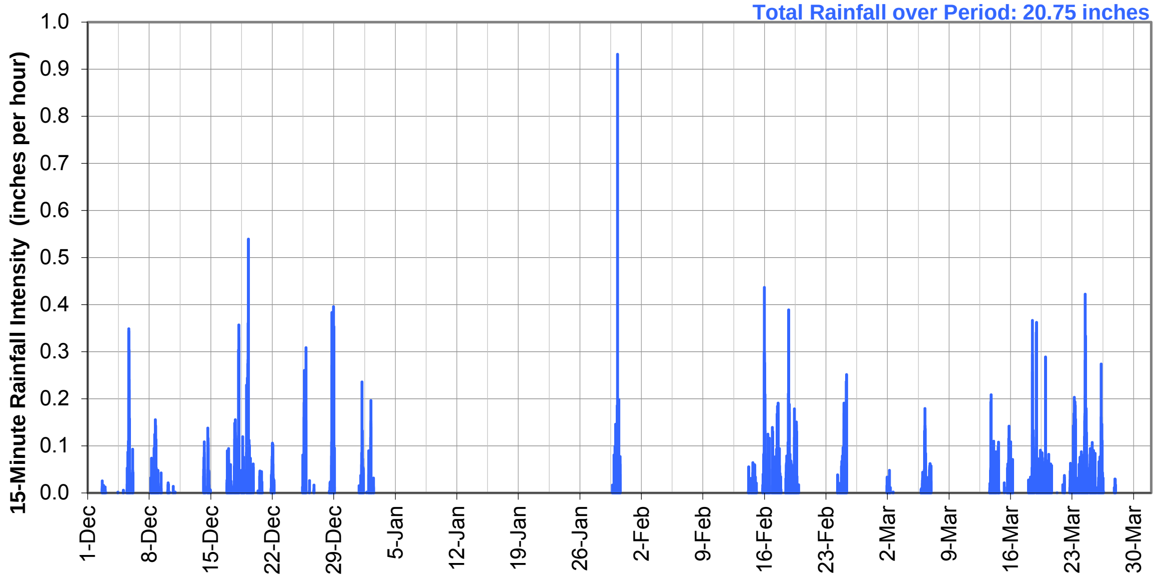


Figure 15. Rainfall Activity, 2010/2011 (Basin 83E)

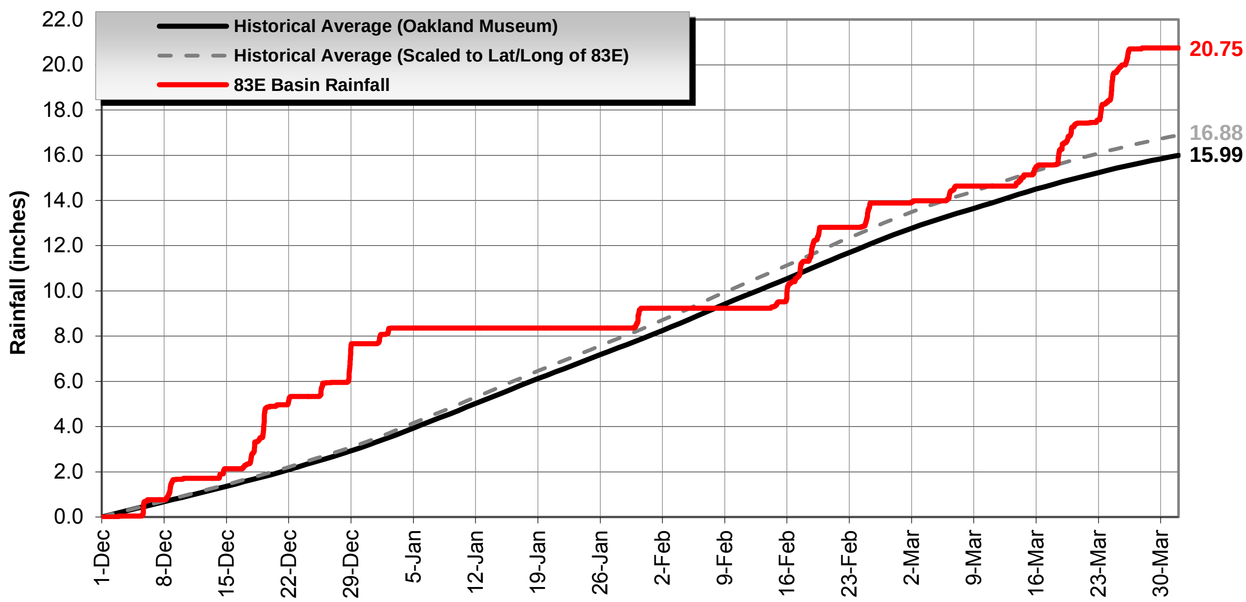


Figure 16. Rainfall Accumulation Plot, 2010/2011 (Basin 83E)

2011/2012 Wet Weather Season

There were two main rainfall events that occurred over the course of the 2011/2012 flow monitoring period, summarized in Table 5 for the seven rain gauges that were installed. Detailed descriptions of the rain gauge sites, including photographs, data and graphs specific to each gauge, are included in *Appendix A*.

Table 5. 2011/2012 Rainfall Events

Rainfall Event	RG1 (in)	RG2 (in)	RG4 (in)	RG5 (in)	RG7 (in)	RG8 (in)	RG9 (in)
Event 1: January 19 to 24, 2012	2.78	2.44	2.62	2.41	3.21	3.55	3.99
Event 2: March 13 to 17, 2012	3.93	3.32	3.84	3.93	3.70	5.61	6.46
Event 3: March 24 to 31, 2012	2.87	2.39	2.56	2.05	2.55	2.99	3.02
Total Rainfall over Monitoring Period	*10.85*	*9.28*	*9.96*	*9.38*	*11.11*	*14.02*	*15.87*

Figure 17 graphically displays the rainfall activity recorded over the flow monitoring period. For the purposes of this section, the triangulated rain data for Basin 83E was utilized. Figure 18 shows the rain accumulation plot of the period rainfall, as well as the historical average rainfall[4] in the City during this project duration. Rainfall totals were at approximately 74% of the historical normal levels during this time period. Triangulated rainfall for the 2011/2012 flow monitoring basins is included in *Appendix C*.

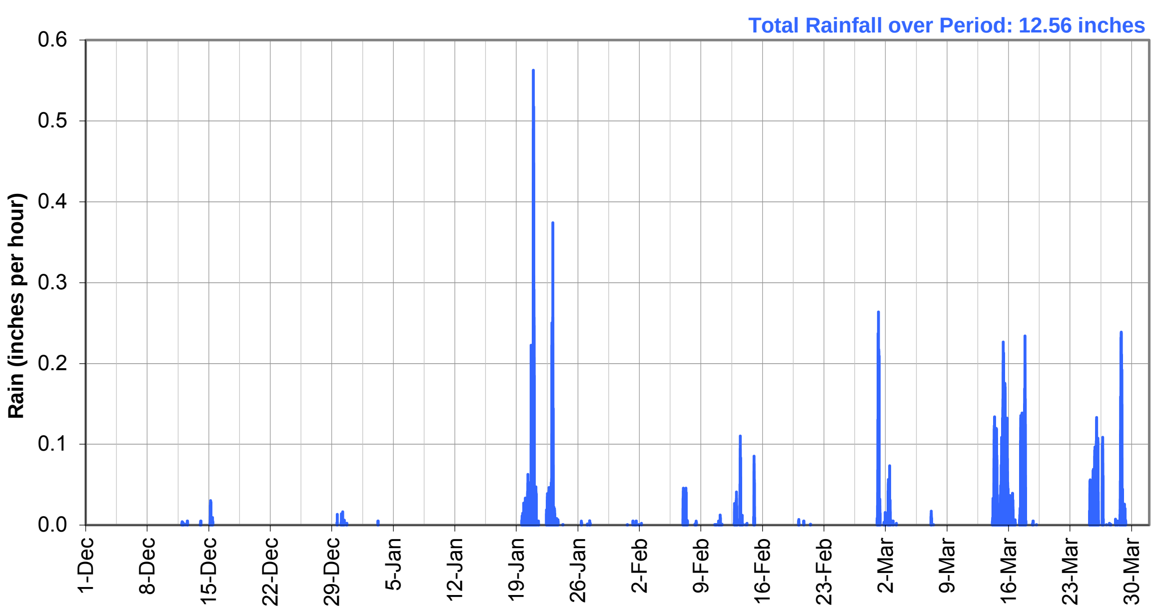


Figure 17. Rainfall Activity, 2011/2012 (Basin 83E)

[4] Historical data taken from the WRCC: http://www.wrcc.dri.edu/summary/climsmnca.html.
Basin rainfall scaling source: hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

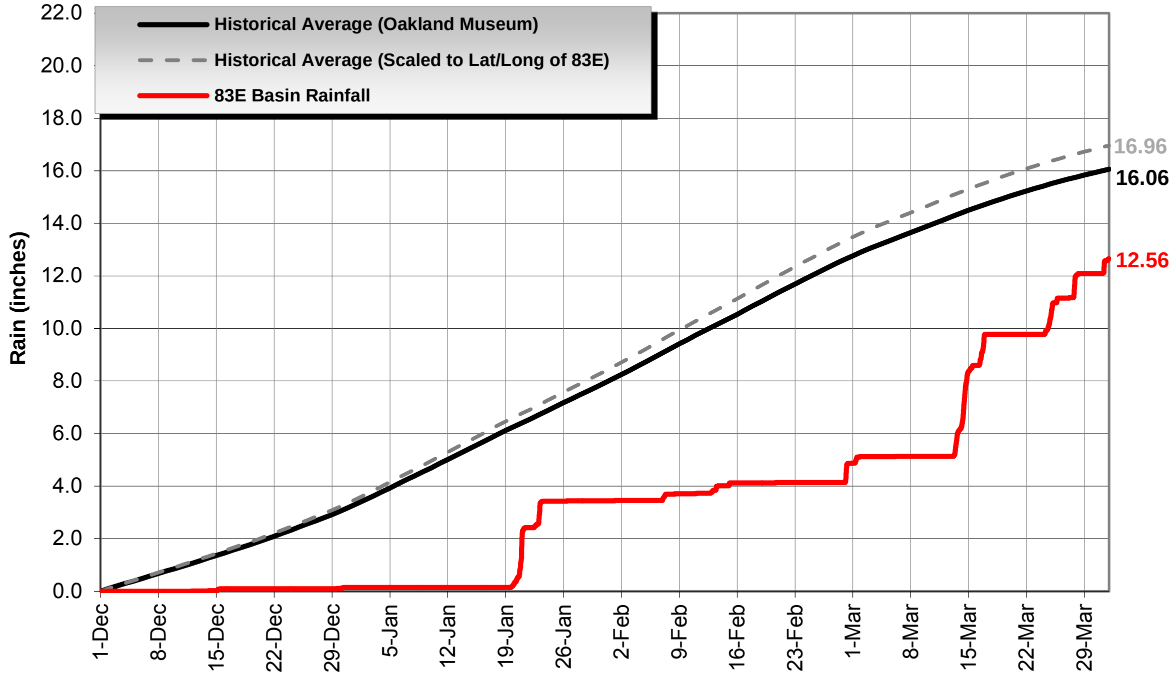


Figure 18. Rainfall Accumulation Plot, 2011/2012 (Basin 83E)

Storm 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[5]. Storm events are classified by intensity and duration. Based on historical data, frequency contour maps for storm events of given intensity and duration have been developed by the National Oceanic and Atmospheric Administration (NOAA) for all areas within the continental United States. For example, the NOAA Rainfall Frequency Atlas[6] classifies a 10-year, 24-hour storm event at the Basin 83E centroid as 4.19 inches (Figure 19). This means that in any given year, at this specific location, there is a 10% chance that 4.19 inches of rain will fall in any 24-hour period. For the purposes of this section, the rain data from Basin 83E was used.

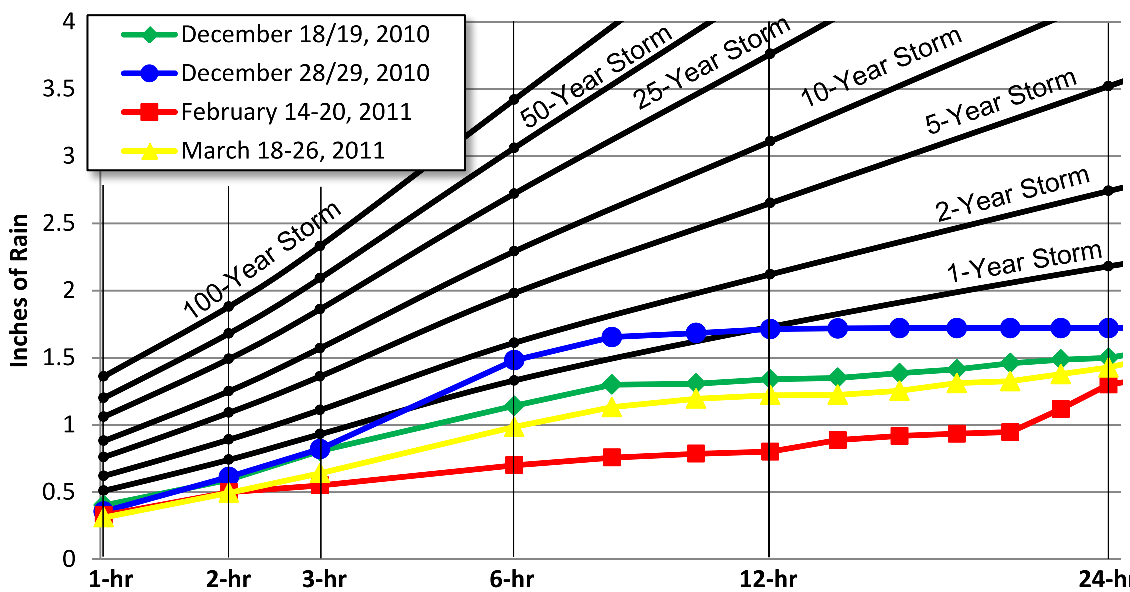
Figure 19. NOAA Northern California Rainfall Frequency Map

[5] Sanitary sewers are often designed to withstand I/I contribution to sanitary flows for "design" storm events of specific sizes.

[6] NOAA Western U.S. Precipitation Frequency Maps Atlas 2, 1973: http://www.wrcc.dri.edu/pcpnfreq.html

From the NOAA frequency maps, for a specific latitude and longitude, the rainfall densities for period durations ranging from 5 minutes to 60 days are known for rain events ranging from 1-year to 100-year intensities. These are plotted to develop a rain event frequency map specific to each rainfall monitoring site. Superimposing the peak measured densities for Events 1, 2, 3 and 4 on the rain event frequency plot determines the classification of the storm event for each rain gauge, as shown in Figure 20 for the 2010/2011 study, and in Figure 21 for the 2011/2012 study.

Table 6 summarizes the maximum classification for the four storm events for the 2010/2011 project and the three events for the 2011/2012 project for Basin 83E.



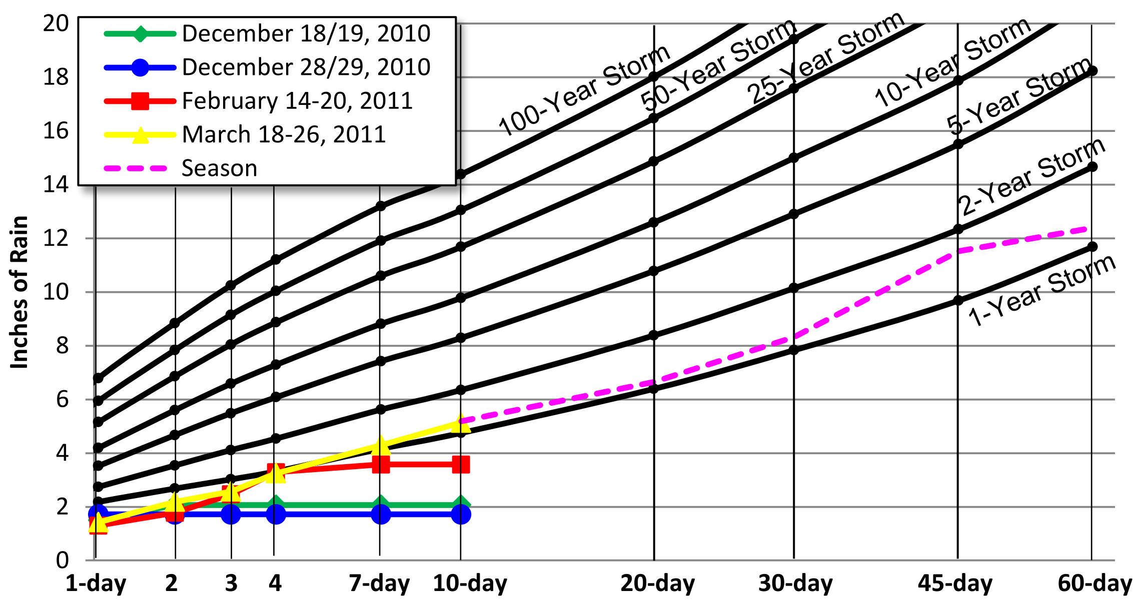


Figure 20. 2010/2011 Rainfall Event Classification (Basin 83E)

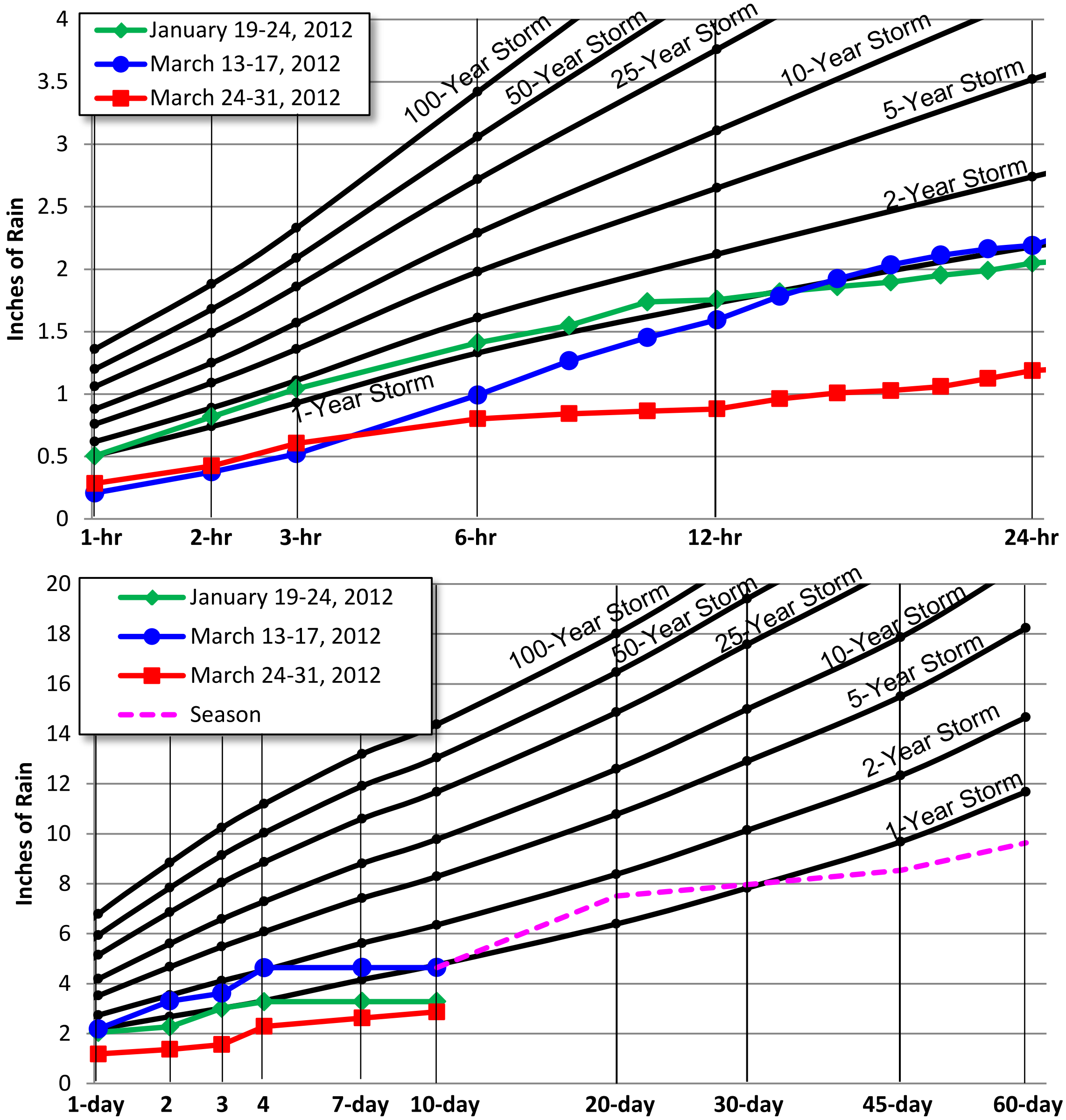


Figure 21. 2011/2012 Rainfall Event Classification (Basin 83E)

Table 6. Maximum Classification of Rainfall Events

Rainfall Event	Basin 83E (in)
2010/2011 Flow Monitoring	
Event 1: December 16 to December 22, 2010	< 1 year
Event 2: December 28, 2010, to January 2, 2011	1.5-year, 8-hour
Event 3: February 14 to February 20, 2011	1-year, 4-day
Event 4: March 18 to March 26, 2011	1-year, 10-day
2011/2012 Flow Monitoring	
Event 1: January 19 to January 24, 2012	1-year, 10-hour 1-year, 4-day
Event 2: March 13 to March 17, 2012	1-year, 24-hour 2-year, 4-day
Event 3: March 24 to March 31, 2012	< 1 year

Year 2010/2011 Notes

It is noted that Event 3 and Event 4 were longer, sustained rainfall events involving smaller storms that were “stacked” back-to-back. These longer-duration stacked rainfall events create high soil saturation levels. From this saturated soil condition, it makes sense that the greatest I/I response was observed in the system during the mid-February and March 2011 storm events. For this reason, the period of February 14 through March 31, 2011 was selected for I/I analysis.

Year 2011/2012 Notes

The greatest I/I response for this season occurred on March 14, 2012 in the midst of the more intense 1-year, 24-hour event portion of the storm. Prior to the highest intensity rainfall rates on March 14, there were 24 hours of solid rainfall, which should have caused a “mostly” saturated soil condition. The rainfall from March 16 to March 17 was less intense than during March 14, but took place during probable high soil saturation conditions. The period of March 14 through March 31, 2012 was selected for I/I analysis.

2010/2011 EBMUD FLOW MONITORING PROGRAM

As part of the EBMUD flow monitoring program, 71 flow meters were installed in the City's collection system, and were generally located at most of the City's connections to the EBMUD interceptor system. EBMUD also installed flow meters where wastewater is conveyed from one EBMUD member agency's collection system to another member agency's collection system (e.g., flow meters were installed to capture flows from the City of Piedmont sewers to the City of Oakland sewers).

Since the EBMUD flow monitoring sites were at the City's connections to the EBMUD interceptor system, an I/I analysis can be conducted on the 22 City Basins (major basins) to determine which basins are contributing the most infiltration and inflow relative to basin size. Additionally, the basins can be summed to determine the flow monitoring and I/I analysis data for the overall City collection system.

Examples within this section will be utilized to explain in detail the analysis methods used throughout this report. Subsequent sections will not include such detailed examples.

City Basin Flow Calculation

The 22 City Basins were calculated from the furthest downstream flow monitoring site(s) entering the EBMUD interceptor(s). For example, as shown in Figure 22 (referencing the Figure 7 flow schematic), the total flow from Basin 52 is taken directly from EBMUD Site 52-1. Basin 64 flows are calculated as the sum of flows from EBMUD Sites 64-1, 64-2, 64-3, 64-4, 64-5, 64-6, 64-7 and 64-8.

Basin 52 = 52-1
Basin 64 = 64-1 + 64-2 + 64-3 + 64-4 + 64-5 + 64-6 + 64-7 + 64-8

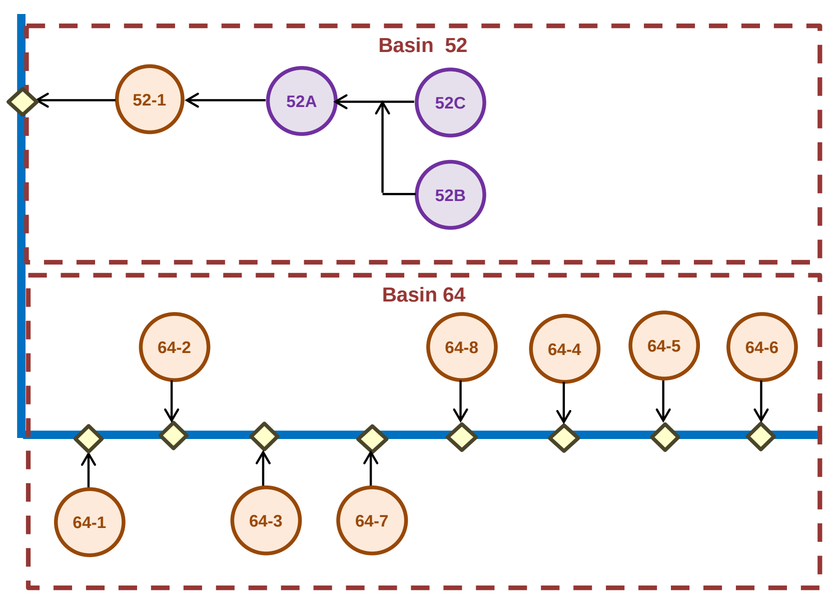


Figure 22. City Basin Flow Calculation (Basins 52 and 64)

Basins 17, 20, 21, 23, 50 and 54 involve common borders with other Satellite agencies. For the City of Berkeley and the City of Emeryville, the boundary conditions were monitored and the affecting flows were adjusted so that flows from Oakland were isolated. For example, the City Basin 21 flows would be calculated as follows (Figure 23):

City Basin 21 = (21L-S1 + 21L-S2 + 21U-1) – (21L-S3)

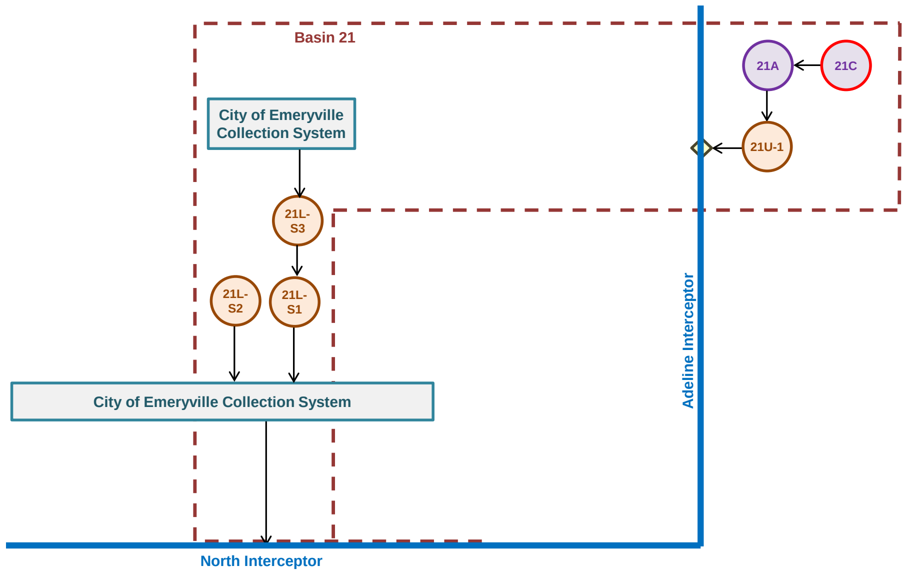


Figure 23. City Basin Flow Calculation (Basin 21)

The City of Piedmont is unique because the city limits are completely enclosed within the City of Oakland city limits, and completely defined within Basin 54. Flows for Basin 54 were determined as follows (Figure 24):

City of Piedmont = (54-S1 + S2 + S3 + S4 + S4A + S5 + S6 + S7) – (54-S8 + S9)
Basin 54 (Oakland Contribution) = (54-1 + 54-2) – (City of Piedmont)

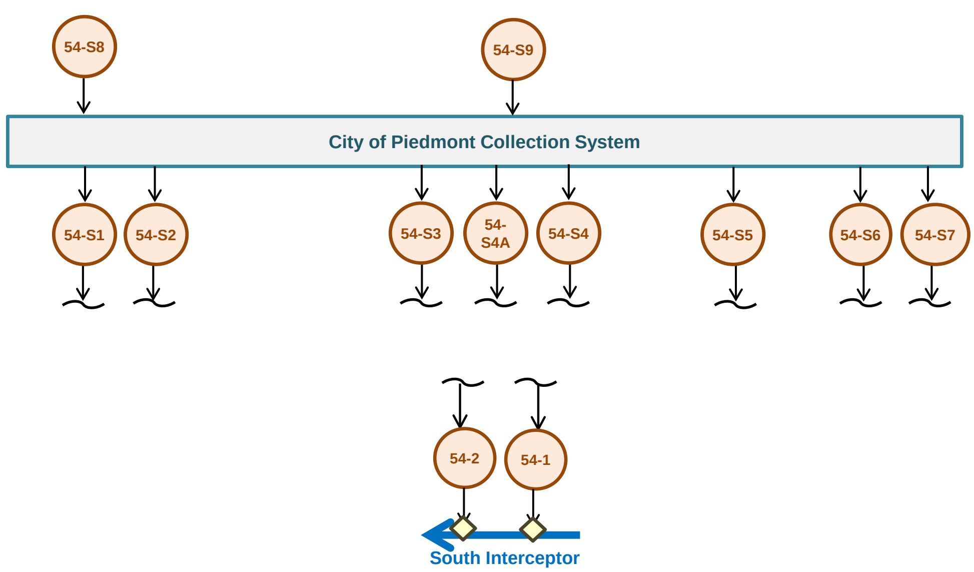


Figure 24. City Basin Flow Calculation (Basin 54 and Piedmont)

Average Dry Weather Flow Data

Weekday and weekend flow patterns differ and must be separated when determining average dry weather flows. Days least affected by rainfall were used to estimate weekend and weekday average flows. Table 7 shows the average dry weather flow (ADWF) recorded during this study for each City Basin. Figure 25 illustrates a typical variation of weekday and weekend flow, as recorded for Basin 52.

Table 7.
Dry Weather Flow Summary

City Basin	Weekday ADWF (mgd)	Weekend ADWF (mgd)	Overall ADWF (mgd)	Weekend/ Weekday Ratio
Basin 17	0.18	0.19	0.18	1.08
Basin 20	0.26	0.25	0.26	0.98
Basin 21	0.40	0.44	0.41	1.08
Basin 23	0.13	0.13	0.13	0.98
Basin 50	4.61	4.78	4.66	1.04
Basin 52	4.96	4.61	4.86	0.93
Basin 54 (O)	3.42	3.59	3.47	1.05
Basin 54 (P)	0.91	0.92	0.91	1.01
Basin 56	1.70	1.76	1.72	1.03
Basin 58	1.46	1.42	1.45	0.97
Basin 59	0.63	0.65	0.63	1.04
Basin 60	0.73	0.74	0.73	1.01
Basin 61	0.16	0.17	0.16	1.04
Basin 62	0.32	0.33	0.32	1.01
Basin 64	1.69	1.55	1.65	0.91
Basin 80	1.75	1.78	1.76	1.01
Basin 81	1.74	1.88	1.78	1.08
Basin 82	0.99	1.03	1.00	1.04
Basin 83	2.31	2.45	2.35	1.06
Basin 84	1.83	1.96	1.87	1.07
Basin 85	3.05	3.26	3.11	1.07
Basin 86	0.68	0.70	0.68	1.03
Basin 87	0.34	0.31	0.33	0.91
City of Oakland Total:	33.22	33.82	33.39	1.02

(O) = Oakland Contribution, (P) = Piedmont Contribution

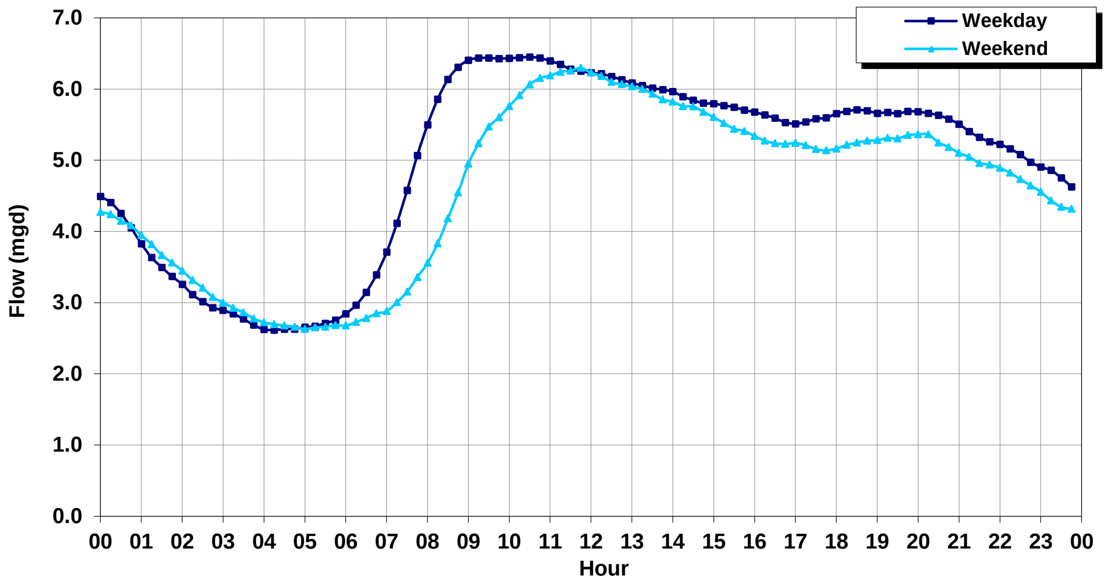


Figure 25. Typical Weekday vs. Weekend Dry Weather Flow Variation (Basin 52)

Wet Weather Flow Data

Flow monitoring data was evaluated to determine how the collection system responds to wet weather events. The period from mid-February to late-March, 2011 was selected for I/I analysis because the storms that occurred during this time period produced the greatest I/I response within the system. For many of the flow monitoring sites, the flows did not return to baseline levels between the mid-February and mid-March storm events. As a result, I/I analysis was conducted over the full period that encompasses both events from February 14 through March 31, 2011.

Figure 26 shows an example of the wet weather response at City Basin 52 from February 13 to February 24, 2011. As can be seen in the figure, there was a significant response to the rainfall during the wet weather events of this period. This wet weather response data was analyzed for infiltration and inflow (I/I).

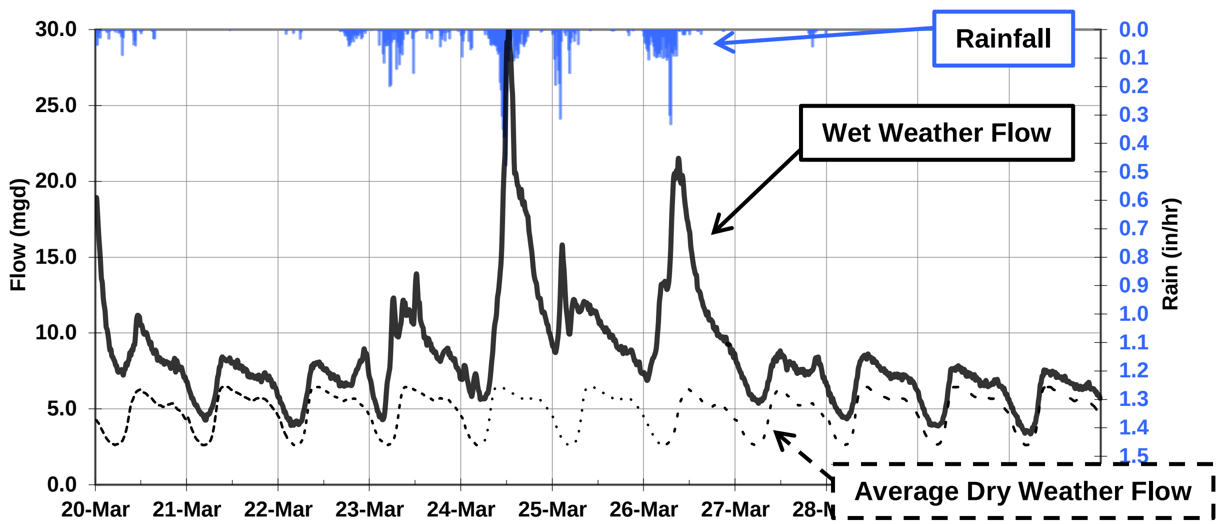


Figure 26. Example Wet Weather Flow Response (City Basin 52)

Figure 27 shows an example of the period flow summary for City Basin 52. On this graph, the user can determine the rainfall and the minimum, maximum and average flows per day across the full 2010/2011 flow monitoring period.

These illustrations allow for quick summarization of flow monitoring site I/I characteristics. For example, it is quickly observed that March 24 had the highest wet weather flows for City Basin 52. On March 24, the average flow rate was approximately 13 mgd, which is approximately 8 mgd higher than the expected ADWF of 5 mgd. On this day, the peak flow rate measured roughly 31 mgd.

The period flow summaries for the City Basins for the 2010/2011 flow monitoring period are shown in *Appendix D*.

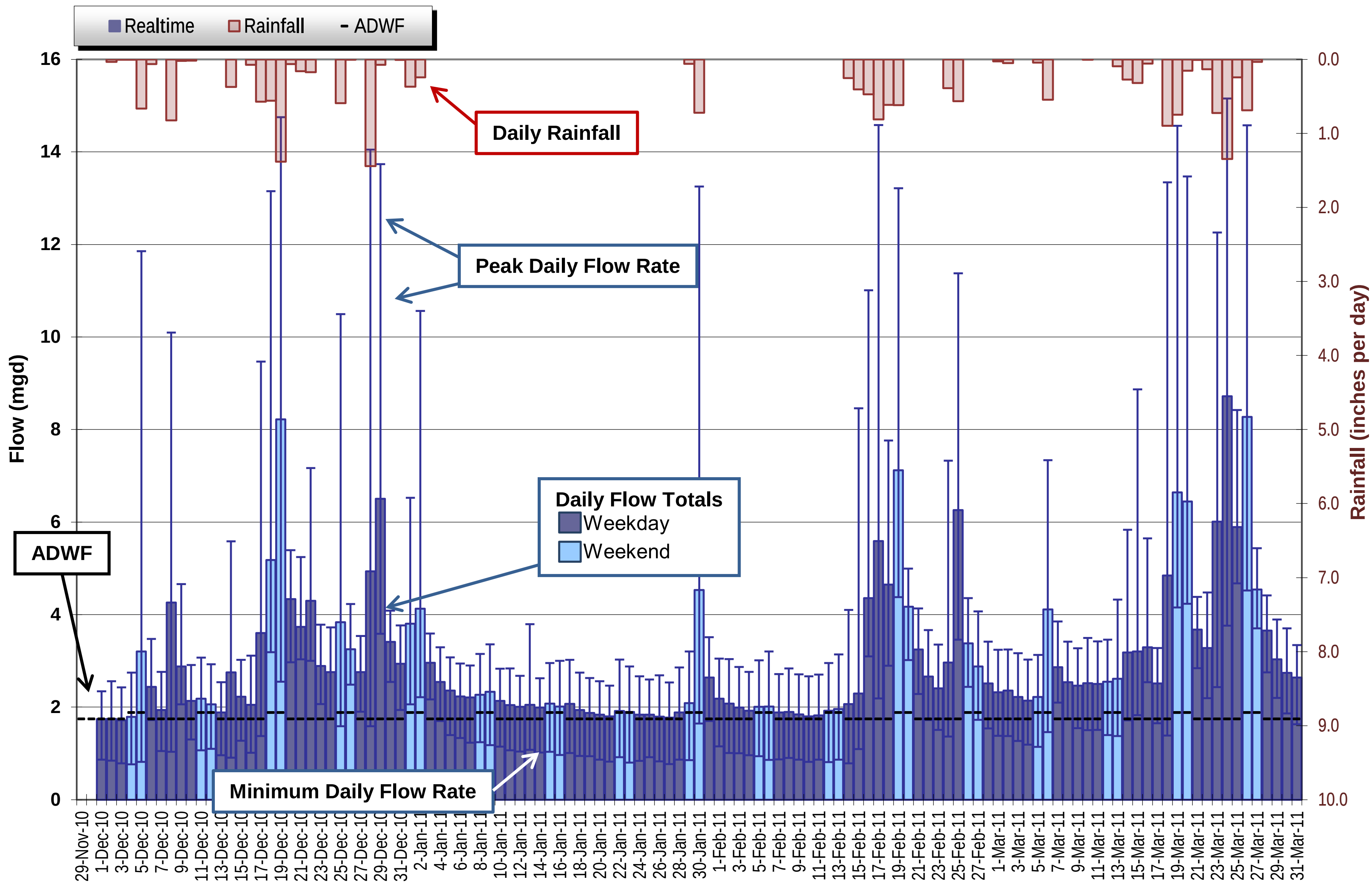


Figure 27. 2010/2011 Period Flow Summary (City Basin 52)

Inflow / Infiltration: Definitions and Identification

Inflow and infiltration (I/I) consist of storm water and groundwater that enter the sewer system through pipe defects and improper storm drainage connections. They are distinguished as follows:

Inflow

- **Definition:** Storm water inflow is defined as water discharged into the sewer system, including private sewer laterals, direct connections such as downspouts, yard and area drains, holes in manhole covers, cross-connections from storm drains, or catch basins.
- **Impact:** This component of I/I 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. Because the response and magnitude of inflow is tied closely to the intensity of the storm event, the short-term peak instantaneous flows may result in surcharging and overflows within a collection system. Severe inflow may result in sewage dilution, resulting in the upset of the biological, or secondary, treatment at the treatment facility.
- **Cost of Source Identification and Removal:** Inflow locations are usually less difficult to find and less expensive to correct than infiltration sources. Inflow sources include direct and indirect cross-connections with storm drainage systems, roof downspouts, and various types of surface drains. Generally, the costs to identify and remove sources of inflow are low compared to potential benefits to public health and safety or the costs of building new facilities to convey and treat the resulting peak flows.
- **Graphical Identification:** Inflow is usually recognized graphically by large-magnitude, short-duration spikes immediately following a rain event.

Infiltration

- **Definition:** Infiltration is defined as water entering the sanitary sewer system through defects in pipes, pipe joints, and manhole walls, which may include cracks, offset joints, root intrusion points, and broken pipes.
- **Impact:** Infiltration typically creates long-term annual volumetric problems. The major impact is the cost of pumping and treating the additional volume of water, and of paying for treatment (for municipalities that are billed strictly on flow volume).
- **Cost of Source Detection and Removal:** Infiltration sources are usually harder to find and more expensive to correct than inflow sources. Infiltration sources include defects in deteriorated sewer pipes or manholes that may be widespread throughout a sanitary sewer system.
- **Graphical Identification:** Infiltration is often recognized graphically by a gradual increase in flow after a wet-weather event. The increased flow typically sustains for a period after rainfall has stopped and then gradually drops off as soils become less saturated and as groundwater levels recede to normal levels.

Components of Infiltration

Infiltration can be further subdivided into components as follows:

- **Groundwater Infiltration (GWI):** Groundwater infiltration depends on the depth of the groundwater table above the pipelines, as well as the percentage of the system submerged. The variation of groundwater levels and subsequent groundwater infiltration rates is seasonal by nature. On a day-to-day basis, groundwater infiltration rates are relatively steady and will not fluctuate greatly.

- **Rainfall-Dependent Infiltration (RDI):** This component occurs as a result of storm water and enters the sewer system through pipe defects, as with groundwater infiltration. The storm water first percolates directly into the soil and then migrates to an infiltration point. Typically, the time of concentration for rainfall-related infiltration may be 24 hours or longer, but this depends on the soil permeability and saturation levels.
- **Rainfall-Responsive Infiltration (RRI):** This component is storm water which enters the collection system indirectly through pipe defects, and normally occurs in sewers constructed close to the ground surface, such as private laterals. Rainfall-responsive infiltration is independent of the groundwater table and reaches defective sewers via the pipe trench in which the sewer is constructed, particularly if the pipe is placed in impermeable soil and bedded and backfilled with a granular material. In this case, the pipe trench serves as a conduit similar to a French drain, conveying storm drainage to defective joints and other openings in the system. This type of infiltration can have a quick response and graphically can look very similar to inflow.

Figure 28 illustrates the possible sources and components of I/I.

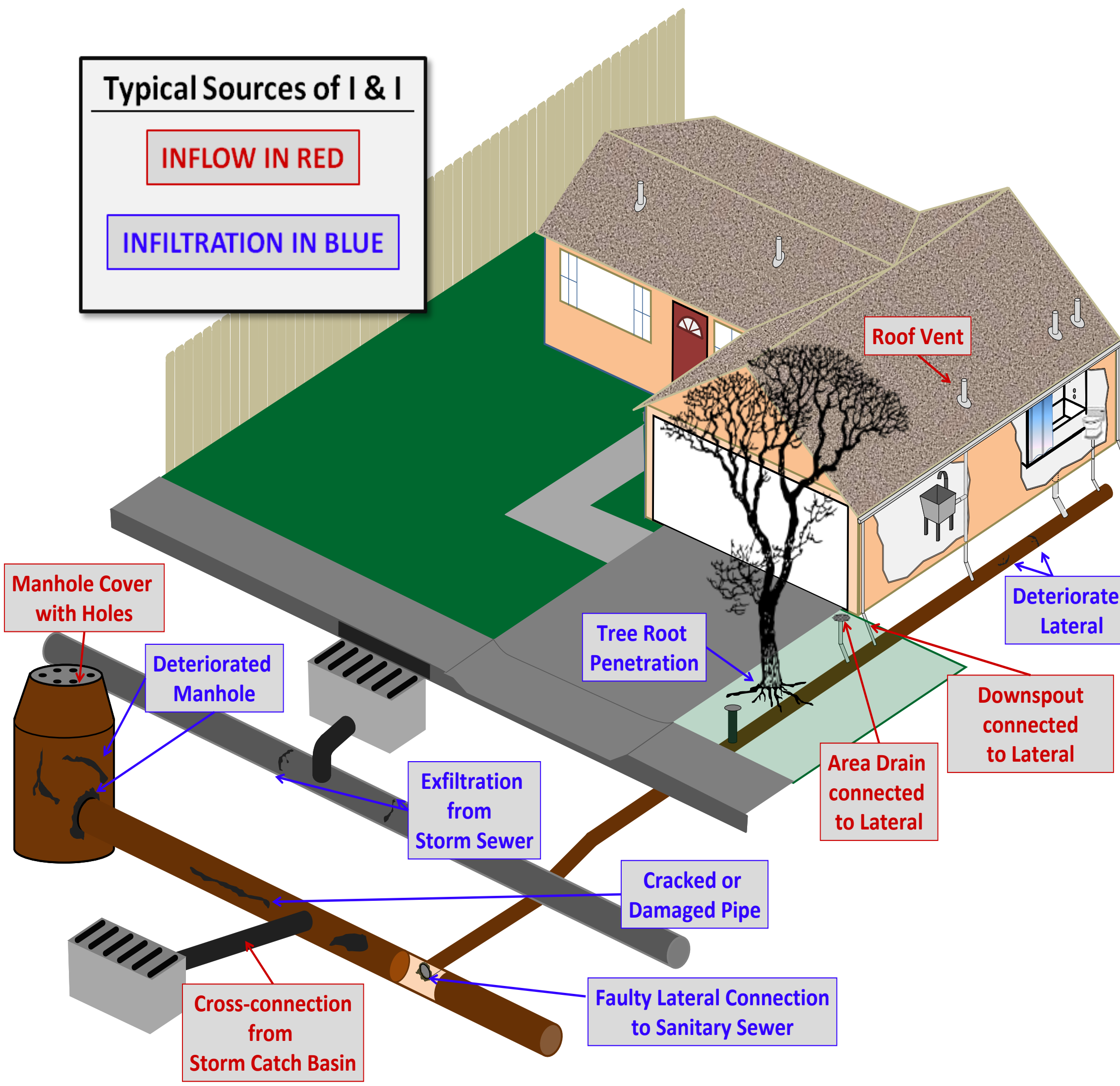


Figure 28. Typical Sources of Infiltration and Inflow

Inflow / Infiltration: Overview of Analysis Methods

After differentiating I/I flows from ADWF flows, various calculations can be made (1) to determine which I/I component (inflow or infiltration) is more prevalent at a particular site and (2) to compare the relative magnitude of the I/I components between drainage basins and between storm events.

Inflow Analysis

Peak I/I Flow Rate: Inflow is characterized by sharp, direct spikes occurring during a rainfall event. Peak I/I rates are used for inflow analysis[7]. After determining the peak I/I flow rate for a given site, and for a given storm event, there are ways to *normalize* the peak I/I rates for an "apples-to-apples" comparison amongst the different drainage basins:

- **Peaking Factor:** Peak measured flow rate divided by average dry weather flow (ADWF). This is a ratio and is expressed without units.

Infiltration Analysis

RDI Rate: Infiltration occurring after the conclusion of a storm event is classified as rainfall-dependent infiltration. Analysis is conducted by looking at the infiltration rates at set periods after the conclusion of a storm event. Depending on the system and the time required for flows to return to ADWF levels, RDI may be examined after different time periods to determine the basins with the greatest or most sustained rainfall-dependent infiltration rates. For this study, the infiltration rates on March 16, 20 and 28, 2011 were calculated and averaged[8]. This RDI rate was divided by average dry weather flow (ADWF). This is a ratio and is expressed without units as a percentage.

Combined I/I Analysis

Total Infiltration: The total inflow and infiltration is measured in gallons per site and per storm event. Because it is based on total I/I volume, it is an indicator of combined inflow and infiltration and is used to identify the overall volumetric influence of I/I within the monitoring basin. As with inflow, pipe length, basin area, and dry weather flow are used to normalize combined I/I for basin comparison:

- **R-Value:** Total infiltration (gallons) divided by the total rainfall that fell within the acreage of a particular basin (gallons of rainfall). This is expressed as a percentage and is explained as "the percent of rain that enters the sanitary sewer collection system." Systems with R-values less than 5%[9] are often considered to be performing well.

[7] I/I flow rate is the realtime flow less the estimated average dry weather flow rate. It is an estimate of flows attributable to rainfall. By using peak measured flow rates (inclusive of ADWF), the I/I flow rate would be skewed higher or lower depending on whether the storm event I/I response occurs during low flow or high flow hours.

[8] These dates were used because there was a period of dry weather immediately following a good sized rainfall event, when soil saturation levels were still high, but the effects of inflow would be minimal.

[9] Keefe, P.N. "Test Basins for I/I Reduction and SSO Elimination." 1998 WEF Wet Weather Specialty Conference, Cleveland.

Figure 29 illustrates a sample of how this analysis is conducted and some of the measurements that are used to distinguish infiltration and inflow. Similar graphs generated for the individual flow monitoring sites can be found in *Appendix B*.

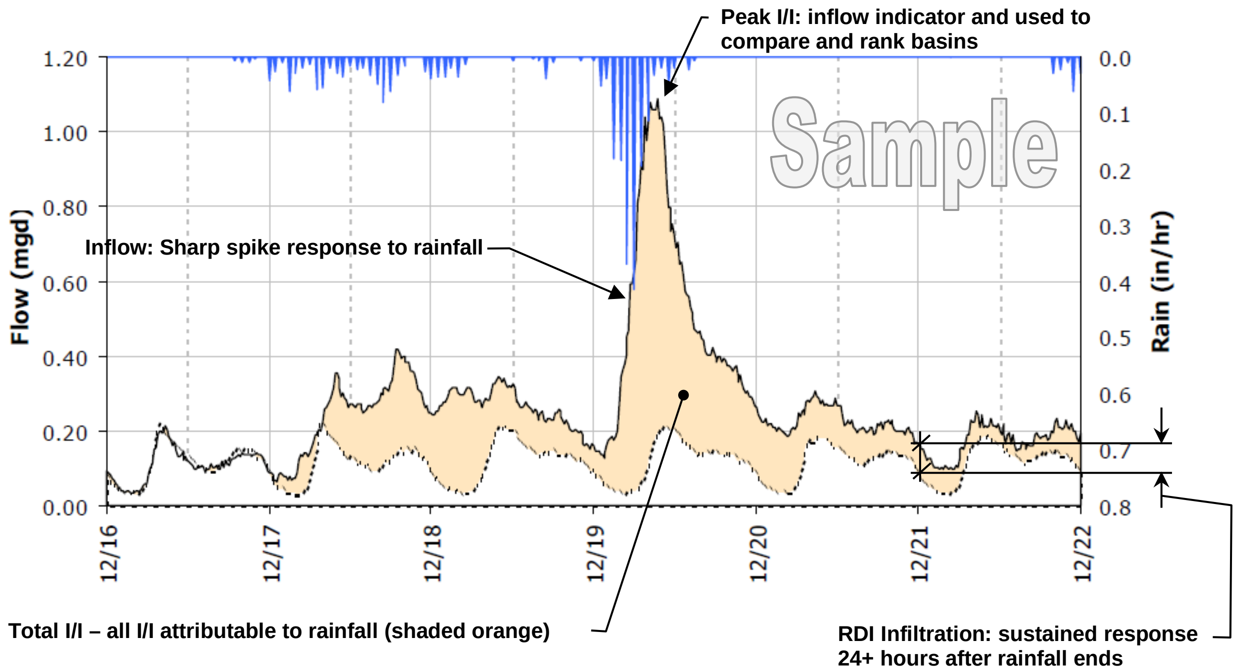


Figure 29. Sample Infiltration and Inflow Isolation Graph

CITY BASIN INFLOW / INFILTRATION RESULTS

Table 8 summarizes the inflow, RDI infiltration and combined I/I analysis results. Figure 30, Figure 31 and Figure 32 show bar graph summaries of the inflow, RDI infiltration and combined I/I analysis results, respectively. Figure 33, Figure 34 and Figure 35 show temperature map summaries of the inflow, RDI infiltration and combined I/I analysis results for the City Basins, respectively.

Table 8.
City Basin I/I Analysis Summary

Basin	ADWF (mgd)	Peak Measured Flow (mgd)	Peaking Factor	RDI Rate (mgd)	RDI Factor	Total Inflow / Infiltration (gallons x 10^6)	R-Value (%)
Basin 17	0.18	1.60	8.8	0.19	1.05	9.9	8.7%
Basin 20	0.26	3.88	15.1	0.19	0.73	17.6	36.5%
Basin 21	0.41	5.78	14.0	0.27	0.66	24.4	32.1%
Basin 23	0.13	1.87	14.6	0.07	0.57	4.1	30.5%
Basin 50	4.66	53.33	11.4	3.33	0.72	263.3	19.5%
Basin 52	4.86	30.33	6.2	1.16	0.23	98.3	15.0%
Basin 54 (O)	3.47	18.82	5.4	2.49	0.73	125.3	21.4%
Basin 54 (P)	0.91	20.58	22.6	0.70	0.78	54.6	14.3%
Basin 56	1.72	11.75	6.8	1.46	0.86	78.6	10.5%
Basin 58	1.45	17.56	12.1	0.62	0.42	54.9	40.7%
Basin 59	0.63	5.43	8.6	0.19	0.30	13.7	17.7%
Basin 60	0.73	15.34	21.0	0.36	0.49	27.5	19.5%
Basin 61	0.16	0.84	5.2	0.06	0.38	3.8	9.3%
Basin 62	0.32	3.46	10.7	0.10	0.32	9.1	12.7%
Basin 64	1.65	8.23	5.0	0.24	0.14	15.2	2.4%
Basin 80	1.76	15.15	8.6	1.63	0.93	84.5	19.2%
Basin 81	1.78	15.15	8.5	1.23	0.71	90.9	29.3%
Basin 82	1.00	8.74	8.7	0.39	0.39	41.9	25.1%
Basin 83	2.35	20.32	8.6	1.33	0.57	90.1	10.9%
Basin 84	1.87	20.68	11.1	1.83	1.00	123.1	25.2%
Basin 85	3.11	21.66	7.0	1.76	0.58	109.0	6.9%
Basin 86	0.68	5.63	8.3	0.34	0.50	22.2	10.3%
Basin 87	0.33	1.45	4.4	0.09	0.26	6.6	1.1%
City of Oakland Total:	31.27	225.57	7.2	17.74	0.57	1173.1	12.5%

(O) = Oakland Contribution, (P) = Piedmont Contribution

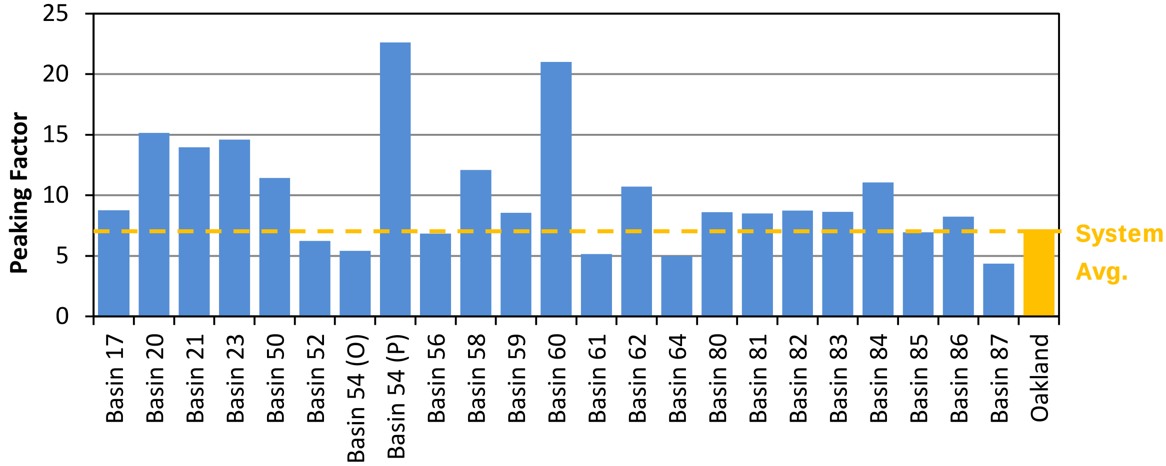


Figure 30. Bar Graphs: Inflow Summary (City Basins)

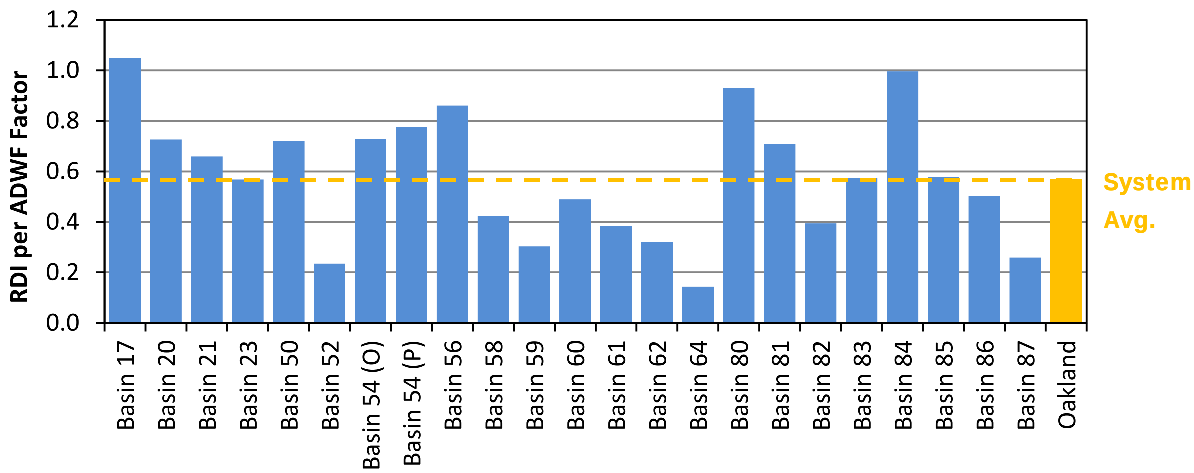


Figure 31. Bar Graphs: Infiltration (RDI) Summary (City Basins)

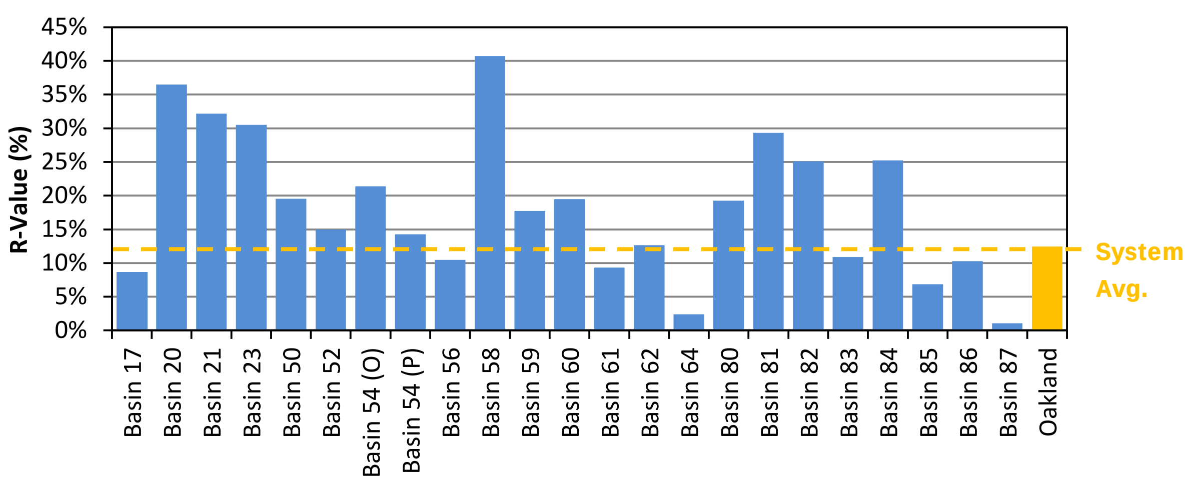


Figure 32. Bar Graphs: Total I/I Summary (City Basins)

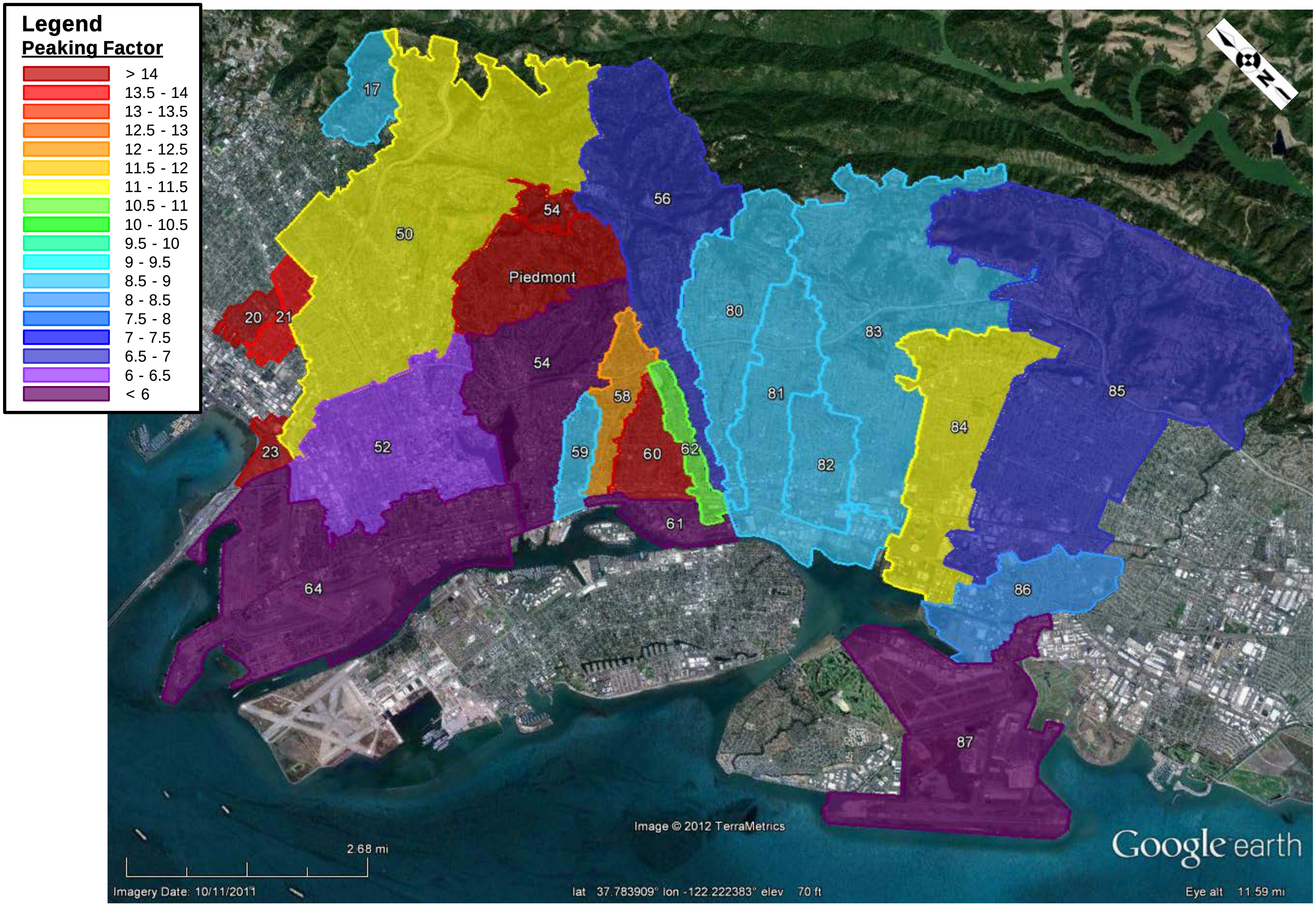


Figure 33. Inflow Temperature Map (City Basins)

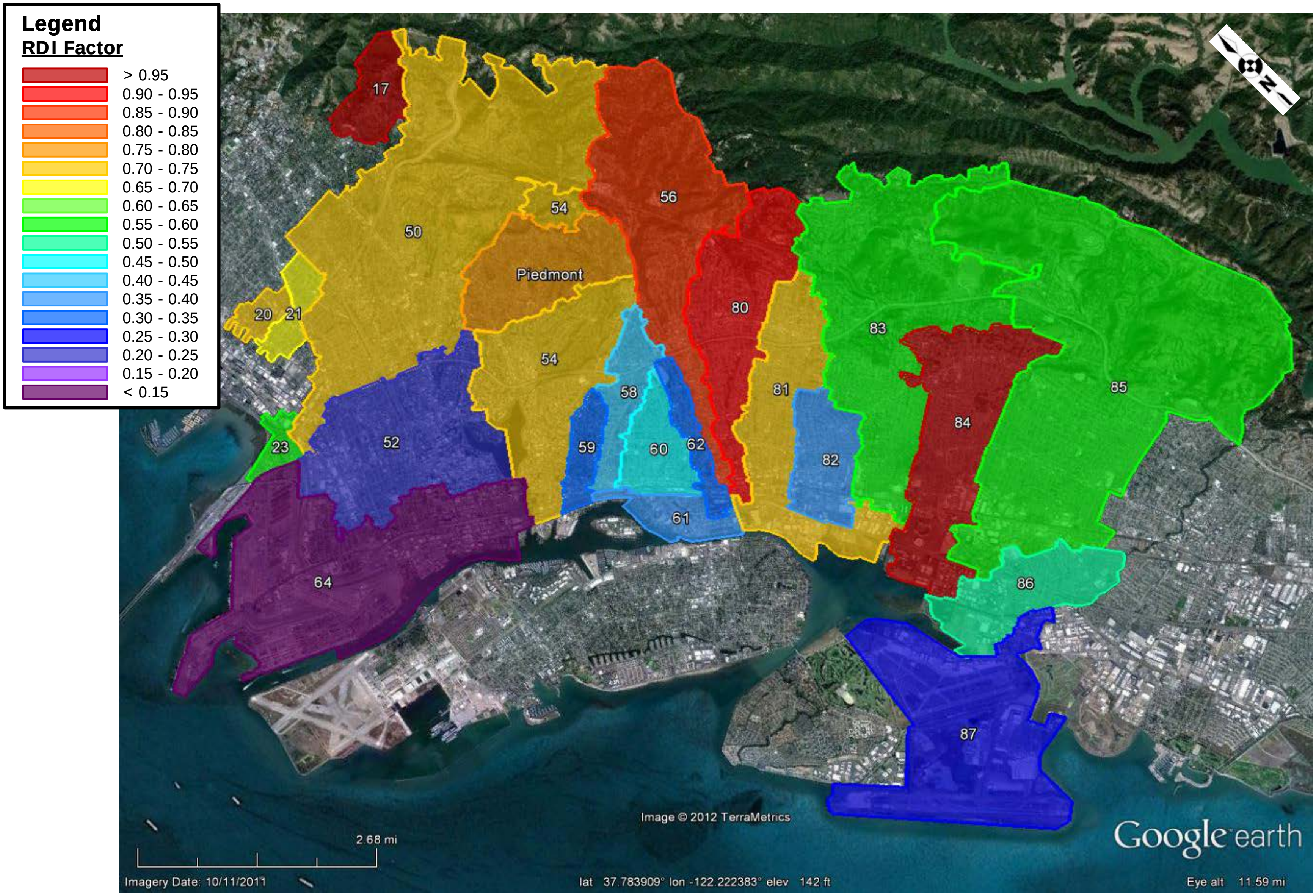


Figure 34. Infiltration (RDI) Temperature Map (City Basins)

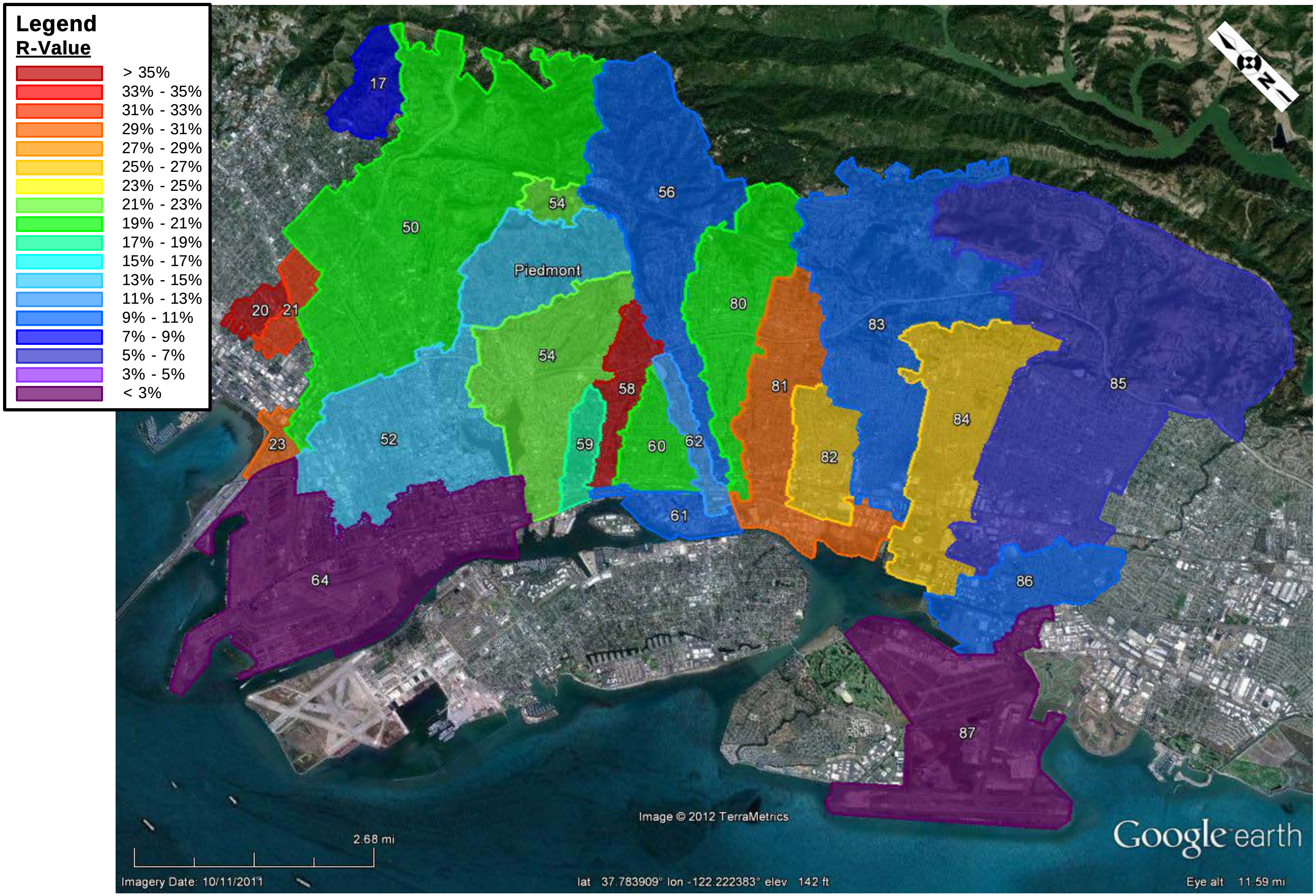


Figure 35. Total I/I Temperature Map (City Basins)

Discussion on Peaking Factors and Attenuation

The effects of attenuation must be considered when looking at peak flows and peaking factors especially when looking at the City Basins which are large basins. Flow attenuation in a sewer collection system is the natural process of the reduction of the peak flow rate through redistribution of the same volume of flow over a longer period of time. This occurs as a result of friction (resistance) 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 similar to this concept. A flow profile with a strong peak will tend to stabilize towards equilibrium, as shown in Figure 36.

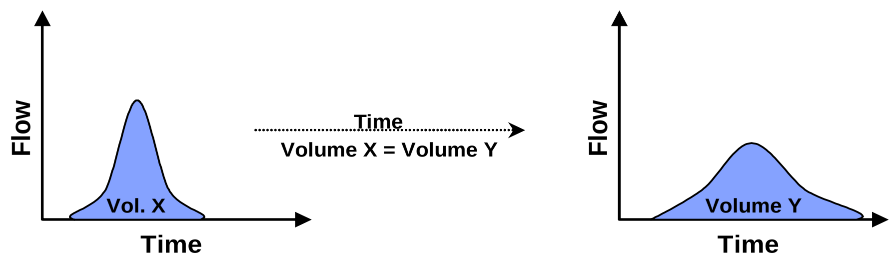


Figure 36. Attenuation Illustration

As the flows from the basins combine within the trunk sewer lines, the peaks from each basin will (a) not necessarily coincide at the same time, and (b) due to the length and time of travel through the trunk sewers, peak flows will attenuate prior to reaching the treatment facility. 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.

For example, as measured at the furthest downstream, single discharge point, the peaking factor for Basin 50 was 10.7. It should not then be concluded that the peaking factor within all of Basin 50 is approximately 10.7. Due to the significant conveyance lengths within Basin 50, the effects of attenuation will be considerable. Generally, the larger the basins and/or the longer the conveyance times, the more attenuation will occur.

The flow monitoring data and flow monitoring basin I/I analysis is presented in the next section, to better identify the I/I issues within the smaller sub-catchment areas of the City collection system.

CITY OF OAKLAND FLOW MONITORING PROGRAM

I/I Analysis Plan and Strategy

Flow meters were deployed in different locations from Season 1 to Season 2 to better isolate and parse the basins with the highest I/I rates into smaller and smaller catchment areas. However, relocation of flow meters results in different data sets and different storm events between Season 1 and Season 2. An “apples-to-apples” comparison of basins is made by applying synthetic I/I hydrograph methodology (synthetic hydrographs are discussed below). The following strategy was utilized to capture as much relevant data as possible and optimize I/I analysis within the entirety of the collection system across both flow monitoring seasons:

1. **2010/2011 Flow Monitoring:** Seventy flow monitors were installed from December 1, 2010 to March 31, 2011 to capture flow from within 19 of 22 City Basins.
2. **Preliminary I/I Analysis:** V&A conducted Season 1 preliminary I/I analysis to determine the Flow Monitoring Basins with the highest I/I rates. Synthetic hydrograph analysis was performed. A 5-year, 7-hour design storm event was used for final estimation of Flow Monitoring Basin flows.
3. **Sub-Basin Selection:** The Flow Monitoring Basins with higher infiltration and inflow rates were selected for more focused Season 2 flow monitoring, dividing the Season 1 Flow Monitoring Basins into smaller catchment areas.
4. **2011/2012 Flow Monitoring:** Sixty-one flow monitors were installed from December 1, 2011 to March 31, 2012 to capture flow from the Flow Monitoring Basins with the highest I/I rates, and to help with the model calibration effort.
5. **Final I/I Analysis:** Synthetic hydrograph analysis methods were used for normalization of Season 1 and Season 2 flows amongst the different Flow Monitoring Basins. The EBMUD 5-year, 7-hour design storm event was used for final estimation of Flow Monitoring Basin flows.

Synthetic Hydrographs

In order to model design storms, synthetic hydrographs were developed to approximate the actual RDI hydrograph shape in terms of the time to the peak and the recession coefficient. The actual RDI hydrograph was best matched with a synthetic hydrograph by separating the synthetic hydrograph into seven volume components (R1 through R7). The seven components represent different response times to the rainfall event; therefore, they represent different infiltration or inflow paths into the sewer system. R1 is characterized by a short response time and is assumed to consist of mainly inflow. R7 represents slower response and longer recession times and consists of mostly infiltration. Levels of soil saturation are also considered. Using synthetic hydrograph analysis, appropriate time and recession parameters were estimated by a trial-and-error procedure until a good match was obtained. For example, the hydrograph and its component hydrographs for the period of March 13 to 31, 2011, for Site 83E is shown in Figure 37. It is shown that a good match between the synthetic and actual hydrographs is achieved.

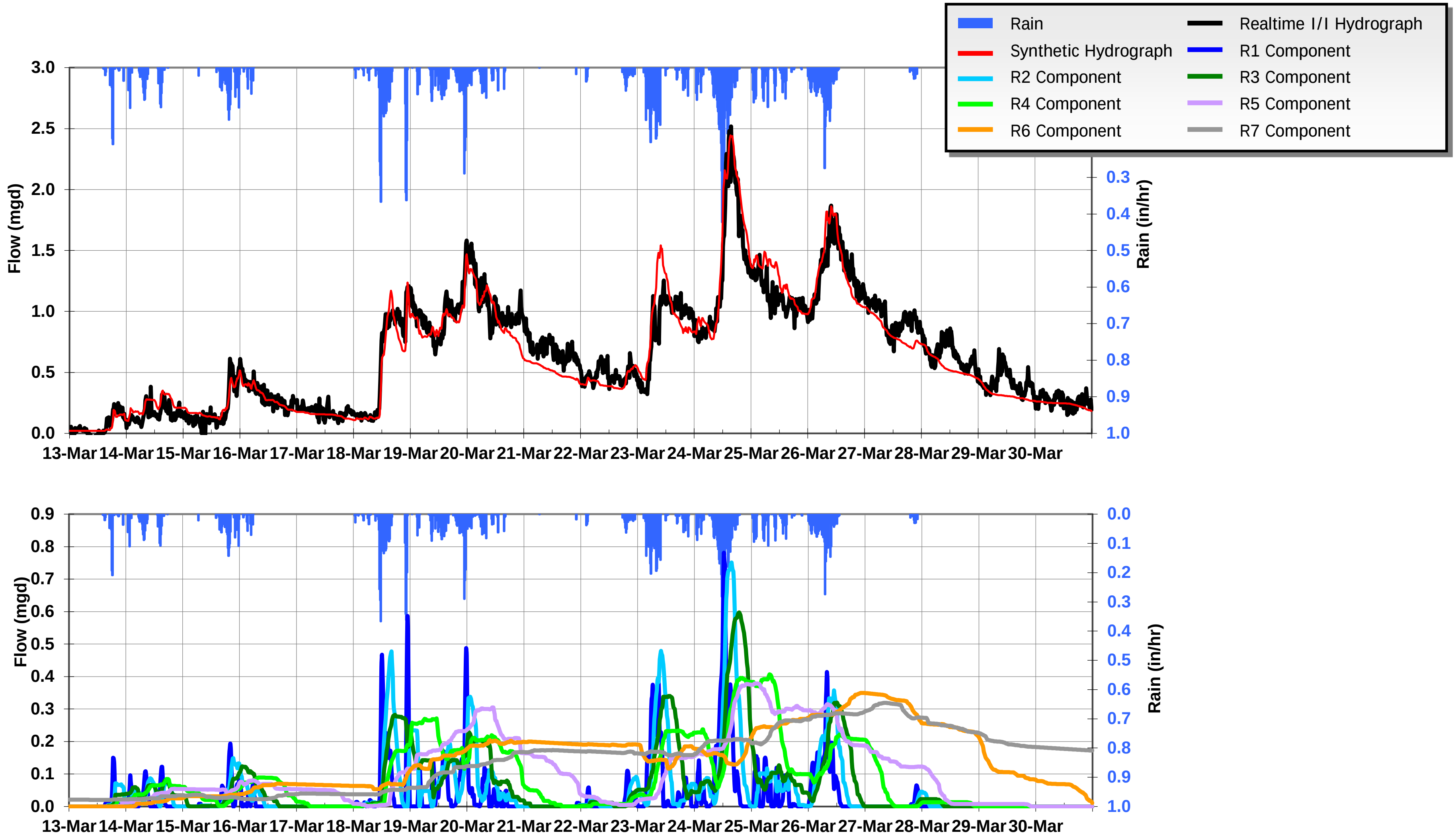


Figure 37. Example of Synthetic Hydrograph, Site 83E

Design Storm Development

With the I/I response modeled by a synthetic hydrograph, design storms can be applied. Design storms can serve two functions:

a) Synthetic I/I hydrographs across different wet weather seasons can be normalized by applying the synthetic I/I hydrograph equations to the same design storm event; therefore, they are normalized to each other, making for easier and better comparisons.

b) Design storms are rainfall events used to analyze the performance of a collection system under extreme wet weather events. The predicted peak I/I flows were simulated through the model that Carollo developed for the City to determine capacity issues within the City collection system.

The design storm used for this study is based on the EBMUD I/I Study Storm and is the specific rainfall event developed and used for the East Bay Sewer System Evaluation Survey and EBMUD Wet Weather Facilities Plan during the 1980's. The design storm is a historical storm with a total of 1.57 inches (Oakland Airport) that has a 5-year rainfall return period over a 7-hour duration, broken down into 15-minute increments.

The design storm rainfall was assumed to occur simultaneously over the entire City service area. However, the total volume of the design storm varied throughout the collection system to account for increasing rainfall from low-elevation areas near the Bay to high elevations. V&A performed the calculations to determine the appropriate 5-year, 7-hour design storm rainfall volume for each individual flow monitoring basin. An example design storm for Meter 83E is shown on Figure 38. As can be seen, the volume of rainfall for Meter 83E is greater than the general design storm due to the increased elevation of Basin 83E.

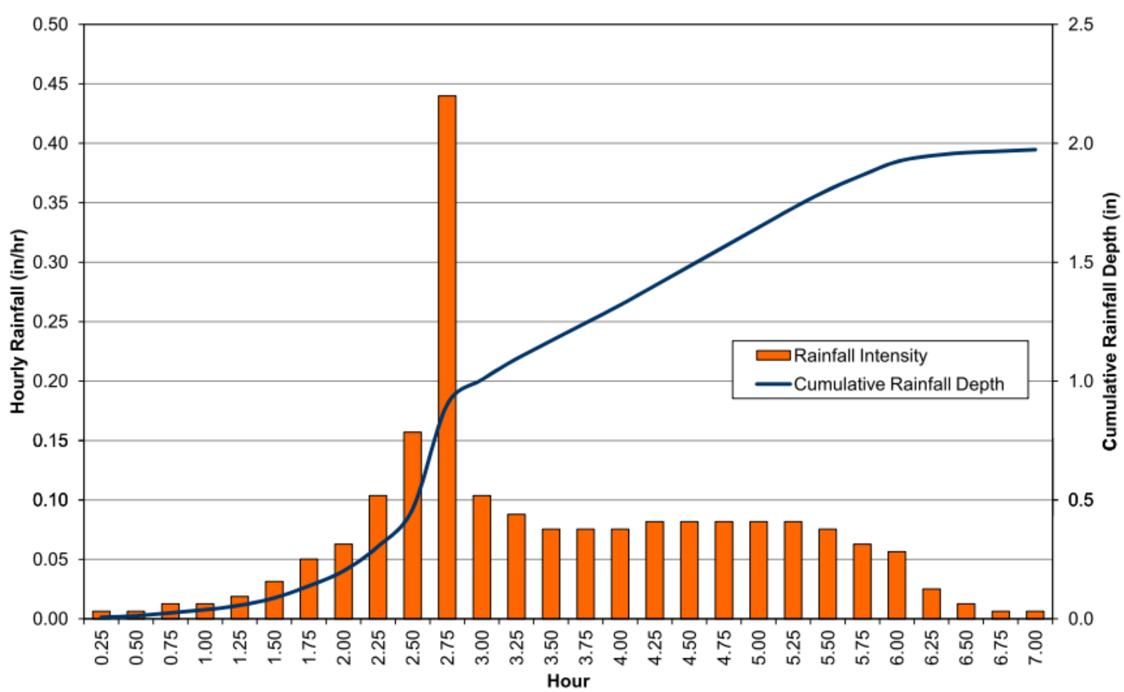


Figure 38. Meter 83E 5-Year, 7-Hour Design Storm

The 5-year, 7-hour storm event was applied to the synthetic I/I hydrograph components developed for each flow monitoring site. This method produces the best estimated response to the design storm events. These results assume full ground saturation, and the peak I/I flows from the design storm coincide with peak dry weather flows to get a "worst-case scenario" of peak wet weather flows. Figure 39 shows the synthetic hydrograph response for the design storm event at Meter 83E.

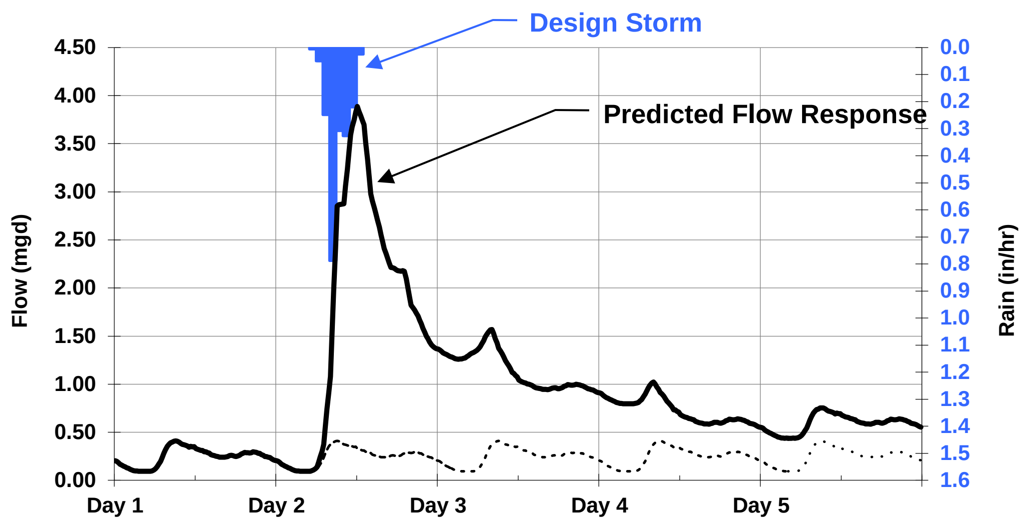


Figure 39. 5-Year, 7-Hour Design Storm: Estimated I/I Response at Meter 83E

EBMUD RDI/I Reductions

EBMUD conducted a flow monitoring and modeling study to identify high RDI/I basins where reduced flows would significantly reduce discharges from the EBMUD wet weather facilities. The EBMUD "Peak RDI/I Reduction – Flattened Hydrograph Shape" map was utilized in this report to help determine the prioritization of flow monitoring basins selected for RDI/I investigation and mitigation within the City of Oakland. The EBMUD "Peak RDI/I Reduction by ITA – Flattened Hydrograph Shape" is shown in Figure 40 and uses color codes of Red, Orange, Yellow, Dark Green and Light Green to show the varying degrees of required RDI/I reduction.

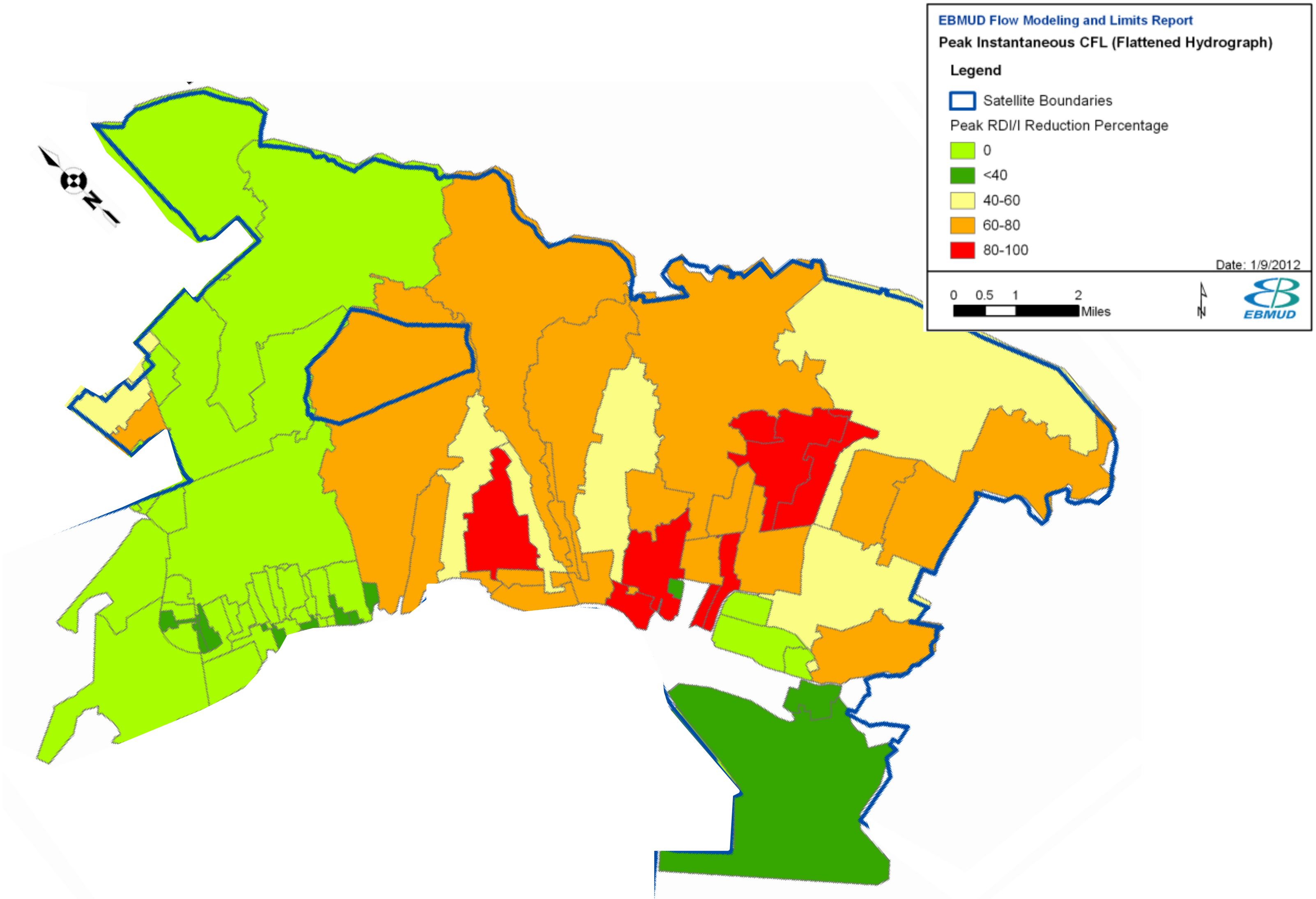


Figure 40. EBMUD Peak RDI/I Reduction by ITA – Flattened Hydrograph Shape

RDI/I Results Summary

Flow monitoring over the course of two wet weather seasons resulted in the definition of 142 flow monitoring basins within the City collection system. RDI/I flows were differentiated from average dry weather (ADWF) flows and analyzed. The inflow[10] component and the rain dependent infiltration[11] (RDI) component were isolated for each flow monitoring basin and the relative magnitudes of the inflow component and the RDI component were compared between flow monitoring basins.

The flow monitoring basins with the highest degree of inflow and RDI were classified per the parameters shown in Table 9.

Table 9. Inflow and RDI Classification Parameters

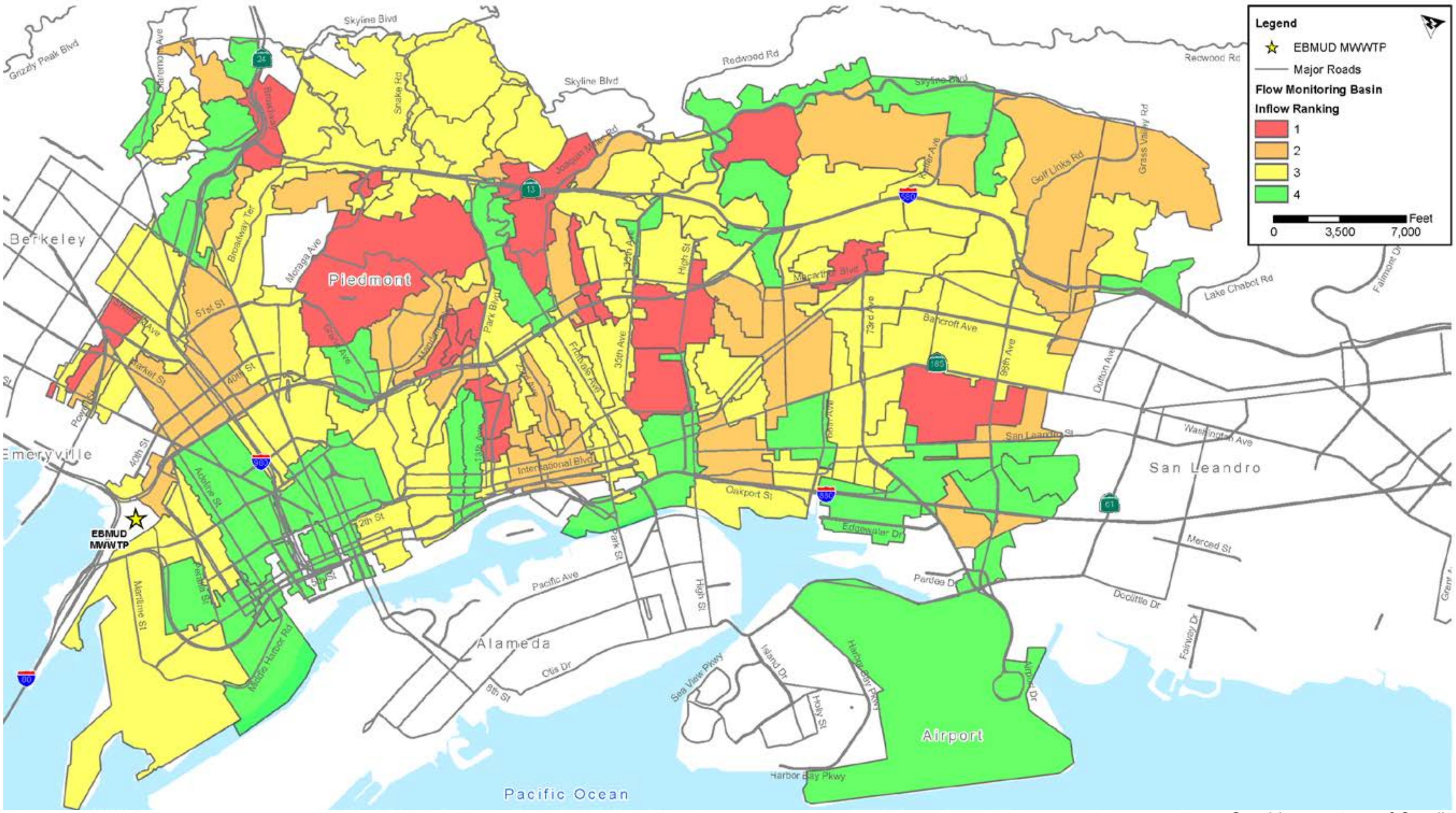
Ranking	Color Code	Inflow Design Storm Peaking Factor	RDI Measured RDI Factor[12]
1	RED	PF > 30	RDI > 1.5
2	ORANGE	20 < PF < 30	1.0 < RDI < 1.5
3	YELLOW	10 < PF < 20	0.5 < RDI < 1.0
4	GREEN	PF < 10	RDI < 0.5

Figure 41 shows the classification map for inflow and Figure 42 shows the classification map for RDI for flow monitoring basins within the City of Oakland.

[10] Inflow is storm water discharged into the sewer system through direct connections such as downspouts, area drains, cross-connections to catch basins, etc. This component of I/I often causes a peak flow problem in the sewer system.

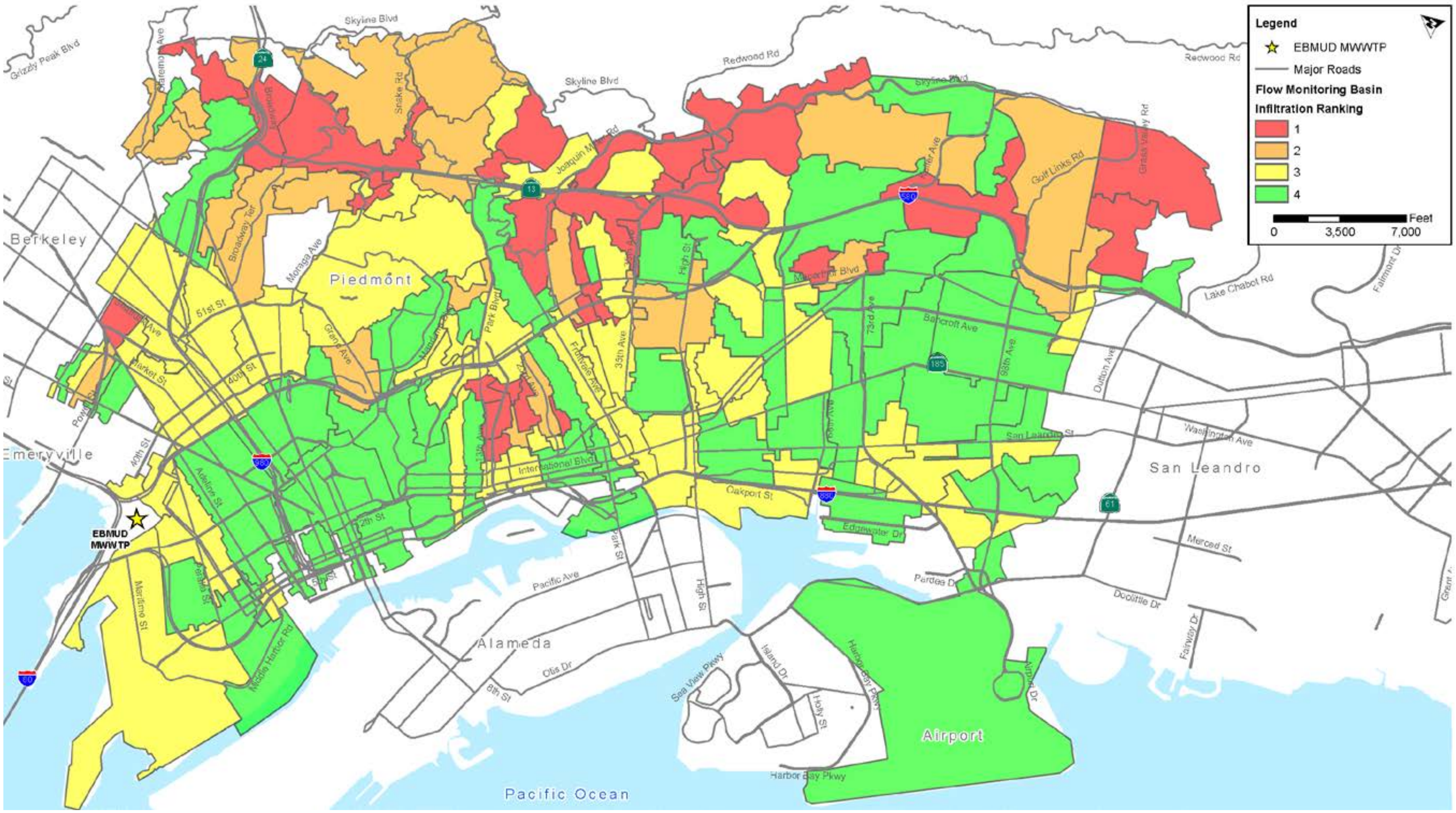
[11] Rain dependent infiltration is defined as water entering the sanitary sewer system through defects in pipes, pipe joints, and manhole walls, which may include cracks, offset joints, root intrusion points, and broken pipes.

[12] RDI factor is the ratio of infiltration rate to ADWF rate under saturated soil conditions, 24 hours after the conclusion of significant rainfall. An RDI factor of 1.2 means that the measured infiltration (RDI) rate was 1.2 x ADWF.



Graphics courtesy of Carollo

Figure 41. Design Storm Event Peaking Factors by Flow Monitoring Basin (Inflow)



Graphics courtesy of Carollo

Figure 42. RDI Factors by Flow Monitoring Basin (Infiltration)

RDI/I Results Prioritization

A prioritized list of basins targeted for rehabilitation was developed. The list of targeted basins was developed by coordinating with EBMUD to identify the reaches of its interceptor system that currently experience capacity constraints (reference Figure 40).

Table 10 summarizes the criteria used for the prioritization of City of Oakland flow monitoring basins (Priority 1 indicates the highest priority).

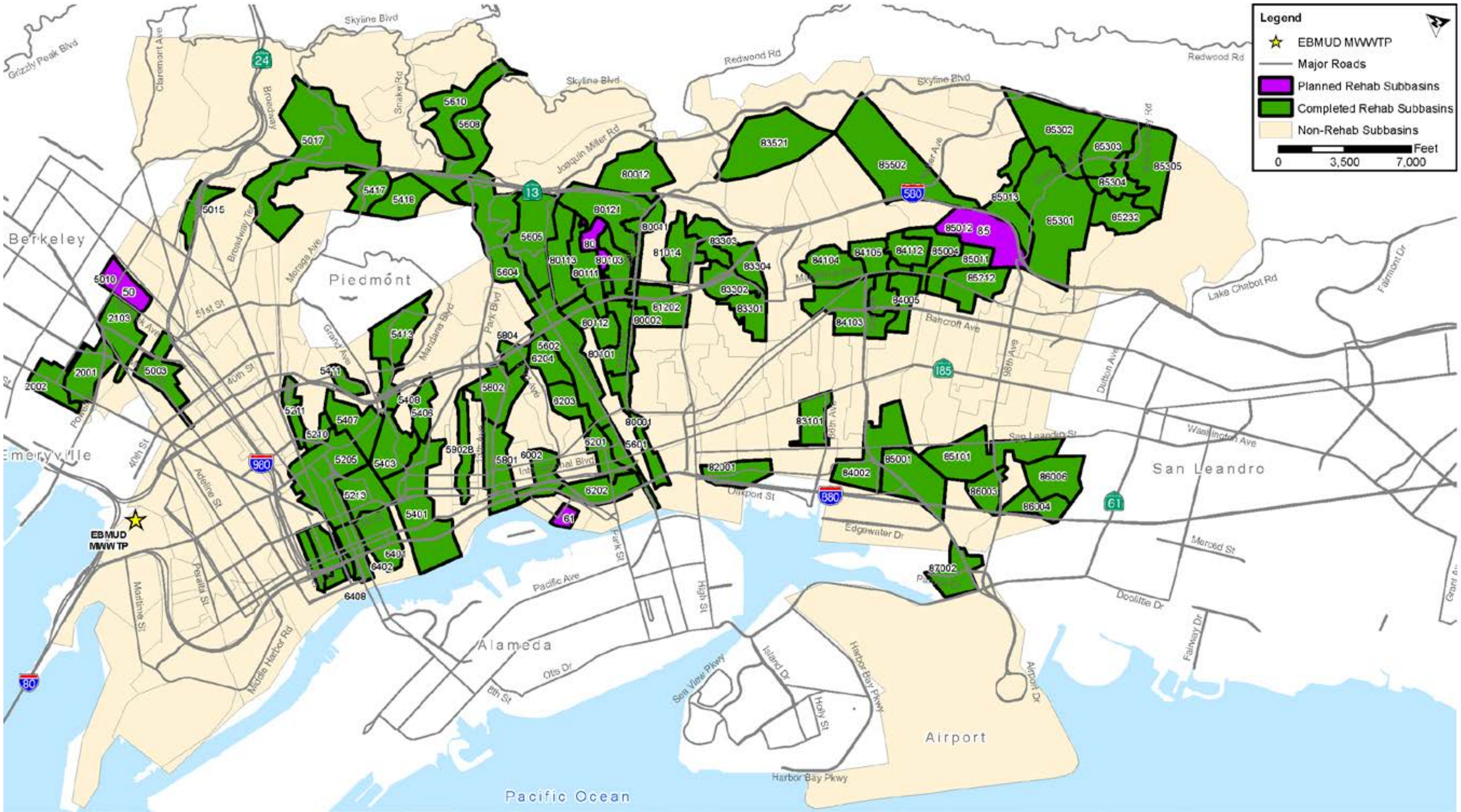
Table 10. Flow Monitoring Basin Prioritization Criteria

		Ref. Figure 41and Figure 42			
		OAKLAND Ranking 1	OAKLAND Ranking 2	OAKLAND Ranking 3	OAKLAND Ranking 4
Ref. Figure 40	EBMUD RED	**1**	**4**	**7**	-
	EBMUD ORANGE	**2**	**5**	**8**	-
	EBMUD YELLOW	**3**	**6**	**9**	-
	EBMUD DARK GREEN	-	-	-	-
	EBMUD LIGHT GREEN	-	-	-	-

For example, an Oakland flow basin Ranked 1 for inflow and located within an orange shaded area requiring RDI/I reduction per the EBMUD study was assigned a ranking of 2 for inflow. A similar process was completed for RDI.

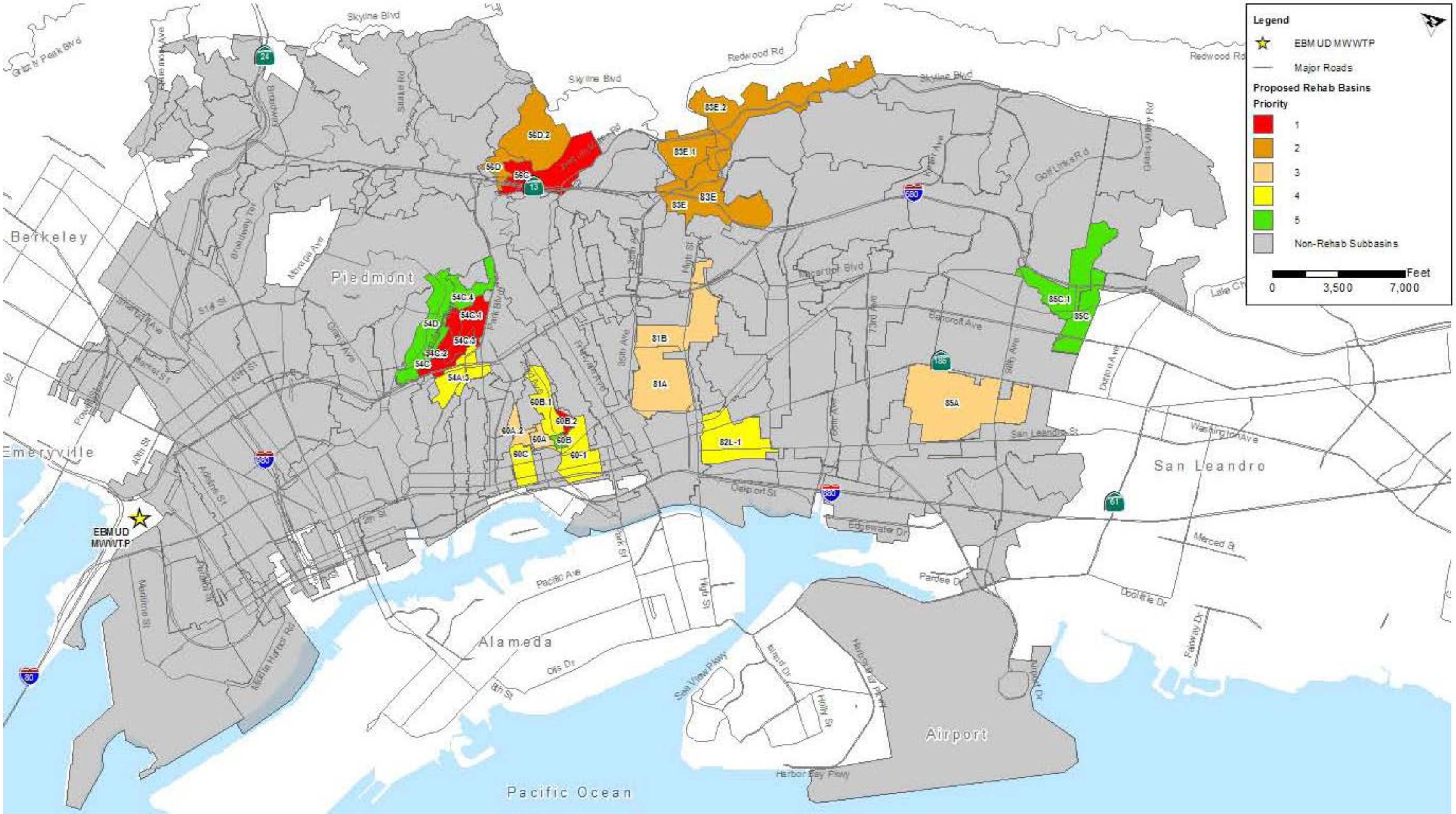
A final list of sub-basins was prioritized based on the combination of severity of inflow and infiltration, and also considered City subbasins that had been previously rehabilitated or were planned for rehabilitation (Figure 43).

Table 11 summarizes the list of subbasins that are targeted for rehabilitation. Figure 44 illustrates the target rehabilitation basins.



Graphics courtesy of Carollo

Figure 43. Completed and Planned Rehabilitation Subbasins



Graphics courtesy of Carollo

Figure 44. Prioritized Rehabilitation Subbasins

Table 11. Target Rehabilitation Basins

Basin	Priority
54C.1 54C.2 54C.3 56C 60B.2	1
56D 56D.2 83E 83E.1 83E.2	2
81A 81B 85A 60A 60A.2	3
60B.1 82L-1 60C 60-1 54A.3	4
54C 54C.4 54D 60B 85C 85C.1	5

Options for Future Investigation and Mitigation of Inflow and RDI (Infiltration)

The list of flow monitoring basins listed in Table 11 will be targeted for inflow and RDI (infiltration) investigation and mitigation measures. Inflow investigation and mitigation measures include the following:

- Coordination with EBMUD on future mitigation RDI/I investigation measures and activities.
- Annual review of home sales in priority basins to track lateral testing and repair.
- Establishment of a list of prequalified contractors to assist the City in making repairs as defects are located during inflow and RDI (infiltration) investigations.
- Inflow Investigation: Smoke testing investigation.
- Inflow Mitigation: Private lateral inspection and repair, City Ordinance Number 13080 in accordance with the East Bay Regional Private Sewer Lateral Program.
- RDI (infiltration) Investigation: Night-time infiltration reconnaissance – Night-time I/I reconnaissance requires opening manhole lids at key nodes within the sub-basin during low-flow hours (typically between 1am and 4am), and measuring the flow rates. Clear water flow is tracked, measured and documented, and any visual evidence of infiltration is documented. This work results in dividing the sub-basin into between 10 and 30 mini-basins[13]. Based on the spot flow measurement results, each mini-basin can be ranked for volume of infiltration in terms of gallons of I/I per inch-diameter-mile (IDM)[14].

The City will continue to coordinate with EBMUD to develop recommendations for future rehabilitation projects to target I/I reduction. It should be noted that the Private Lateral Inspection and Repair program is on-going City-wide and will have an impact on RDI/I rates in basins that have been rehabilitated in the past.

[13] Mini-basin sizes are typically the size of neighborhoods – a few city blocks, but can be less, depending on results measured during the reconnaissance.

[14] Inch-diameter-mile (miles of pipeline multiplied by the diameter of the pipeline in inches). This is the industry standard unit of measurement for stating length of pipe within a sanitary drainage basin.

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APPENDIX D – DRY WEATHER FLOW CALIBRATION SHEETS

City of Oakland
Sewer System Hydraulic Model Calibration
DRY WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Weekday Dry Weather Flow: Metered DWF[(2)] Average (mgd)	Weekday Metered DWF Maximum (mgd)	Weekday Modeled DWF Average (mgd)	Weekday Modeled DWF Maximum (mgd)	Weekday Percent Difference[(3)] Average (%)	Weekday Percent Difference Maximum (%)	Weekend Dry Weather Flow: Metered DWF[(2)] Average (mgd)	Weekend Metered DWF Maximum (mgd)	Weekend Modeled DWF Average (mgd)	Weekend Modeled DWF Maximum (mgd)	Weekend Percent Difference[(3)] Average (%)	Weekend Percent Difference Maximum (%)	Average Dry Weather Flow[(4)]: Metered Daily Average (mgd)	Modeled Daily Average (mgd)	Percent Difference[(3)] (%)
Basin 17															
17A[(1)]	0.025	0.048	--	--	--	--	0.026	0.050	--	--	--	--	0.026	--	--
17B[(1)]	0.041	0.084	--	--	--	--	0.040	0.068	--	--	--	--	0.041	--	--
17U-S1	0.064	0.099	0.064	0.099	0.0%	-0.2%	0.071	0.110	0.071	0.109	0.0%	-0.1%	0.066	0.066	0.0%
17U-S2	0.070	0.100	0.070	0.100	0.0%	-0.1%	0.071	0.103	0.071	0.103	-0.1%	-0.4%	0.070	0.070	0.0%
17U-S3[(1)]	0.045	0.080	--	--	--	--	0.050	0.094	--	--	--	--	0.046	--	--
Basin 20															
20A[(1)]	0.005	0.009	--	--	--	--	0.006	0.010	--	--	--	--	0.006	--	--
20B	0.050	0.076	0.049	0.075	-0.2%	-0.3%	0.049	0.077	0.049	0.076	-0.2%	-0.3%	0.049	0.049	-0.2%
20-S1	0.172	0.249	0.171	0.252	-0.2%	1.3%	0.168	0.253	0.168	0.253	0.2%	0.0%	0.171	0.170	-0.1%
20-S2[(1)]	0.081	0.115	--	--	--	--	0.078	0.118	--	--	--	--	0.080	--	--
Basin 21															
21A	0.044	0.086	0.044	0.086	0.1%	0.0%	0.047	0.093	0.047	0.093	-0.1%	-0.2%	0.044	0.044	0.0%
21U-1	0.152	0.241	0.150	0.242	-1.2%	0.2%	0.154	0.253	0.157	0.265	2.2%	4.8%	0.152	0.152	-0.3%
21L-S1	0.218	0.340	0.218	0.341	0.2%	0.3%	0.244	0.410	0.243	0.412	-0.4%	0.5%	0.225	0.225	0.0%
21L-S2	0.102	0.145	0.102	0.145	0.0%	0.1%	0.107	0.160	0.107	0.160	-0.2%	-0.1%	0.103	0.103	0.0%
21L-S3[(1)]	0.066	0.114	--	--	--	--	0.070	0.116	--	--	--	--	0.067	--	--
Basin 23															
23-1[(1)]	0.129	0.204	--	--	--	--	0.127	0.210	--	--	--	--	0.128	--	--
Basin 50															
50L-S1	0.091	0.130	0.091	0.130	-0.2%	-0.2%	0.095	0.142	0.095	0.141	-0.3%	-0.2%	0.092	0.092	-0.2%
50	2.498	3.677	2.463	3.712	-1.4%	0.9%	2.491	3.556	2.428	3.584	-2.5%	0.8%	2.496	2.453	-1.7%
50A	0.977	1.386	0.976	1.378	0.0%	-0.5%	1.010	1.361	1.012	1.362	0.1%	0.1%	0.986	0.987	0.0%
50B	0.699	1.083	0.700	1.071	0.2%	-1.1%	0.693	1.082	0.692	1.079	-0.2%	-0.2%	0.697	0.698	0.1%
50U-1	2.205	3.657	2.265	3.562	2.7%	-2.6%	2.243	3.436	2.308	3.401	2.9%	-1.0%	2.216	2.277	2.8%
50L-1	2.498	3.596	2.468	3.715	-1.2%	3.3%	2.637	3.859	2.433	3.589	-7.8%	-7.0%	2.538	2.458	-3.2%
50C.1	0.464	0.528	0.463	0.547	-0.1%	3.6%	0.481	0.544	0.479	0.544	-0.3%	-0.1%	0.469	0.468	-0.2%
50C.2	0.147	0.219	0.147	0.219	0.0%	0.1%	0.157	0.300	0.157	0.300	0.0%	-0.3%	0.150	0.150	0.0%
50D	0.846	1.162	0.836	1.212	-1.2%	4.3%	0.879	1.197	0.870	1.288	-1.0%	7.6%	0.856	0.846	-1.1%

City of Oakland

Sewer System Hydraulic Model Calibration

DRY WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Weekday Dry Weather Flow						Weekend Dry Weather Flow						Average Dry Weather Flow[4]		
	Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered Daily Average	Modeled Daily Average	Percent Difference[3]
	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	(mgd)	(mgd)	(%)
50E	0.069	0.188	0.070	0.188	0.5%	0.0%	0.069	0.162	0.069	0.162	0.2%	0.2%	0.069	0.069	0.4%
50F	0.113	0.195	0.113	0.187	0.0%	-4.1%	0.116	0.165	0.116	0.164	-0.3%	-0.6%	0.114	0.113	-0.1%
50G	0.650	1.017	0.664	0.989	2.1%	-2.7%	0.677	0.997	0.692	1.015	2.2%	1.8%	0.658	0.672	2.1%
50H	0.281	0.493	0.280	0.493	-0.1%	-0.1%	0.296	0.480	0.294	0.477	-0.4%	-0.6%	0.285	0.284	-0.2%
Basin 52															
52A	4.094	5.118	4.136	5.611	1.0%	9.6%	3.869	5.021	3.845	5.297	-0.6%	5.5%	4.030	4.053	0.6%
52B	1.620	2.346	1.627	2.607	0.4%	11.1%	1.460	2.191	1.456	2.467	-0.2%	12.6%	1.574	1.578	0.2%
52C	1.041	1.520	1.041	1.601	0.0%	5.4%	1.000	1.492	0.997	1.520	-0.2%	1.9%	1.030	1.029	-0.1%
52-1	4.956	6.440	5.058	6.817	2.1%	5.9%	4.611	6.246	4.748	6.528	3.0%	4.5%	4.858	4.969	2.3%
Basin 54															
54-S1	0.275	0.591	0.275	0.591	0.0%	-0.1%	0.284	0.469	0.283	0.467	-0.1%	-0.6%	0.277	0.277	0.0%
54-S2	0.333	0.638	0.334	0.638	0.1%	0.0%	0.342	0.527	0.342	0.526	0.1%	-0.3%	0.336	0.336	0.1%
54B.1	0.108	0.205	0.114	0.181	5.2%	-11.9%	0.109	0.186	0.113	0.174	3.4%	-6.3%	0.109	0.114	4.7%
54B.2	0.486	0.801	0.486	0.707	0.0%	-11.8%	0.473	0.704	0.442	0.652	-6.7%	-7.5%	0.482	0.473	-1.8%
54B.3	0.184	0.354	0.204	0.387	10.9%	9.4%	0.202	0.322	0.173	0.341	-14.3%	5.8%	0.189	0.195	3.2%
54B.4	0.105	0.169	0.105	0.169	0.0%	0.1%	0.108	0.150	0.108	0.150	0.1%	0.0%	0.106	0.106	0.1%
54-1	4.327	6.471	4.317	6.797	-0.2%	5.0%	4.503	6.629	4.400	6.736	-2.3%	1.6%	4.377	4.341	-0.8%
54-2	0.000	0.000	0.000	0.000	0.0%	0.0%	0.000	0.000	0.000	0.000	0.0%	0.0%	0.000	0.000	0.0%
54-S3	0.073	0.129	0.073	0.129	0.0%	-0.1%	0.075	0.114	0.075	0.114	0.0%	0.1%	0.073	0.073	0.0%
54-S4	0.009	0.014	0.009	0.014	0.0%	0.0%	0.010	0.015	0.010	0.015	0.0%	0.2%	0.010	0.010	0.0%
54-S4A	0.030	0.071	0.030	0.071	-0.1%	-0.2%	0.031	0.060	0.031	0.060	-0.1%	0.0%	0.031	0.031	-0.1%
54D	0.388	0.679	0.391	0.682	0.7%	0.6%	0.399	0.646	0.402	0.650	0.5%	0.6%	0.391	0.394	0.6%
54D.1	0.041	0.087	0.041	0.087	1.5%	-0.1%	0.039	0.072	0.039	0.075	1.0%	3.7%	0.040	0.041	1.4%
54-S5[1]	0.105	0.157	--	--	--	--	0.102	0.141	--	--	--	--	0.104	--	--
54-S6	0.094	0.130	0.095	0.130	0.2%	0.3%	0.096	0.134	0.096	0.134	0.0%	0.2%	0.095	0.095	0.1%
54-S7	0.072	0.117	0.072	0.117	0.0%	0.0%	0.070	0.105	0.070	0.105	0.0%	0.1%	0.072	0.072	0.0%
54-S8[1]	0.021	0.052	--	--	--	--	0.022	0.042	--	--	--	--	0.021	--	--
54-S9[1]	0.066	0.099	--	--	--	--	0.071	0.099	--	--	--	--	0.067	--	--
54A	0.484	0.708	0.484	0.709	0.0%	0.2%	0.480	0.678	0.479	0.678	-0.2%	0.0%	0.483	0.482	0.0%

City of Oakland
Sewer System Hydraulic Model Calibration
DRY WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Weekday Dry Weather Flow						Weekend Dry Weather Flow						Average Dry Weather Flow[4]		
	Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered Daily Average	Modeled Daily Average	Percent Difference[3]
	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	(mgd)	(mgd)	(%)
54C	0.512	0.923	0.511	0.923	-0.1%	0.0%	0.514	0.809	0.512	0.810	-0.3%	0.0%	0.512	0.511	-0.2%
54C.1	0.382	0.692	0.382	0.691	0.0%	-0.1%	0.394	0.636	0.393	0.638	-0.1%	0.4%	0.385	0.385	0.0%
Basin 56															
56A	0.357	0.611	0.357	0.612	0.1%	0.1%	0.365	0.625	0.364	0.626	-0.2%	0.2%	0.359	0.359	0.0%
56A.1	1.070	1.478	1.068	1.475	-0.2%	-0.2%	1.126	1.495	1.128	1.559	0.2%	4.3%	1.086	1.085	-0.1%
56B	0.360	0.606	0.357	0.600	-0.7%	-0.9%	0.377	0.583	0.382	0.591	1.4%	1.4%	0.365	0.365	-0.1%
56C	0.089	0.151	0.089	0.151	0.0%	0.1%	0.093	0.146	0.093	0.146	-0.1%	0.3%	0.090	0.090	0.0%
56D	0.108	0.256	0.108	0.256	0.0%	0.0%	0.112	0.230	0.112	0.229	0.0%	-0.4%	0.109	0.109	0.0%
56E	0.229	0.407	0.229	0.405	0.0%	-0.6%	0.250	0.404	0.249	0.402	-0.2%	-0.5%	0.235	0.235	0.0%
56-1	1.702	2.666	1.726	2.624	1.4%	-1.6%	1.758	2.671	1.805	2.737	2.7%	2.5%	1.718	1.749	1.8%
Basin 58															
58A	0.540	0.822	0.541	0.764	0.1%	-7.1%	0.555	0.823	0.559	0.807	0.8%	-1.9%	0.544	0.546	0.3%
58B	0.391	0.613	0.391	0.613	0.1%	0.0%	0.417	0.661	0.416	0.660	-0.1%	-0.2%	0.398	0.398	0.0%
58-1	1.462	1.955	1.459	1.955	-0.2%	0.0%	1.423	2.028	1.451	2.048	1.9%	1.0%	1.451	1.457	0.4%
Basin 59															
59A	0.369	0.537	0.369	0.537	0.0%	0.0%	0.411	0.562	0.411	0.567	-0.2%	0.8%	0.381	0.381	0.0%
59-1	0.627	0.812	0.619	0.801	-1.2%	-1.3%	0.653	0.851	0.671	0.884	2.8%	4.0%	0.635	0.634	-0.1%
Basin 60															
60A	0.231	0.326	0.231	0.326	0.1%	-0.1%	0.235	0.356	0.235	0.354	-0.3%	-0.5%	0.232	0.232	0.0%
60B	0.283	0.516	0.283	0.517	0.1%	0.2%	0.298	0.572	0.297	0.571	-0.3%	-0.3%	0.287	0.287	0.0%
60-1	0.728	0.955	0.728	1.050	0.1%	9.9%	0.737	1.016	0.750	1.102	1.8%	8.5%	0.730	0.734	0.6%
Basin 61															
61A	0.161	0.215	0.161	0.215	0.1%	0.1%	0.168	0.230	0.167	0.230	-0.3%	0.1%	0.163	0.163	0.0%
Basin 62															
62A	0.283	0.451	0.283	0.450	0.1%	-0.2%	0.282	0.455	0.281	0.453	-0.3%	-0.4%	0.283	0.283	0.0%
62-1	0.322	0.458	0.326	0.502	1.3%	9.7%	0.326	0.500	0.325	0.507	-0.2%	1.4%	0.323	0.326	0.9%
Basin 64															
64-1	0.156	0.198	0.158	0.216	1.3%	9.4%	0.133	0.155	0.157	0.208	17.6%	34.5%	0.149	0.157	5.5%
64-2	0.105	0.151	0.105	0.150	0.1%	-0.5%	0.109	0.164	0.109	0.164	-0.4%	0.1%	0.106	0.106	0.0%

City of Oakland
Sewer System Hydraulic Model Calibration
DRY WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Weekday Dry Weather Flow						Weekend Dry Weather Flow						Average Dry Weather Flow[4]		
	Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered Daily Average	Modeled Daily Average	Percent Difference[3]
	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	(mgd)	(mgd)	(%)
64-3	0.125	0.185	0.123	0.201	-1.5%	8.8%	0.122	0.194	0.119	0.189	-2.3%	-2.5%	0.124	0.122	-1.7%
64-4	0.477	0.657	0.478	0.660	0.1%	0.4%	0.420	0.554	0.418	0.558	-0.4%	0.7%	0.461	0.461	0.0%
64-5	0.378	0.628	0.378	0.629	0.0%	0.2%	0.374	0.633	0.374	0.632	0.0%	-0.2%	0.377	0.377	0.0%
64-6	0.314	0.479	0.314	0.477	0.2%	-0.3%	0.259	0.405	0.258	0.405	-0.6%	0.0%	0.298	0.298	0.0%
64-7	0.040	0.053	0.036	0.077	-8.6%	44.4%	0.037	0.041	0.034	0.062	-7.6%	51.6%	0.039	0.036	-8.3%
64-8	0.097	0.131	0.097	0.130	-0.1%	-0.2%	0.092	0.130	0.093	0.131	0.2%	0.7%	0.096	0.096	0.0%
Basin 80															
80A	0.157	0.324	0.157	0.307	0.2%	-5.1%	0.159	0.307	0.159	0.306	-0.2%	-0.4%	0.158	0.158	0.1%
80B	1.383	1.931	1.388	1.965	0.4%	1.7%	1.428	2.031	1.431	2.024	0.2%	-0.3%	1.396	1.400	0.3%
80C	0.147	0.294	0.147	0.294	0.1%	0.0%	0.150	0.263	0.150	0.264	-0.1%	0.3%	0.148	0.148	0.0%
80D	0.331	0.479	0.329	0.475	-0.5%	-0.8%	0.352	0.481	0.349	0.478	-0.8%	-0.6%	0.337	0.335	-0.6%
80E	0.287	0.460	0.287	0.459	0.2%	-0.2%	0.308	0.478	0.308	0.478	0.1%	-0.2%	0.293	0.293	0.2%
80-1	1.548	2.299	1.545	2.263	-0.2%	-1.6%	1.576	2.303	1.591	2.320	0.9%	0.7%	1.556	1.558	0.1%
80-2	0.204	0.338	0.205	0.339	0.4%	0.3%	0.199	0.386	0.204	0.393	2.4%	2.0%	0.202	0.204	0.9%
Basin 81															
81A	0.077	0.132	0.077	0.132	0.1%	0.1%	0.081	0.156	0.080	0.156	-0.2%	0.0%	0.078	0.078	0.0%
81A.1	0.250	0.368	0.255	0.376	1.8%	2.1%	0.264	0.398	0.268	0.407	1.5%	2.3%	0.254	0.259	1.7%
81B	0.823	1.162	0.822	1.162	-0.1%	-0.1%	0.898	1.334	0.897	1.331	-0.2%	-0.2%	0.844	0.843	-0.1%
81C	0.586	0.793	0.587	0.796	0.1%	0.4%	0.581	0.703	0.580	0.702	-0.2%	-0.1%	0.585	0.585	0.0%
81-1	0.895	1.244	0.856	1.185	-4.3%	-4.7%	0.992	1.532	0.941	1.452	-5.1%	-5.2%	0.922	0.880	-4.6%
81-2	0.664	0.907	0.705	0.977	6.1%	7.6%	0.711	1.103	0.764	1.175	7.5%	6.5%	0.678	0.722	6.6%
81-3	0.181	0.215	0.181	0.215	0.1%	-0.2%	0.173	0.234	0.172	0.234	-0.2%	0.0%	0.179	0.179	0.0%
Basin 82															
82A	0.056	0.073	0.056	0.073	0.1%	0.3%	0.056	0.079	0.056	0.079	-0.2%	0.1%	0.056	0.056	0.0%
82B	0.445	0.650	0.446	0.649	0.0%	-0.2%	0.431	0.606	0.431	0.608	0.0%	0.3%	0.441	0.441	0.0%
82U-1	0.547	0.743	0.543	0.751	-0.7%	1.0%	0.568	0.829	0.561	0.820	-1.2%	-1.1%	0.553	0.548	-0.8%
82L-1	0.441	0.569	0.442	0.567	0.2%	-0.3%	0.460	0.648	0.459	0.648	0.0%	0.0%	0.447	0.447	0.1%
Basin 83															
83B	0.127	0.220	0.130	0.225	2.5%	2.5%	0.143	0.252	0.147	0.259	2.9%	2.5%	0.132	0.135	2.6%

City of Oakland

Sewer System Hydraulic Model Calibration

DRY WEATHER FLOW CALIBRATION SUMMARY

	Weekday Dry Weather Flow						Weekend Dry Weather Flow						Average Dry Weather Flow[4]		
	Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered Daily Average	Modeled Daily Average	Percent Difference[3]
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum			
Meter Site	(mgd)	(mgd)	(mgd)	(mgd)	(%)	(%)	(mgd)	(mgd)	(mgd)	(mgd)	(%)	(%)	(mgd)	(mgd)	(%)
83B.1	0.220	0.345	0.220	0.345	0.2%	0.1%	0.229	0.356	0.229	0.358	0.0%	0.6%	0.222	0.223	0.1%
83C	0.342	0.499	0.342	0.500	0.0%	0.1%	0.357	0.556	0.357	0.557	0.0%	0.2%	0.346	0.346	0.0%
83D	0.393	0.489	0.393	0.488	0.0%	-0.3%	0.378	0.463	0.379	0.460	0.1%	-0.7%	0.389	0.389	0.0%
83E	0.246	0.400	0.246	0.398	0.0%	-0.5%	0.257	0.468	0.257	0.460	0.1%	-1.7%	0.249	0.249	0.0%
83L-1	1.943	2.392	1.969	2.457	1.3%	2.7%	2.066	2.737	2.046	2.755	-1.0%	0.7%	1.978	1.991	0.6%
83L-2	0.369	0.523	0.362	0.511	-1.8%	-2.2%	0.383	0.582	0.374	0.568	-2.2%	-2.4%	0.373	0.366	-1.9%
83U-1	0.505	0.737	0.500	0.732	-1.0%	-0.7%	0.516	0.759	0.503	0.738	-2.4%	-2.7%	0.508	0.501	-1.4%
83U-2	0.594	0.838	0.609	0.848	2.5%	1.3%	0.630	0.941	0.634	0.950	0.6%	1.0%	0.604	0.616	2.0%
83U-3	0.146	0.221	0.147	0.221	0.2%	0.1%	0.153	0.275	0.153	0.276	-0.3%	0.4%	0.148	0.148	0.0%
83U-4	0.627	0.982	0.625	1.005	-0.4%	2.3%	0.670	1.064	0.657	1.070	-1.9%	0.5%	0.639	0.634	-0.8%
83U-F	1.151	1.759	1.139	1.532	-1.1%	-12.9%	1.272	2.248	1.187	1.823	-6.7%	-18.9%	1.186	1.153	-2.8%
83U-1X	0.422	0.569	0.501	0.720	18.7%	26.5%	0.431	0.608	0.504	0.740	17.0%	21.7%	0.424	0.502	18.2%
83U-2X	0.580	0.777	0.610	0.839	5.1%	8.0%	0.621	0.938	0.634	0.946	2.1%	0.9%	0.592	0.617	4.2%
83U-3X	0.320	0.429	0.320	0.428	-0.2%	-0.2%	0.329	0.484	0.331	0.488	0.6%	0.8%	0.323	0.323	0.0%
Basin 84															
84A	0.447	0.561	0.455	0.552	1.8%	-1.6%	0.438	0.568	0.459	0.587	4.7%	3.4%	0.444	0.456	2.6%
84B	0.709	0.954	0.719	0.964	1.5%	1.1%	0.751	1.186	0.749	1.155	-0.2%	-2.6%	0.721	0.728	0.9%
84C	0.124	0.186	0.127	0.190	1.9%	2.0%	0.131	0.234	0.133	0.239	1.9%	2.1%	0.126	0.128	1.9%
84C.1	0.060	0.121	0.058	0.116	-3.5%	-3.8%	0.069	0.125	0.067	0.121	-3.6%	-3.6%	0.063	0.060	-3.5%
84U-1	0.466	0.619	0.475	0.633	1.8%	2.3%	0.487	0.747	0.495	0.772	1.6%	3.3%	0.472	0.480	1.8%
84U-2	0.441	0.633	0.449	0.661	1.9%	4.3%	0.456	0.674	0.460	0.704	0.9%	4.6%	0.445	0.452	1.6%
84U-3	0.427	0.546	0.464	0.590	8.8%	8.1%	0.439	0.597	0.475	0.632	8.2%	6.0%	0.430	0.467	8.6%
84U-1X	0.591	0.821	0.607	0.835	2.8%	1.7%	0.605	0.948	0.631	0.980	4.3%	3.4%	0.595	0.614	3.2%
84U-3X	0.409	0.482	0.408	0.489	-0.4%	1.4%	0.402	0.508	0.413	0.517	2.8%	1.7%	0.407	0.409	0.5%
84L-1	1.134	1.455	1.201	1.529	5.9%	5.0%	1.169	1.687	1.235	1.797	5.7%	6.6%	1.144	1.211	5.8%
84L-2	0.084	0.141	0.085	0.141	0.2%	0.1%	0.059	0.073	0.058	0.073	-0.8%	-0.5%	0.077	0.077	0.0%
84U-F	1.143	1.857	1.139	1.525	-0.3%	-17.9%	1.308	2.389	1.186	1.827	-9.3%	-23.5%	1.190	1.153	-3.2%
Basin 85															
85D	0.318	0.516	0.318	0.515	-0.1%	-0.2%	0.339	0.505	0.338	0.506	-0.2%	0.2%	0.324	0.324	-0.2%

City of Oakland

Sewer System Hydraulic Model Calibration

DRY WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Weekday Dry Weather Flow						Weekend Dry Weather Flow						Average Dry Weather Flow[4]		
	Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered DWF[2]		Modeled DWF		Percent Difference[3]		Metered Daily Average	Modeled Daily Average	Percent Difference[3]
	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	Average (mgd)	Maximum (mgd)	Average (mgd)	Maximum (mgd)	Average (%)	Maximum (%)	(mgd)	(mgd)	(%)
85D.1	0.097	0.161	0.097	0.161	0.1%	0.5%	0.107	0.163	0.107	0.163	-0.3%	0.2%	0.100	0.100	0.0%
85D.2	0.100	0.179	0.100	0.178	0.2%	-0.6%	0.107	0.172	0.108	0.174	0.4%	0.8%	0.102	0.102	0.2%
85E	0.206	0.299	0.207	0.308	0.2%	3.3%	0.225	0.347	0.225	0.348	-0.2%	0.4%	0.212	0.212	0.1%
85E.1	0.102	0.170	0.102	0.170	0.0%	0.1%	0.111	0.174	0.111	0.174	0.0%	0.4%	0.105	0.105	0.0%
85U-1	0.793	1.154	0.819	1.167	3.2%	1.1%	0.840	1.262	0.865	1.254	3.0%	-0.6%	0.807	0.832	3.2%
85A	1.690	2.107	1.758	2.248	4.0%	6.7%	1.752	2.360	1.824	2.494	4.1%	5.7%	1.707	1.777	4.1%
85B	0.761	0.889	0.745	0.868	-2.2%	-2.4%	0.683	0.718	0.674	0.718	-1.3%	0.0%	0.739	0.725	-1.9%
85C	0.302	0.400	0.303	0.390	0.1%	-2.5%	0.349	0.521	0.349	0.521	-0.1%	0.1%	0.316	0.316	0.0%
85U-2	1.499	1.875	1.499	1.873	0.0%	-0.1%	1.550	2.154	1.547	2.164	-0.2%	0.5%	1.513	1.513	-0.1%
85U-F	0.527	0.837	0.615	0.820	16.6%	-2.1%	0.580	1.031	0.646	0.997	11.5%	-3.3%	0.542	0.624	15.1%
85L-1	2.526	2.948	2.604	3.148	3.1%	6.8%	2.681	3.408	2.609	3.334	-2.7%	-2.1%	2.570	2.606	1.4%
85U-2BX	0.000	0.000	0.000	0.000	0.0%	0.0%	0.000	0.000	0.000	0.000	0.0%	0.0%	0.000	0.000	0.0%
Basin 86															
86A	0.523	0.660	0.526	0.661	0.5%	0.2%	0.557	0.763	0.551	0.750	-1.2%	-1.7%	0.533	0.533	0.0%
86B	0.209	0.269	0.209	0.262	0.1%	-2.6%	0.211	0.289	0.211	0.286	-0.1%	-1.2%	0.210	0.210	0.0%
86-1	0.677	0.867	0.675	0.847	-0.2%	-2.3%	0.697	0.916	0.704	0.938	1.1%	2.5%	0.682	0.684	0.2%
Basin 87															
87-1	0.340	0.453	0.305	0.409	-10.1%	-9.6%	0.311	0.378	0.305	0.409	-1.8%	8.4%	0.332	0.305	-7.9%

Notes:

(1) Some flow meters were located on small, 8-inch and smaller diameter sewers, which were not included in the hydraulic model.

(2) Source: 2011 Flow Metering Data from V&A and EBMUD (ADS).

(3) Percent Difference = (Modeled Flow - Measured Flow)/Measured Flow x 100.

(4) ADWF = (5xWeekday Flow + 2xWeekend Flow)/7

City of Oakland

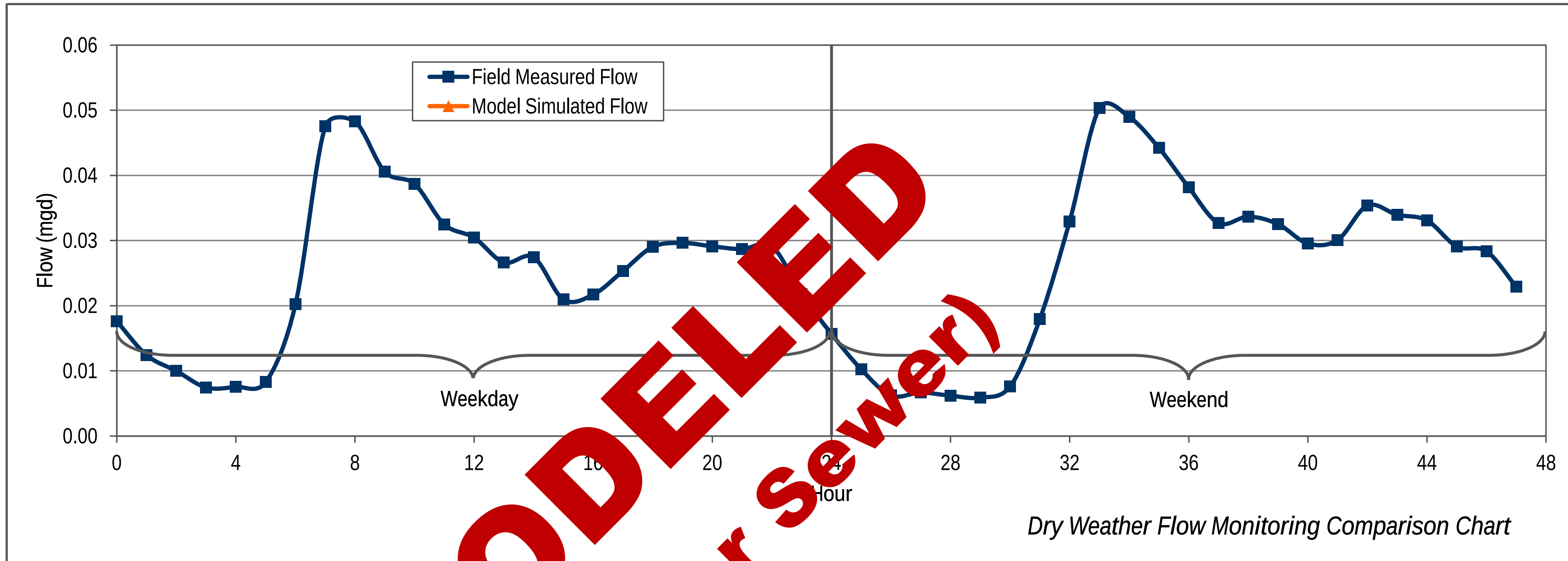
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17A DRY WEATHER CALIBRATION

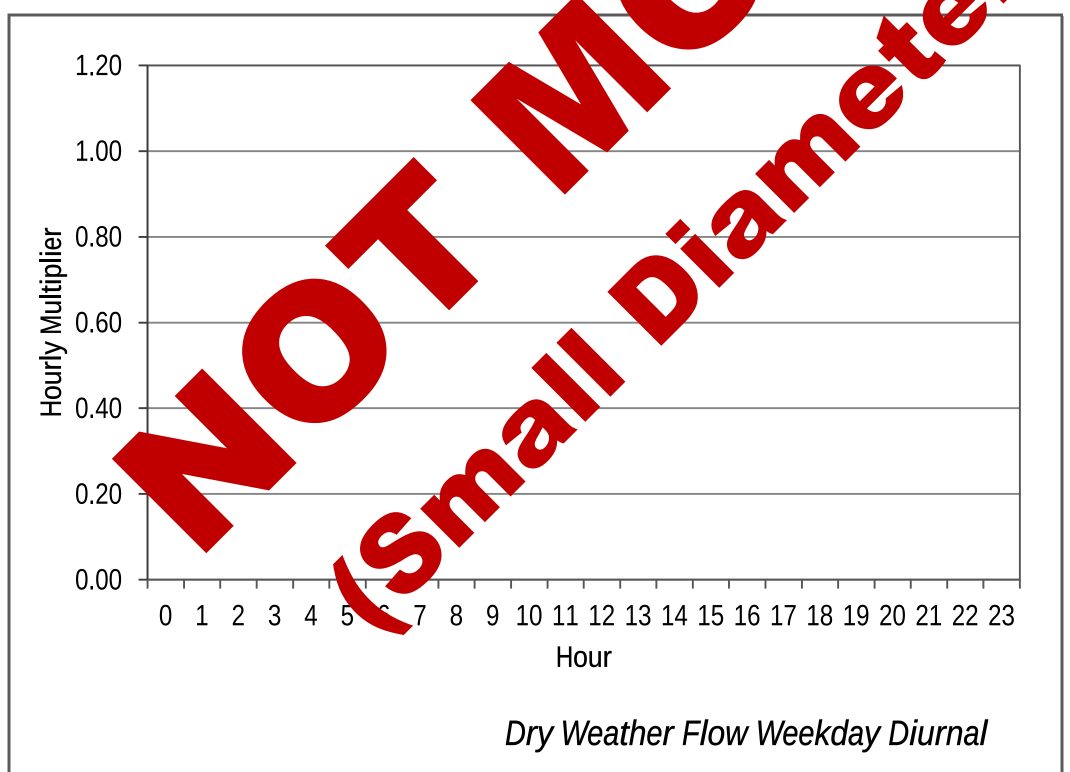
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.018		0.69		
	1	0.012		0.48		
	2	0.010		0.39		
	3	0.007		0.29		
	4	0.008		0.29		
	5	0.008		0.32		
	6	0.020		0.79		
	7	0.048		1.85		
	8	0.048		1.88		
	9	0.041		1.58		
	10	0.039		1.50		
	11	0.032		1.26		
	12	0.030		1.18		
	13	0.027		1.04		
	14	0.027		1.07		
	15	0.021		0.82		
	16	0.022		0.84		
	17	0.025		0.99		
	18	0.029		1.13		
	19	0.030		1.15		
	20	0.029		1.13		
	21	0.029		1.12		
	22	0.029		1.13		
	23	0.022		0.85		
Weekend	24	0.016		0.61		
	25	0.010		0.40		
	26	0.006		0.24		
	27	0.007		0.26		
	28	0.006		0.24		
	29	0.006		0.23		
	30	0.008		0.30		
	31	0.018		0.70		
	32	0.033		1.28		
	33	0.050		1.96		
	34	0.049		1.90		
	35	0.044		1.72		
	36	0.038		1.48		
	37	0.033		1.27		
	38	0.034		1.31		
	39	0.033		1.26		
	40	0.030		1.15		
	41	0.030		1.17		
	42	0.035		1.38		
	43	0.034		1.32		
	44	0.033		1.29		
	45	0.029		1.13		
	46	0.028		1.10		
	47	0.023		0.89		
Average						
	Weekday	0.025	#DIV/0!	0.99	#DIV/0!	#DIV/0!
	Weekend	0.026	#DIV/0!	1.02	#DIV/0!	#DIV/0!
	ADWF(1)	0.026	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

Notes:

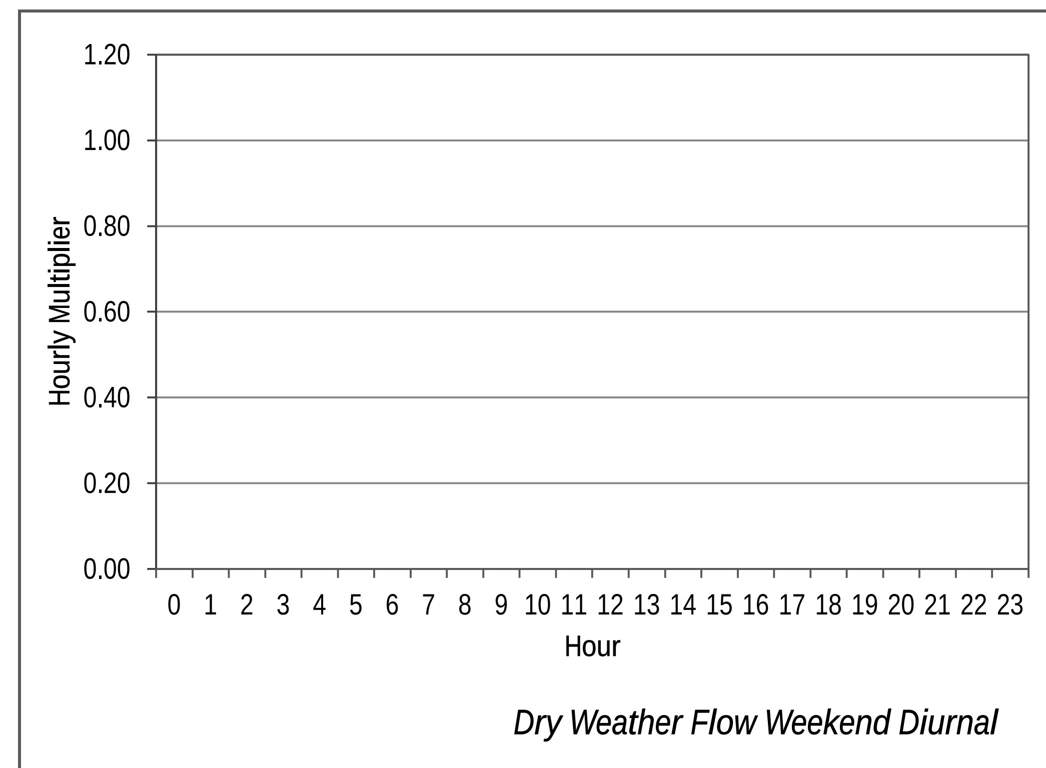
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

NOT MODELED

(Small Diameter Sewer)

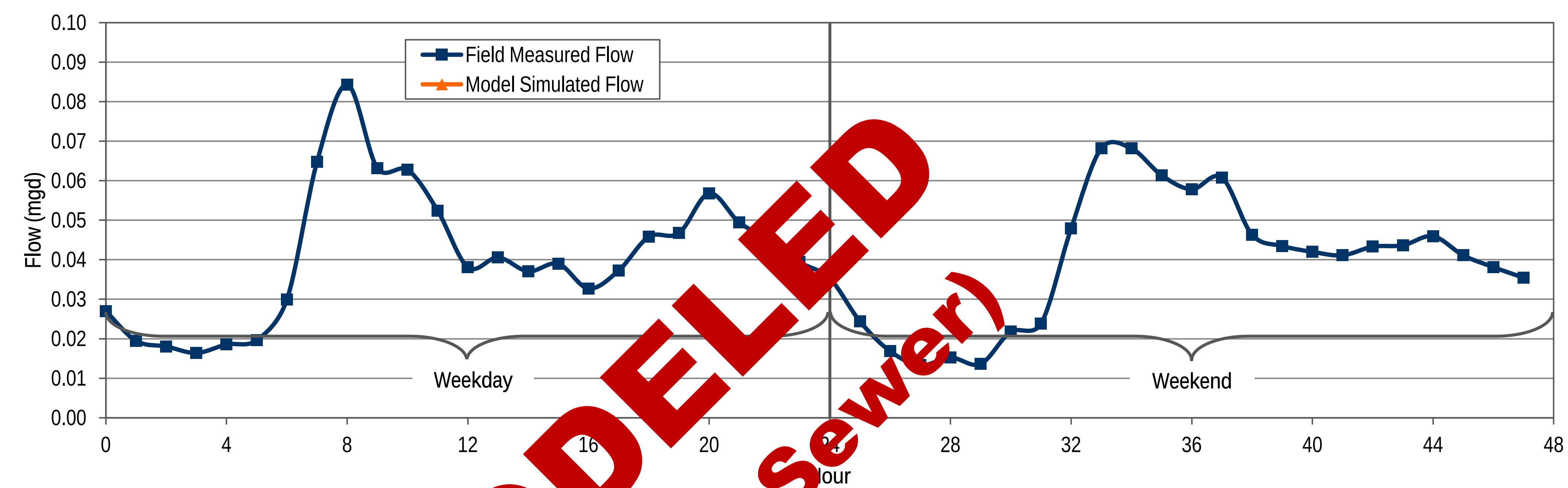
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_17.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 17B DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.027		0.66		
	1	0.019		0.48		
	2	0.018		0.44		
	3	0.016		0.40		
	4	0.019		0.46		
	5	0.020		0.48		
	6	0.030		0.74		
	7	0.065		1.60		
	8	0.084		2.08		
	9	0.063		1.56		
	10	0.063		1.55		
	11	0.052		1.29		
	12	0.038		0.94		
	13	0.041		1.00		
	14	0.037		0.91		
	15	0.039		0.96		
	16	0.033		0.81		
	17	0.037		0.92		
	18	0.046		1.13		
	19	0.047		1.15		
	20	0.057		1.40		
	21	0.049		1.22		
	22	0.045		1.11		
	23	0.039		0.97		
Weekend	24	0.035		0.87		
	25	0.024		0.60		
	26	0.017		0.42		
	27	0.013		0.33		
	28	0.015		0.38		
	29	0.014		0.34		
	30	0.022		0.54		
	31	0.024		0.59		
	32	0.048		1.18		
	33	0.068		1.68		
	34	0.068		1.68		
	35	0.061		1.51		
	36	0.058		1.42		
	37	0.061		1.50		
	38	0.046		1.14		
	39	0.043		1.07		
	40	0.042		1.03		
	41	0.041		1.01		
	42	0.043		1.07		
	43	0.044		1.08		
	44	0.046		1.13		
	45	0.041		1.01		
	46	0.038		0.94		
	47	0.035		0.87		
Average						
Weekday		0.041	#DIV/0!	1.01	#DIV/0!	#DIV/0!
Weekend		0.040	#DIV/0!	0.97	#DIV/0!	#DIV/0!
ADWF[(1)]		0.041	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
Weekday			#DIV/0!			
Weekend			#DIV/0!			

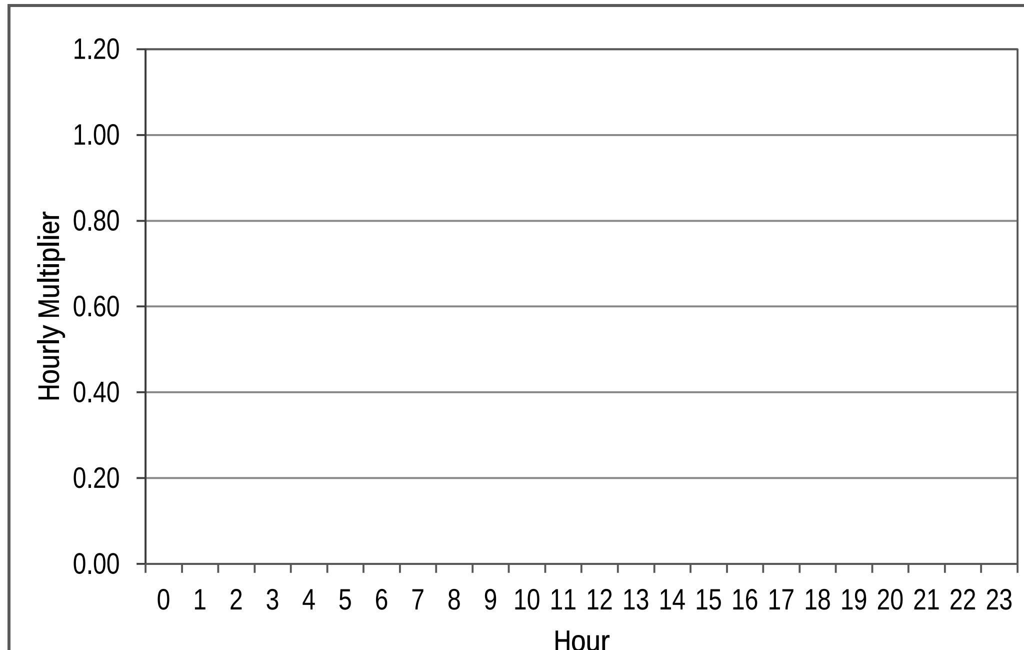
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart

NOT MODELED
(Small Diameter Sewer)

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

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City of Oakland

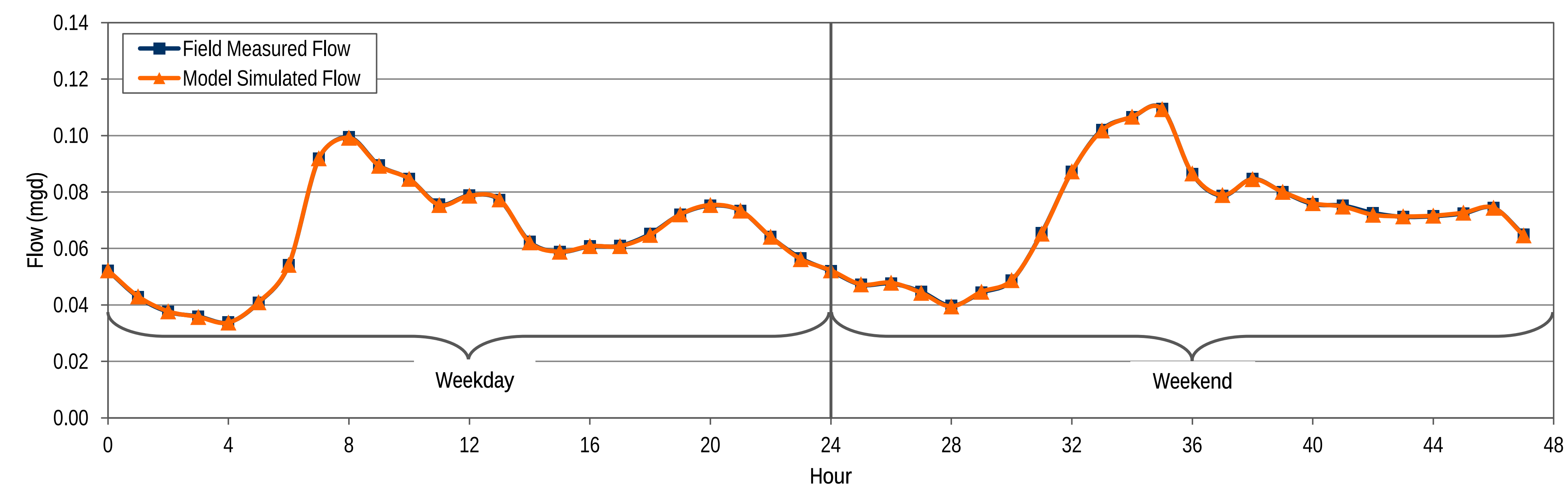
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17U-S1 DRY WEATHER CALIBRATION

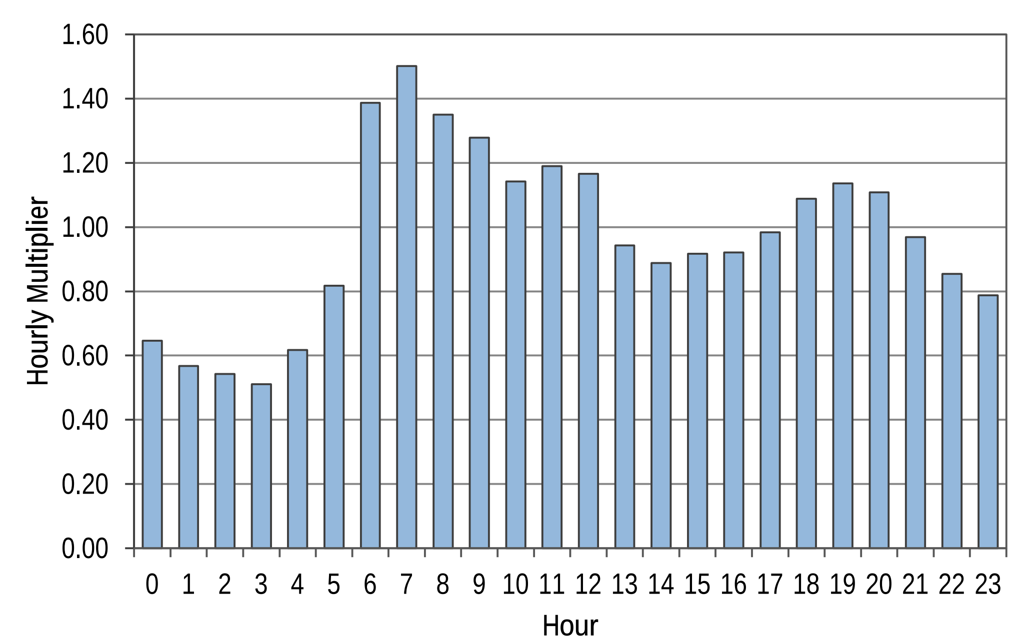
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.052	0.052	0.79	0.65	0.65
	1	0.043	0.043	0.65	0.57	0.57
	2	0.038	0.038	0.57	0.54	0.54
	3	0.036	0.036	0.54	0.51	0.51
	4	0.034	0.034	0.51	0.62	0.62
	5	0.041	0.041	0.62	0.82	0.82
	6	0.054	0.054	0.82	1.39	1.39
	7	0.092	0.092	1.39	1.50	1.50
	8	0.099	0.099	1.50	1.35	1.35
	9	0.089	0.089	1.35	1.28	1.28
	10	0.085	0.085	1.28	1.14	1.14
	11	0.076	0.075	1.14	1.19	1.19
	12	0.079	0.079	1.19	1.17	1.17
	13	0.077	0.077	1.17	0.94	0.94
	14	0.062	0.062	0.94	0.89	0.89
	15	0.059	0.059	0.89	0.92	0.92
	16	0.061	0.061	0.92	0.92	0.92
	17	0.061	0.061	0.92	0.98	0.98
	18	0.065	0.065	0.98	1.09	1.09
	19	0.072	0.072	1.09	1.14	1.14
	20	0.075	0.075	1.14	1.11	1.11
	21	0.073	0.073	1.11	0.97	0.97
	22	0.064	0.064	0.97	0.85	0.85
	23	0.057	0.056	0.85	0.79	0.79
Weekend	24	0.052	0.052	0.79	0.71	0.71
	25	0.047	0.047	0.71	0.72	0.72
	26	0.048	0.048	0.72	0.68	0.68
	27	0.045	0.044	0.68	0.60	0.60
	28	0.040	0.040	0.60	0.67	0.67
	29	0.044	0.045	0.67	0.73	0.73
	30	0.049	0.049	0.73	0.99	0.99
	31	0.066	0.065	0.99	1.32	1.32
	32	0.087	0.087	1.32	1.54	1.54
	33	0.102	0.102	1.54	1.61	1.61
	34	0.107	0.107	1.61	1.65	1.65
	35	0.110	0.109	1.65	1.31	1.31
	36	0.086	0.087	1.31	1.19	1.19
	37	0.079	0.079	1.19	1.28	1.28
	38	0.085	0.085	1.28	1.21	1.21
	39	0.080	0.080	1.21	1.14	1.14
	40	0.076	0.076	1.14	1.14	1.14
	41	0.075	0.075	1.14	1.10	1.10
	42	0.073	0.072	1.10	1.08	1.08
	43	0.071	0.071	1.08	1.08	1.08
	44	0.071	0.072	1.08	1.09	1.09
	45	0.072	0.073	1.09	1.12	1.12
	46	0.074	0.074	1.12	0.98	0.98
	47	0.065	0.065	0.98	0.79	0.79
Average						
	Weekday	0.064	0.064	0.97	0.97	0.97
	Weekend	0.071	0.071	1.07	1.07	1.07
	ADWF[(1)]	0.066	0.066	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

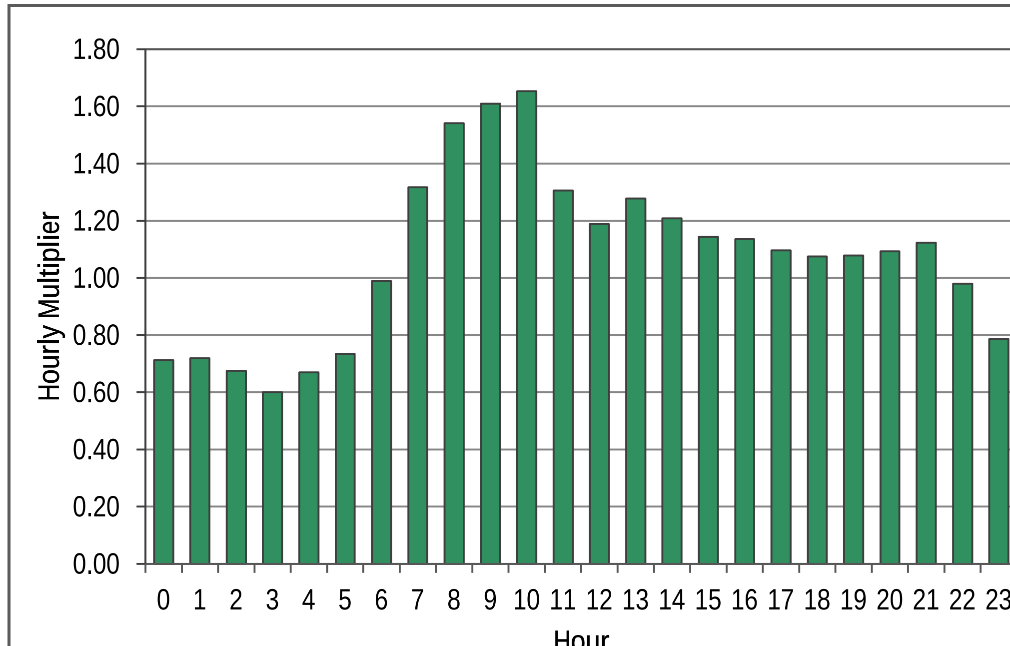
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

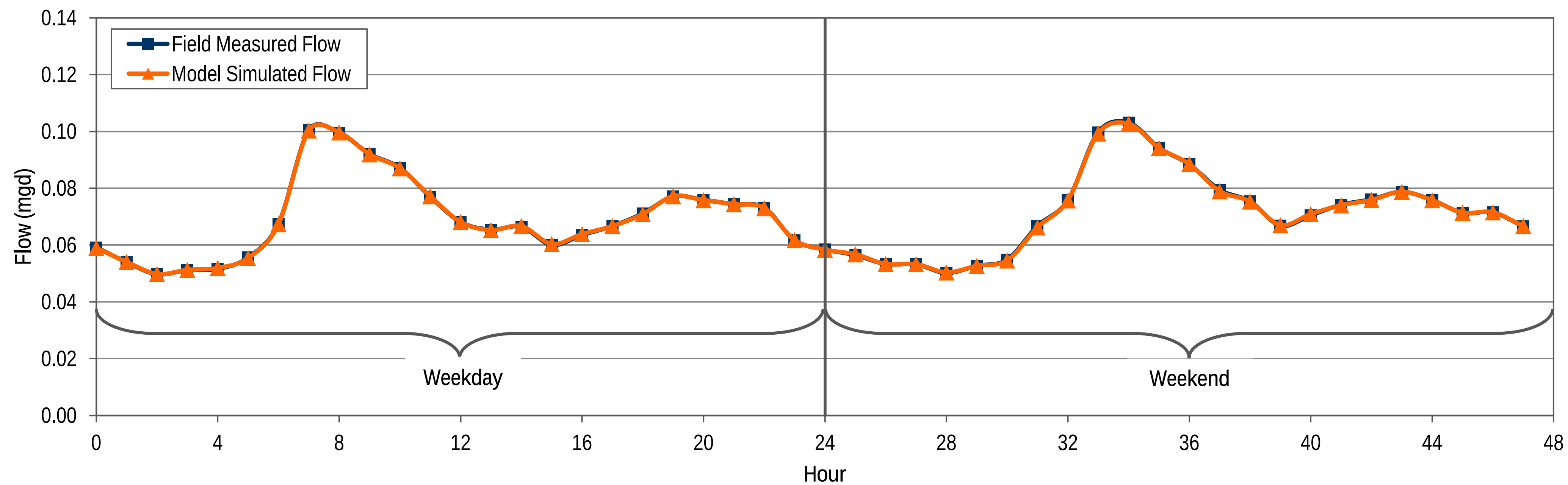
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17U-S2 DRY WEATHER CALIBRATION

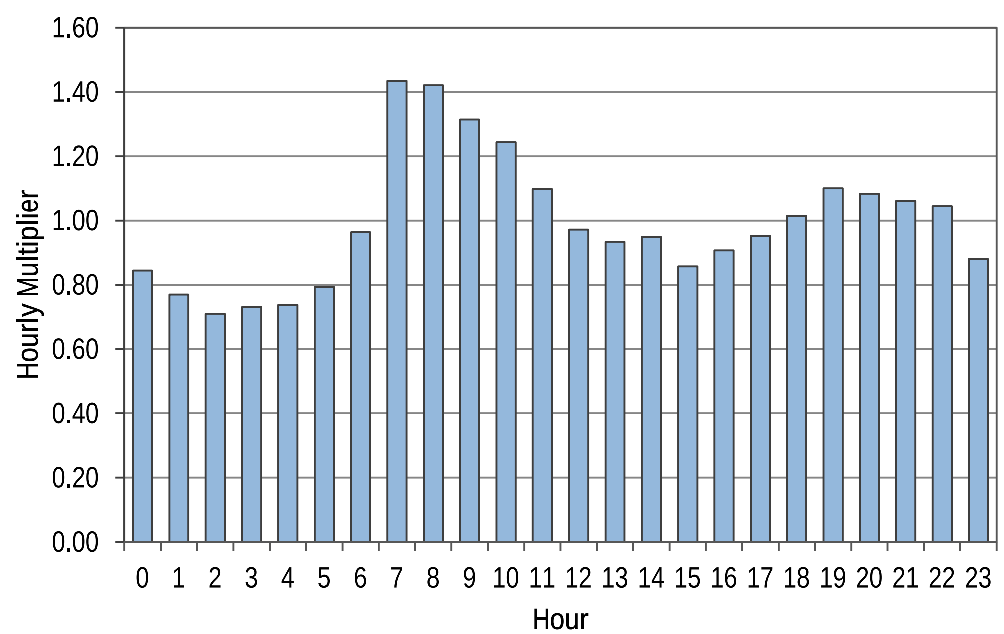
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.059	0.059	0.84	0.84	0.84
	1	0.054	0.054	0.77	0.77	0.77
	2	0.050	0.050	0.71	0.71	0.71
	3	0.051	0.051	0.73	0.73	0.73
	4	0.052	0.052	0.74	0.74	0.74
	5	0.056	0.055	0.79	0.79	0.79
	6	0.067	0.067	0.96	0.96	0.96
	7	0.100	0.100	1.43	1.43	1.43
	8	0.100	0.100	1.42	1.42	1.42
	9	0.092	0.092	1.31	1.31	1.31
	10	0.087	0.087	1.24	1.24	1.24
	11	0.077	0.077	1.10	1.10	1.10
	12	0.068	0.068	0.97	0.97	0.97
	13	0.065	0.065	0.93	0.93	0.93
	14	0.066	0.067	0.95	0.95	0.95
	15	0.060	0.060	0.86	0.86	0.86
	16	0.064	0.064	0.91	0.91	0.91
	17	0.067	0.067	0.95	0.95	0.95
	18	0.071	0.071	1.01	1.01	1.01
	19	0.077	0.077	1.10	1.10	1.10
	20	0.076	0.076	1.08	1.08	1.08
	21	0.074	0.074	1.06	1.06	1.06
	22	0.073	0.073	1.04	1.04	1.04
	23	0.062	0.062	0.88	0.88	0.88
Weekend	24	0.058	0.058	0.83	0.83	0.83
	25	0.056	0.057	0.81	0.81	0.81
	26	0.053	0.053	0.76	0.76	0.76
	27	0.053	0.053	0.76	0.76	0.76
	28	0.050	0.050	0.72	0.72	0.72
	29	0.053	0.053	0.75	0.75	0.75
	30	0.055	0.055	0.78	0.78	0.78
	31	0.067	0.066	0.95	0.95	0.95
	32	0.076	0.076	1.08	1.08	1.08
	33	0.100	0.099	1.42	1.42	1.42
	34	0.103	0.103	1.47	1.47	1.47
	35	0.094	0.094	1.34	1.34	1.34
	36	0.088	0.088	1.26	1.26	1.26
	37	0.079	0.079	1.13	1.13	1.13
	38	0.075	0.075	1.08	1.08	1.08
	39	0.067	0.067	0.95	0.95	0.95
	40	0.070	0.071	1.01	1.01	1.01
	41	0.074	0.074	1.06	1.06	1.06
	42	0.076	0.076	1.09	1.09	1.09
	43	0.079	0.079	1.12	1.12	1.12
	44	0.076	0.076	1.08	1.08	1.08
	45	0.071	0.071	1.02	1.02	1.02
	46	0.071	0.072	1.02	1.02	1.02
	47	0.067	0.067	0.95	0.95	0.95
Average						
	Weekday	0.070	0.070	0.99	0.99	0.99
	Weekend	0.071	0.071	1.02	1.02	1.02
	ADWF[(1)]	0.070	0.070	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.1%			

Notes:

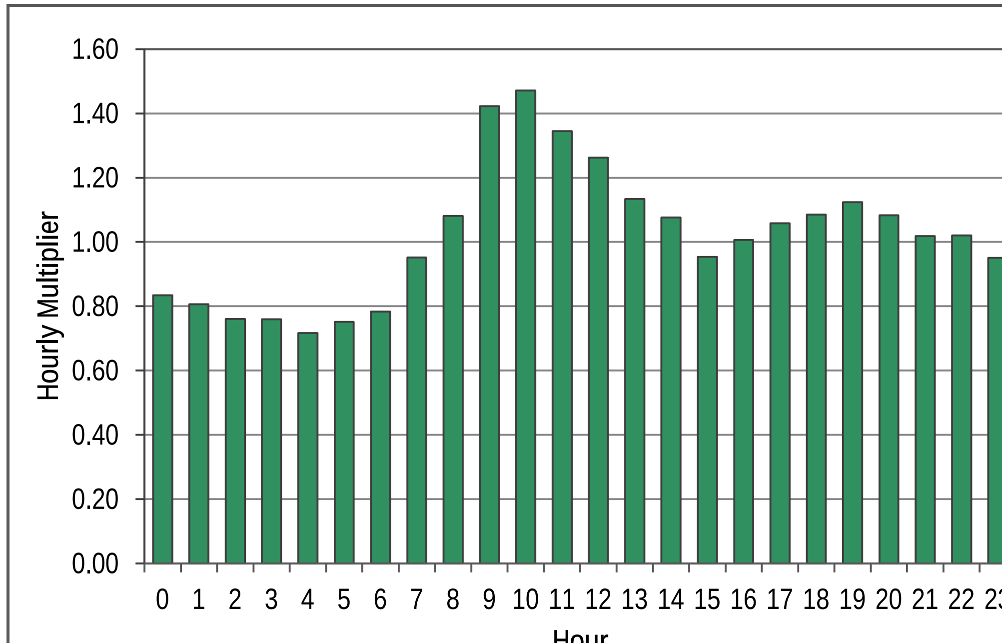
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

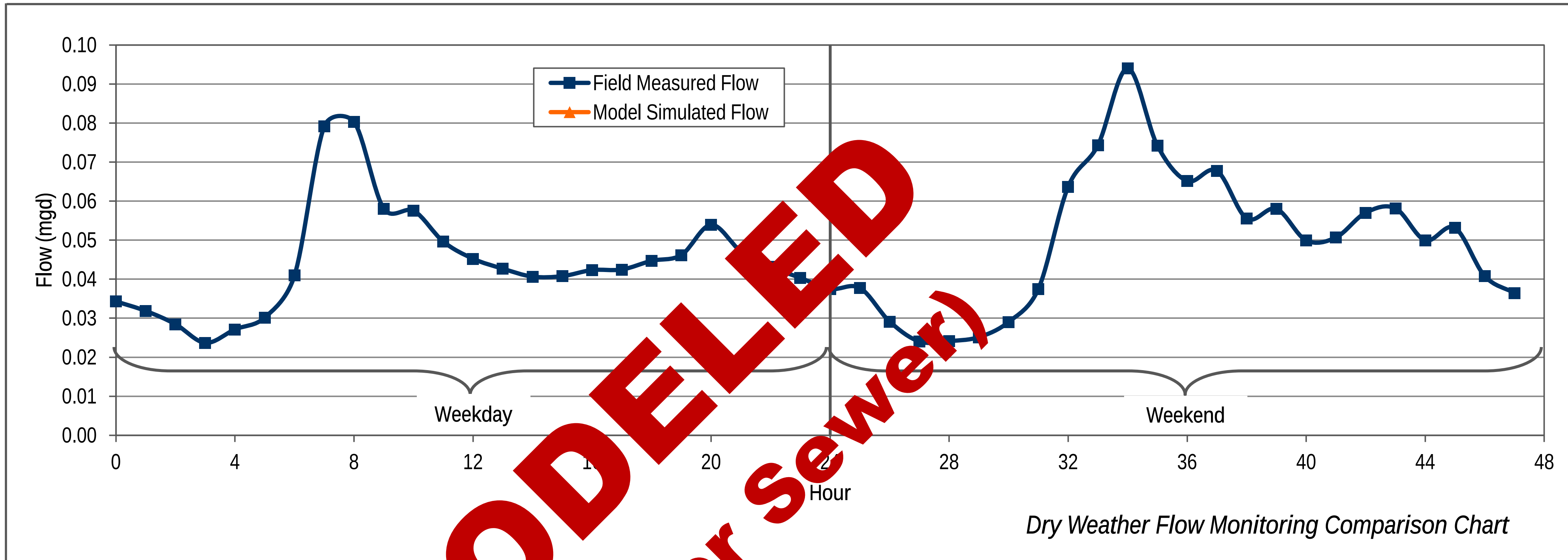
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_17.xlsx

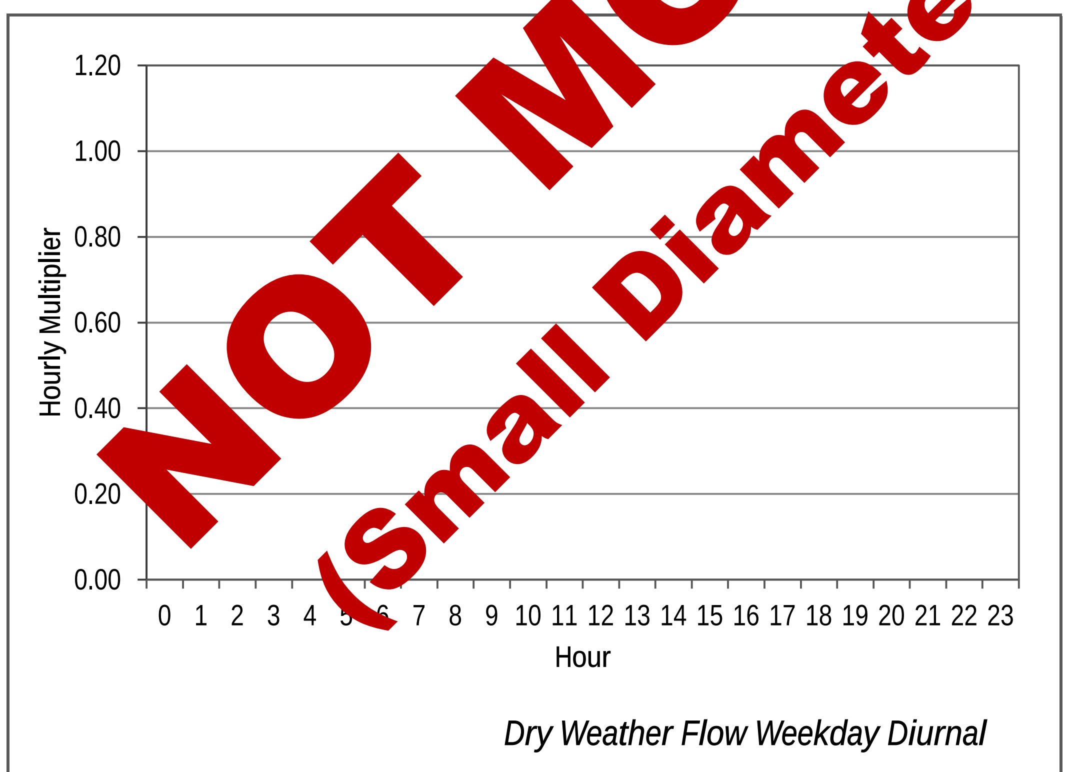
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 17U-S3 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.034		0.74		
	1	0.032		0.69		
	2	0.028		0.62		
	3	0.024		0.51		
	4	0.027		0.59		
	5	0.030		0.65		
	6	0.041		0.89		
	7	0.079		1.72		
	8	0.080		1.74		
	9	0.058		1.26		
	10	0.058		1.25		
	11	0.050		1.08		
	12	0.045		0.98		
	13	0.043		0.93		
	14	0.041		0.88		
	15	0.041		0.88		
	16	0.042		0.92		
	17	0.042		0.92		
	18	0.045		0.97		
	19	0.046		1.00		
	20	0.054		1.17		
	21	0.047		1.02		
	22	0.043		0.94		
	23	0.040		0.88		
Weekend	24	0.037		0.81		
	25	0.038		0.82		
	26	0.029		0.63		
	27	0.024		0.52		
	28	0.024		0.52		
	29	0.025		0.55		
	30	0.029		0.63		
	31	0.037		0.81		
	32	0.064		1.38		
	33	0.074		1.61		
	34	0.094		2.04		
	35	0.074		1.61		
	36	0.065		1.41		
	37	0.068		1.47		
	38	0.056		1.21		
	39	0.058		1.26		
	40	0.050		1.08		
	41	0.051		1.10		
	42	0.057		1.24		
	43	0.058		1.26		
	44	0.050		1.08		
	45	0.053		1.15		
	46	0.041		0.89		
	47	0.036		0.79		
Average						
	Weekday	0.045	#DIV/0!	0.97	#DIV/0!	#DIV/0!
	Weekend	0.050	#DIV/0!	1.08	#DIV/0!	#DIV/0!
	ADWF[1]	0.046	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

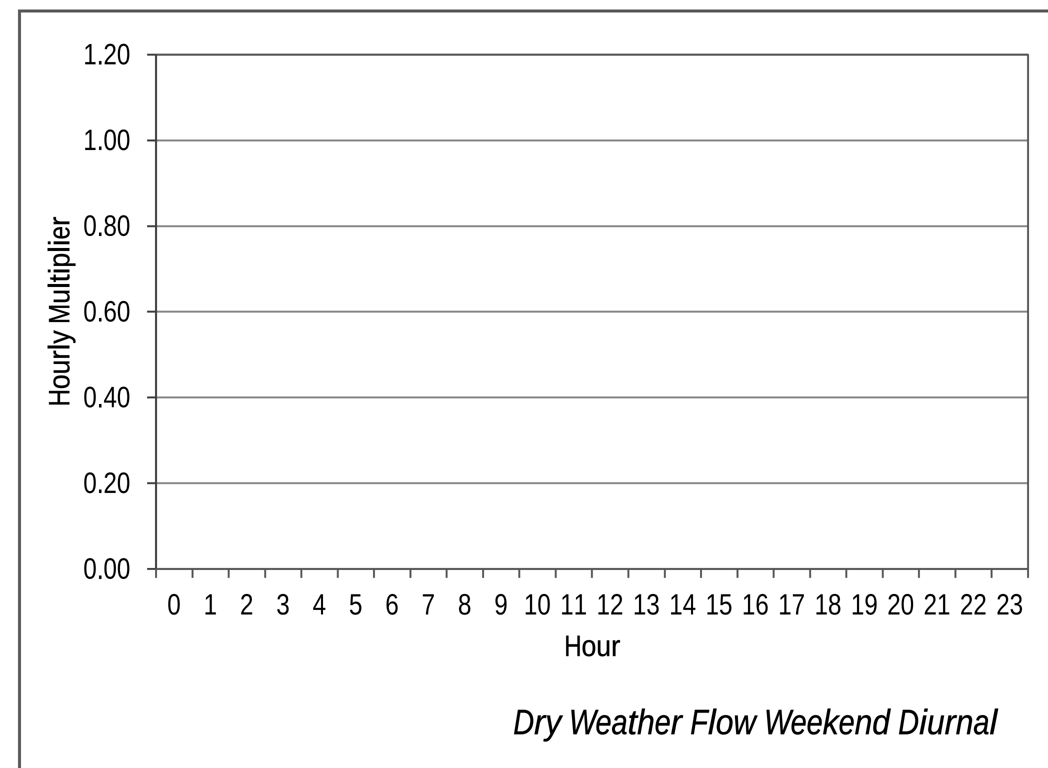
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

NOT MODELED (Small Diameter Sewer)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_17.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20A DRY WEATHER CALIBRATION

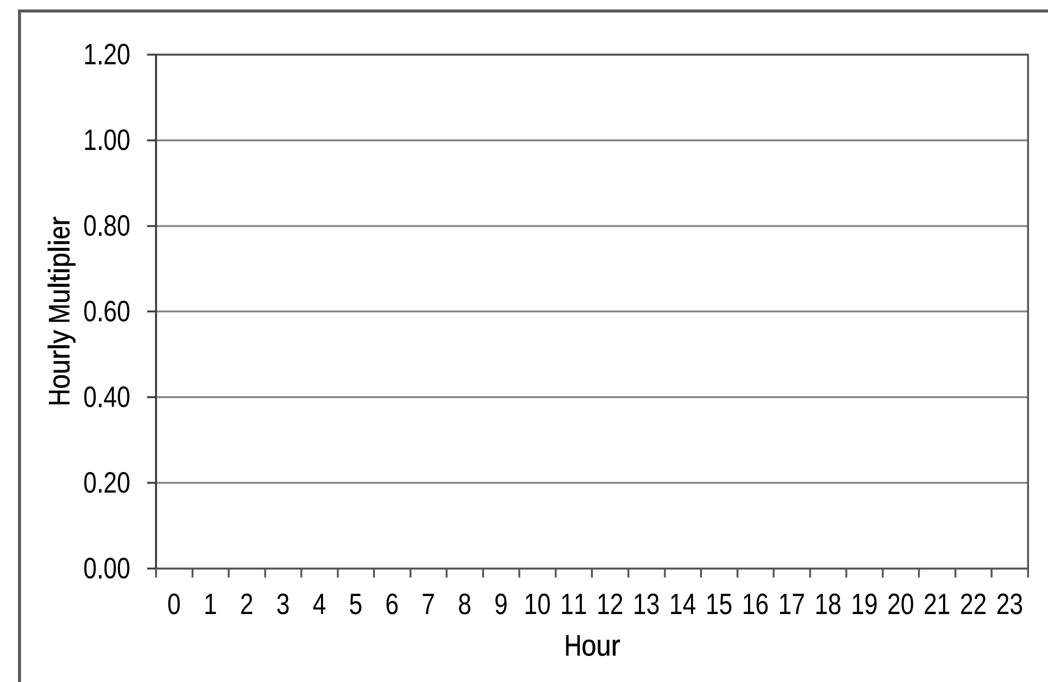
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.004		0.68		
	1	0.003		0.57		
	2	0.002		0.40		
	3	0.002		0.40		
	4	0.002		0.44		
	5	0.003		0.50		
	6	0.007		1.22		
	7	0.009		1.65		
	8	0.007		1.27		
	9	0.006		1.12		
	10	0.006		1.12		
	11	0.006		1.15		
	12	0.007		1.20		
	13	0.007		1.23		
	14	0.006		1.02		
	15	0.005		0.92		
	16	0.006		1.00		
	17	0.006		1.05		
	18	0.007		1.19		
	19	0.007		1.34		
	20	0.007		1.33		
	21	0.006		1.09		
	22	0.005		0.99		
	23	0.005		0.83		
Weekend	24	0.004		0.71		
	25	0.003		0.46		
	26	0.002		0.35		
	27	0.002		0.40		
	28	0.003		0.48		
	29	0.004		0.64		
	30	0.004		0.74		
	31	0.006		1.02		
	32	0.008		1.42		
	33	0.009		1.62		
	34	0.010		1.78		
	35	0.008		1.51		
	36	0.009		1.55		
	37	0.008		1.36		
	38	0.007		1.28		
	39	0.005		0.91		
	40	0.006		1.07		
	41	0.007		1.17		
	42	0.005		0.92		
	43	0.008		1.44		
	44	0.007		1.22		
	45	0.005		0.97		
	46	0.005		0.87		
	47	0.005		0.85		
Average						
	Weekday	0.005	#DIV/0!	0.99	#DIV/0!	#DIV/0!
	Weekend	0.006	#DIV/0!	1.03	#DIV/0!	#DIV/0!
	ADWF[(1)]	0.006	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

Notes:

1. ADWF = (5xWeekday Average + 2xWeekend Average)/7

Dry Weather Flow Monitoring Comparison Chart

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

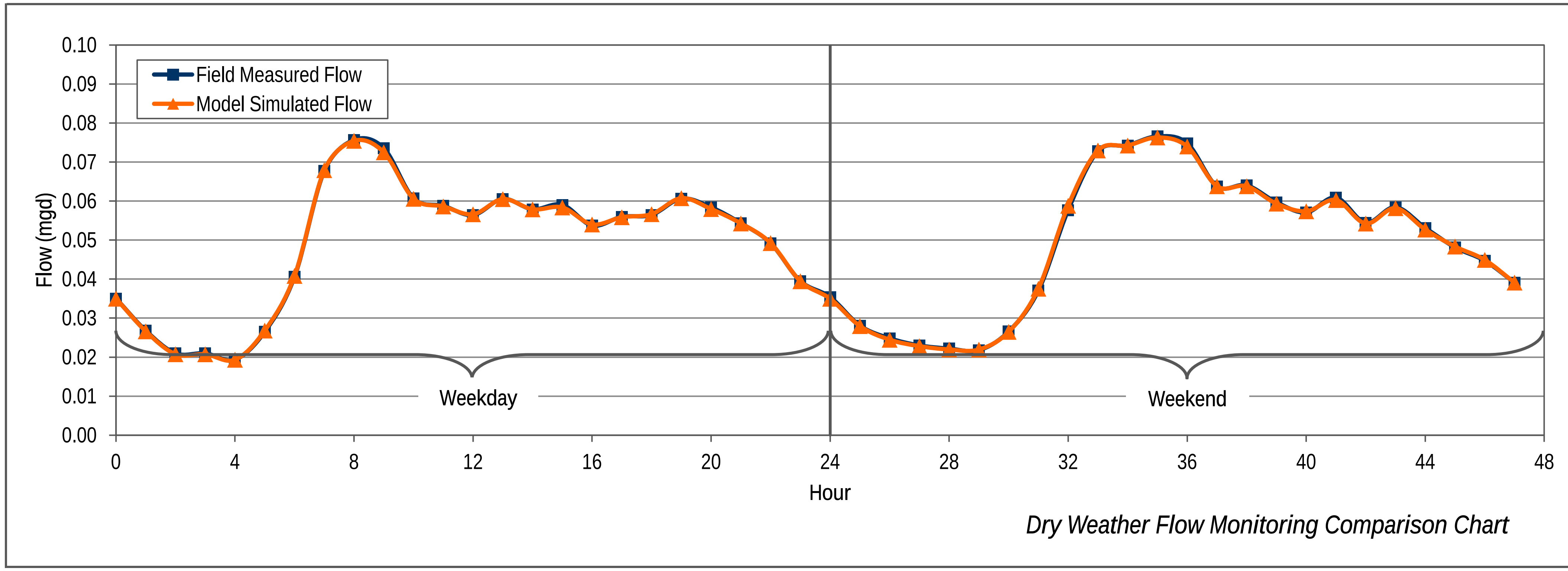
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20B DRY WEATHER CALIBRATION

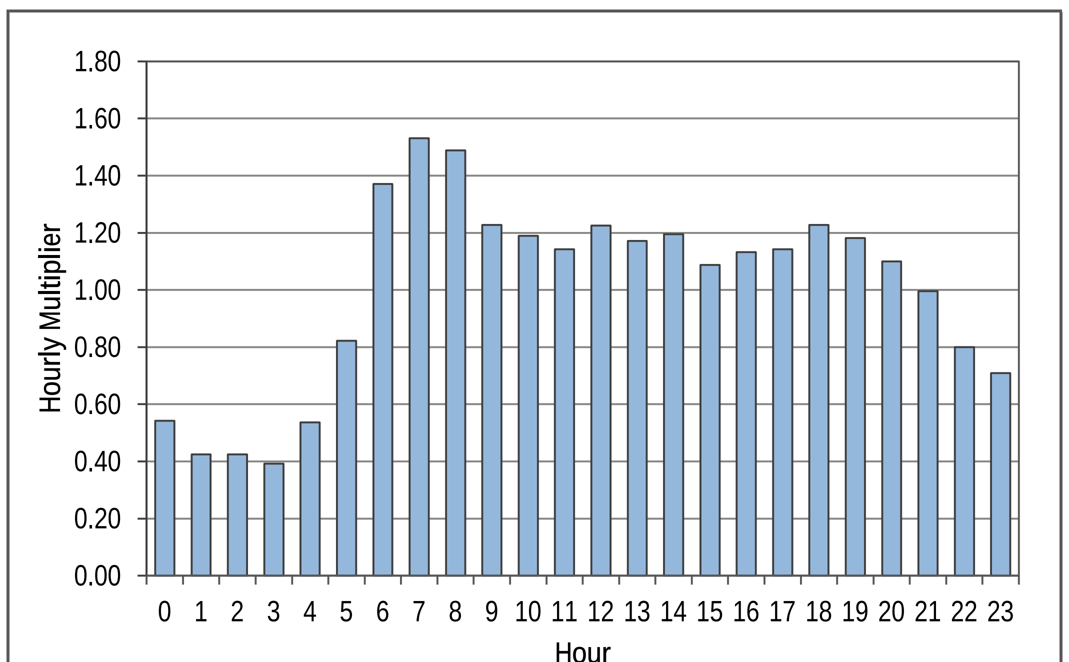
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.035	0.035	0.71	0.54	0.54
	1	0.027	0.027	0.54	0.42	0.42
	2	0.021	0.021	0.42	0.42	0.42
	3	0.021	0.021	0.42	0.39	0.39
	4	0.019	0.019	0.39	0.54	0.54
	5	0.027	0.027	0.54	0.82	0.82
	6	0.041	0.041	0.82	1.37	1.37
	7	0.068	0.068	1.37	1.53	1.53
	8	0.076	0.075	1.53	1.49	1.49
	9	0.074	0.072	1.49	1.23	1.23
	10	0.061	0.061	1.23	1.19	1.19
	11	0.059	0.059	1.19	1.14	1.14
	12	0.056	0.057	1.14	1.23	1.23
	13	0.061	0.060	1.23	1.17	1.17
	14	0.058	0.058	1.17	1.19	1.19
	15	0.059	0.058	1.19	1.09	1.09
	16	0.054	0.054	1.09	1.13	1.13
	17	0.056	0.056	1.13	1.14	1.14
	18	0.056	0.057	1.14	1.23	1.23
	19	0.061	0.061	1.23	1.18	1.18
	20	0.058	0.058	1.18	1.10	1.10
	21	0.054	0.054	1.10	1.00	1.00
	22	0.049	0.049	1.00	0.80	0.80
	23	0.039	0.039	0.80	0.71	0.71
Weekend	24	0.035	0.035	0.72	0.57	0.57
	25	0.028	0.028	0.57	0.50	0.50
	26	0.025	0.024	0.50	0.47	0.47
	27	0.023	0.023	0.47	0.45	0.45
	28	0.022	0.022	0.45	0.44	0.44
	29	0.022	0.022	0.44	0.54	0.54
	30	0.027	0.026	0.54	0.75	0.75
	31	0.037	0.038	0.75	1.17	1.17
	32	0.058	0.059	1.17	1.47	1.47
	33	0.073	0.073	1.47	1.50	1.50
	34	0.074	0.074	1.50	1.55	1.55
	35	0.077	0.076	1.55	1.51	1.51
	36	0.075	0.074	1.51	1.29	1.29
	37	0.064	0.064	1.29	1.30	1.30
	38	0.064	0.064	1.30	1.21	1.21
	39	0.060	0.059	1.21	1.16	1.16
	40	0.057	0.057	1.16	1.23	1.23
	41	0.061	0.060	1.23	1.10	1.10
	42	0.054	0.054	1.10	1.18	1.18
	43	0.058	0.058	1.18	1.08	1.08
	44	0.053	0.053	1.08	0.97	0.97
	45	0.048	0.048	0.97	0.91	0.91
	46	0.045	0.045	0.91	0.79	0.79
	47	0.039	0.039	0.79	0.72	0.72
Average						
Weekday		0.050	0.049	1.00	1.00	1.00
Weekend		0.049	0.049	0.99	0.99	0.99
ADWF[(1)]		0.049	0.049	1.00	1.00	1.00
% Error						
Weekday			-0.2%			
Weekend			-0.2%			

Notes:

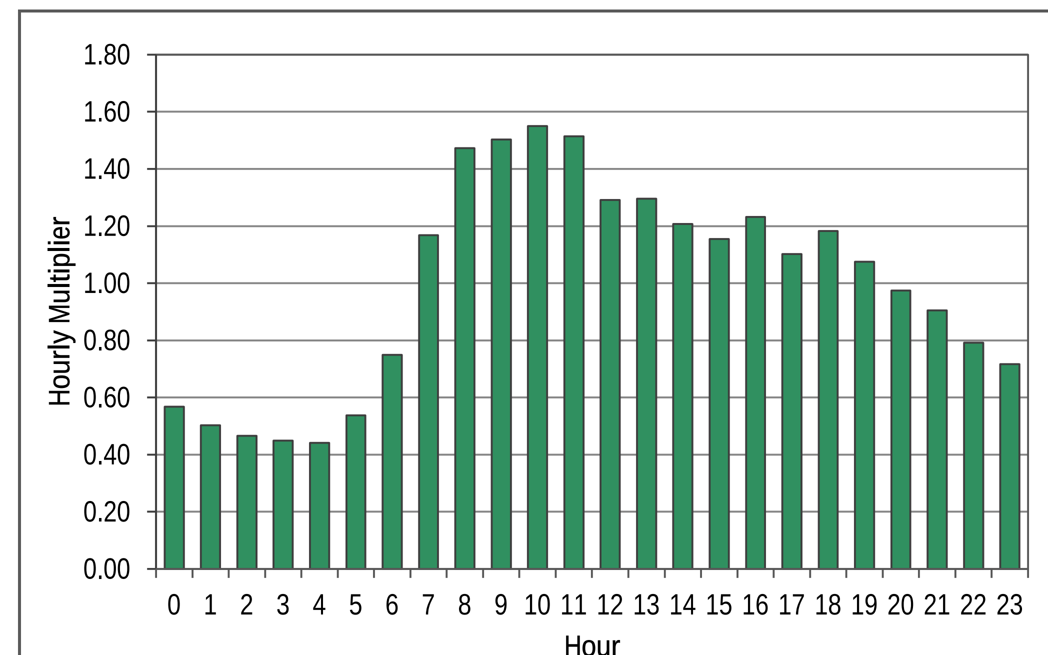
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

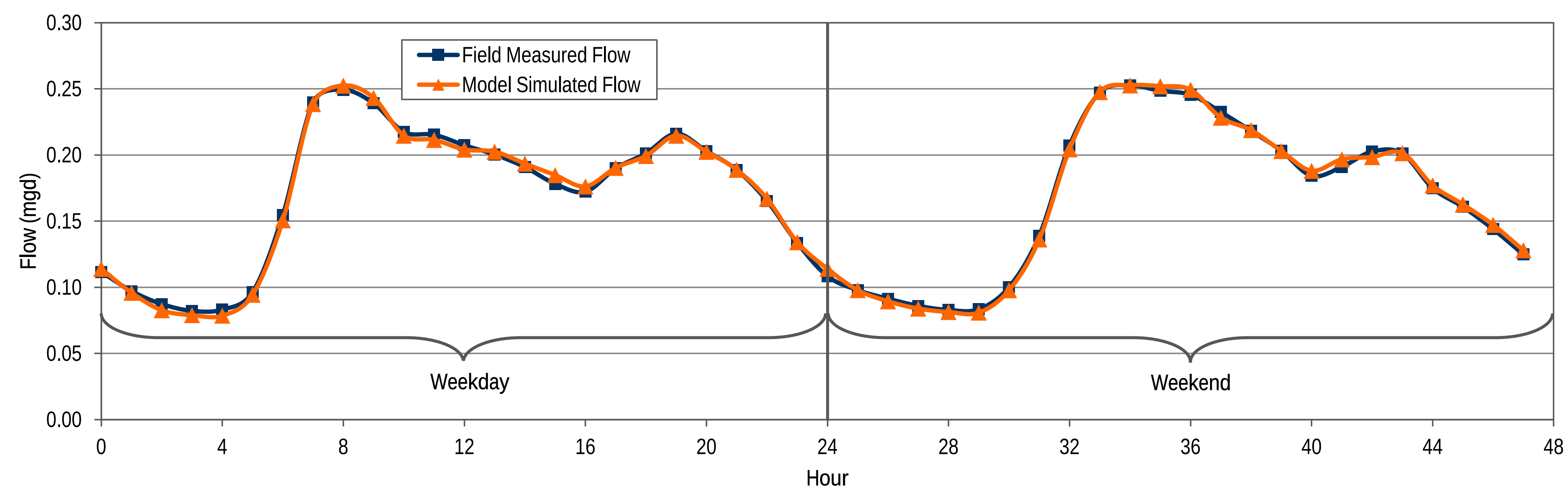
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20-S1 DRY WEATHER CALIBRATION

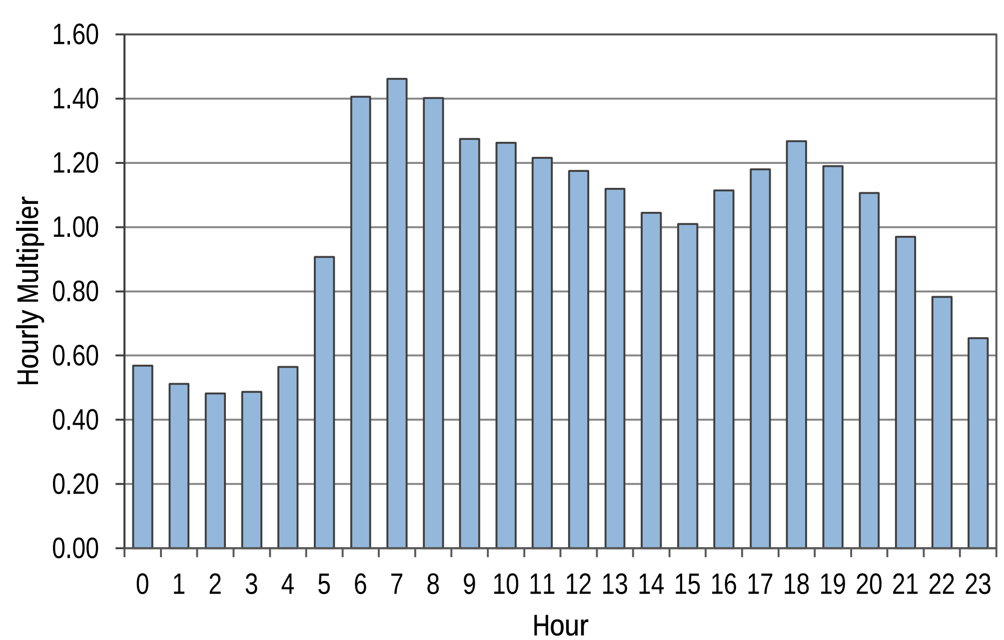
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.112	0.114	0.65	0.57	0.57
	1	0.097	0.096	0.57	0.51	0.51
	2	0.087	0.083	0.51	0.48	0.48
	3	0.082	0.079	0.48	0.49	0.49
	4	0.083	0.079	0.49	0.56	0.56
	5	0.096	0.094	0.56	0.91	0.91
	6	0.155	0.151	0.91	1.41	1.41
	7	0.240	0.238	1.41	1.46	1.46
	8	0.249	0.252	1.46	1.40	1.40
	9	0.239	0.243	1.40	1.27	1.27
	10	0.217	0.215	1.27	1.26	1.26
	11	0.215	0.211	1.26	1.22	1.22
	12	0.207	0.204	1.22	1.17	1.17
	13	0.200	0.202	1.17	1.12	1.12
	14	0.191	0.193	1.12	1.04	1.04
	15	0.178	0.185	1.04	1.01	1.01
	16	0.172	0.176	1.01	1.11	1.11
	17	0.190	0.190	1.11	1.18	1.18
	18	0.201	0.199	1.18	1.27	1.27
	19	0.216	0.215	1.27	1.19	1.19
	20	0.203	0.202	1.19	1.11	1.11
	21	0.189	0.189	1.11	0.97	0.97
	22	0.165	0.167	0.97	0.78	0.78
	23	0.134	0.134	0.78	0.65	0.65
Weekend	24	0.108	0.114	0.64	0.57	0.57
	25	0.098	0.098	0.57	0.54	0.54
	26	0.091	0.089	0.54	0.50	0.50
	27	0.086	0.084	0.50	0.49	0.49
	28	0.083	0.081	0.49	0.49	0.49
	29	0.083	0.081	0.49	0.59	0.59
	30	0.100	0.098	0.59	0.81	0.81
	31	0.139	0.136	0.81	1.21	1.21
	32	0.207	0.204	1.21	1.45	1.45
	33	0.247	0.248	1.45	1.48	1.48
	34	0.253	0.253	1.48	1.46	1.46
	35	0.249	0.252	1.46	1.44	1.44
	36	0.246	0.249	1.44	1.36	1.36
	37	0.233	0.228	1.36	1.28	1.28
	38	0.218	0.219	1.28	1.19	1.19
	39	0.203	0.203	1.19	1.08	1.08
	40	0.184	0.188	1.08	1.12	1.12
	41	0.191	0.197	1.12	1.19	1.19
	42	0.203	0.198	1.19	1.18	1.18
	43	0.201	0.201	1.18	1.03	1.03
	44	0.175	0.177	1.03	0.94	0.94
	45	0.161	0.163	0.94	0.84	0.84
	46	0.144	0.147	0.84	0.73	0.73
	47	0.125	0.128	0.73	0.64	0.64
Average						
	Weekday	0.172	0.17	1.01	1.01	1.01
	Weekend	0.168	0.17	0.98	0.98	0.98
	ADWF[1]	0.171	0.17	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		0.2%			

Notes:

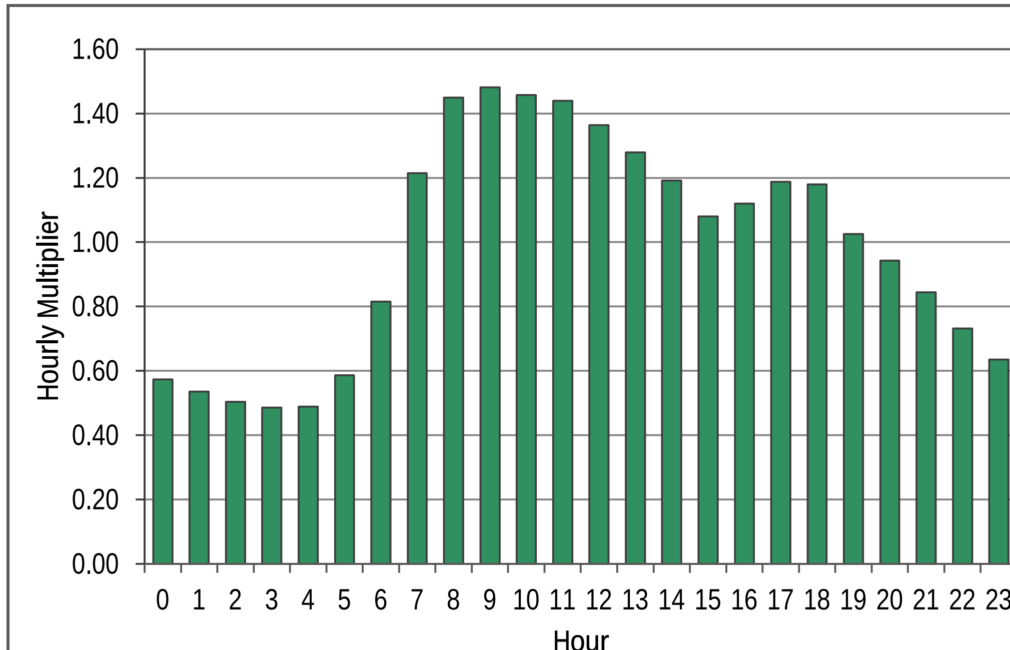
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

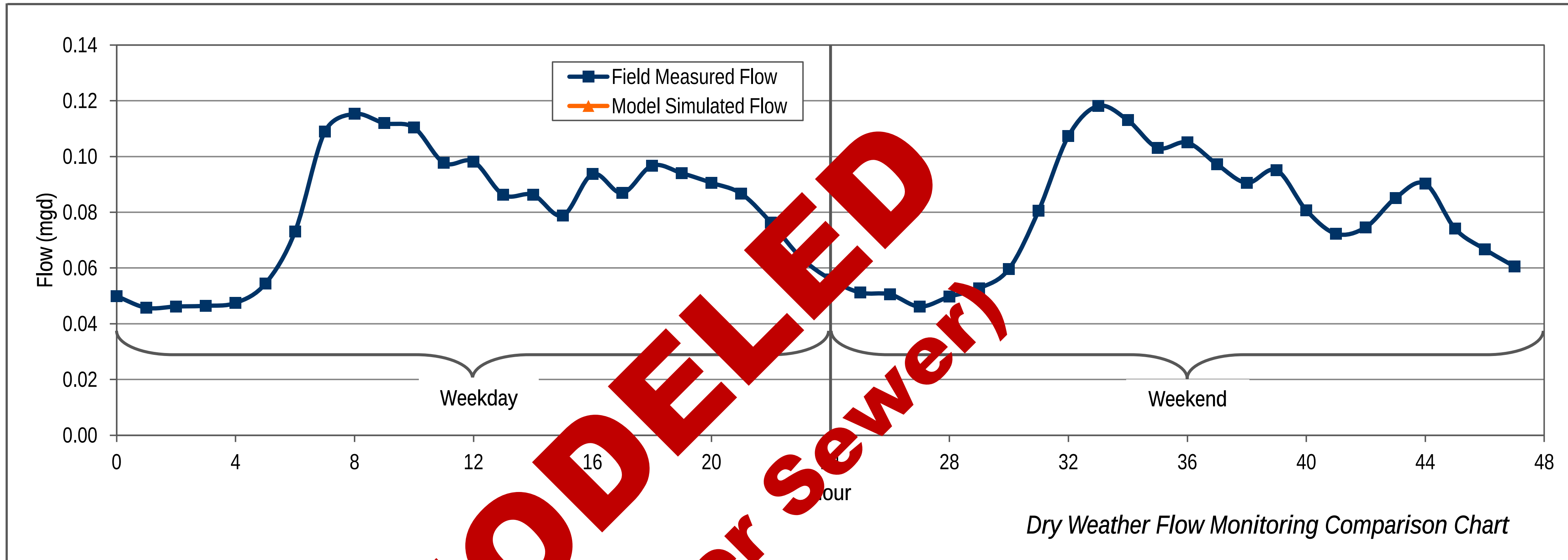
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20-S2 DRY WEATHER CALIBRATION

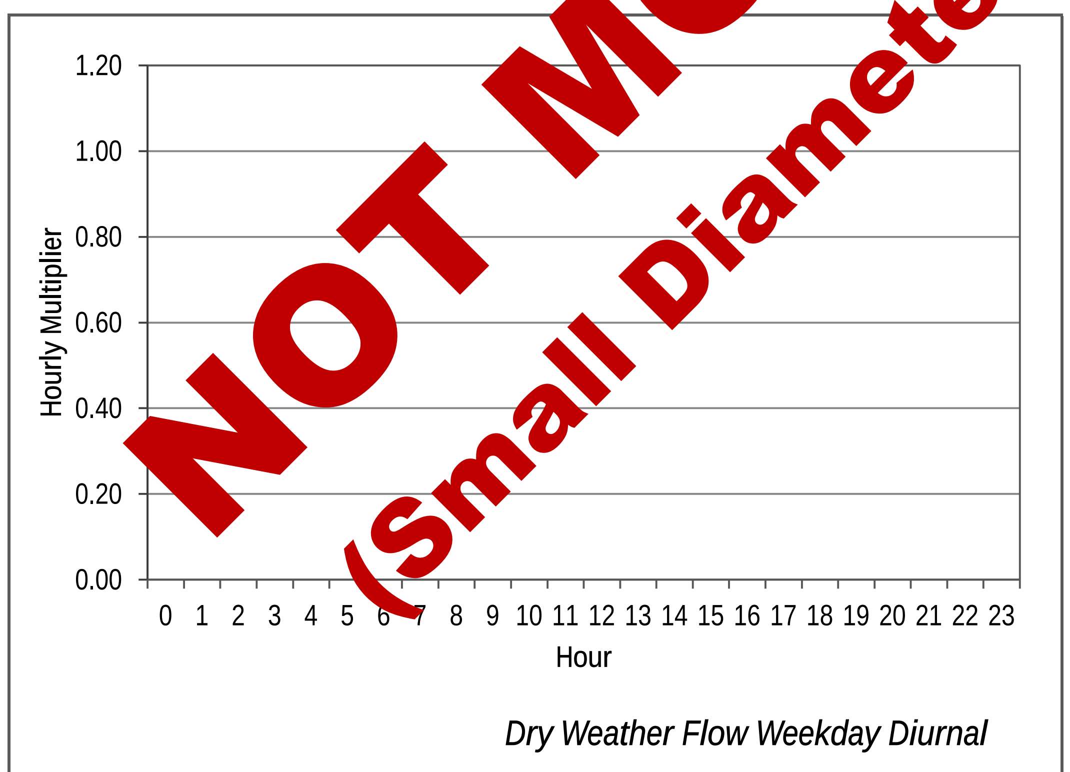
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.050		0.62	0.62	
	1	0.046		0.57	0.57	
	2	0.046		0.58	0.58	
	3	0.046		0.58	0.58	
	4	0.047		0.59	0.59	
	5	0.054		0.68	0.68	
	6	0.073		0.91	0.91	
	7	0.109		1.36	1.36	
	8	0.115		1.44	1.44	
	9	0.112		1.39	1.39	
	10	0.110		1.37	1.37	
	11	0.098		1.22	1.22	
	12	0.098		1.22	1.22	
	13	0.086		1.07	1.07	
	14	0.086		1.07	1.07	
	15	0.079		0.98	0.98	
	16	0.094		1.17	1.17	
	17	0.087		1.08	1.08	
	18	0.097		1.20	1.20	
	19	0.094		1.17	1.17	
	20	0.091		1.13	1.13	
	21	0.087		1.08	1.08	
	22	0.076		0.95	0.95	
	23	0.064		0.79	0.79	
Weekend	24	0.056		0.70	0.70	
	25	0.051		0.64	0.64	
	26	0.051		0.63	0.63	
	27	0.046		0.57	0.57	
	28	0.050		0.62	0.62	
	29	0.053		0.66	0.66	
	30	0.060		0.74	0.74	
	31	0.081		1.00	1.00	
	32	0.107		1.34	1.34	
	33	0.118		1.47	1.47	
	34	0.113		1.41	1.41	
	35	0.103		1.28	1.28	
	36	0.105		1.31	1.31	
	37	0.097		1.21	1.21	
	38	0.091		1.13	1.13	
	39	0.095		1.18	1.18	
	40	0.081		1.01	1.01	
	41	0.072		0.90	0.90	
	42	0.075		0.93	0.93	
	43	0.085		1.06	1.06	
	44	0.090		1.12	1.12	
	45	0.074		0.92	0.92	
	46	0.067		0.83	0.83	
	47	0.061		0.75	0.75	
Average						
	Weekday	0.081	#DIV/0!	1.01	1.01	#DIV/0!
	Weekend	0.078	#DIV/0!	0.98	0.98	#DIV/0!
	ADWF[(1)]	0.080	#DIV/0!	1.00	1.00	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

Notes:

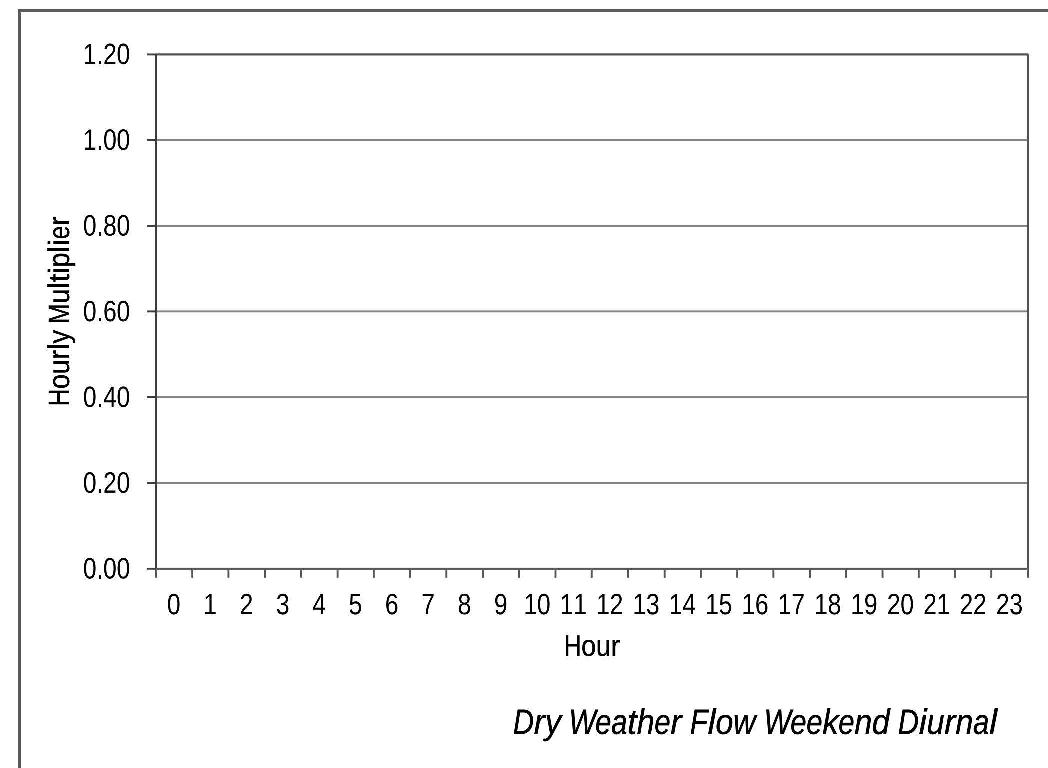
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

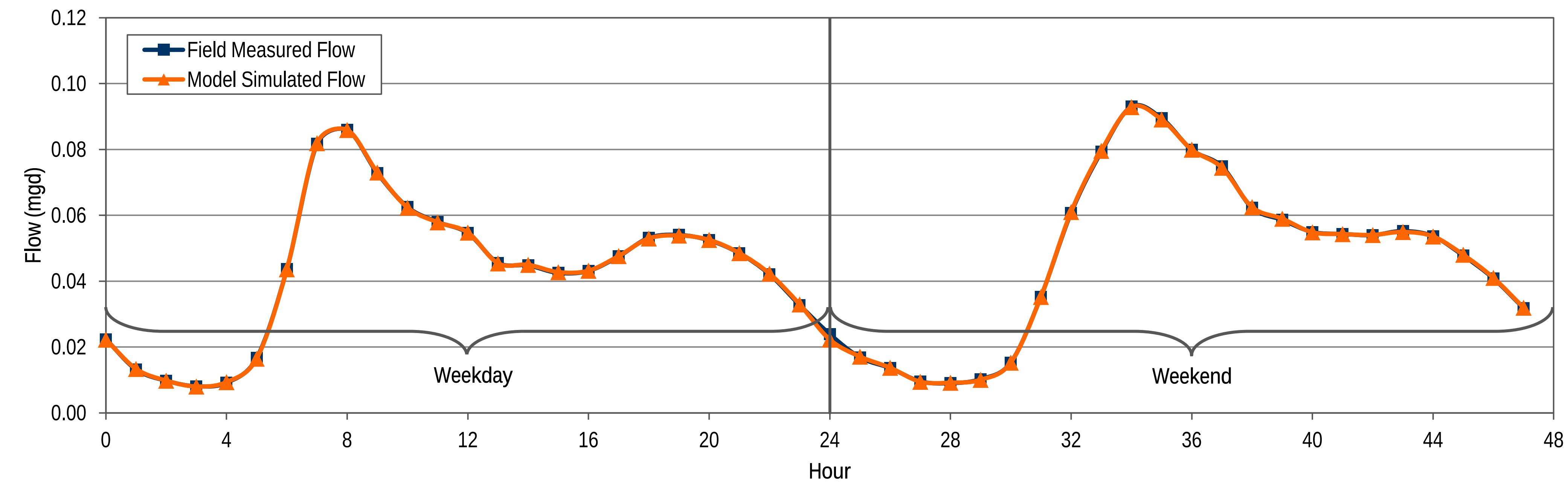
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21A DRY WEATHER CALIBRATION

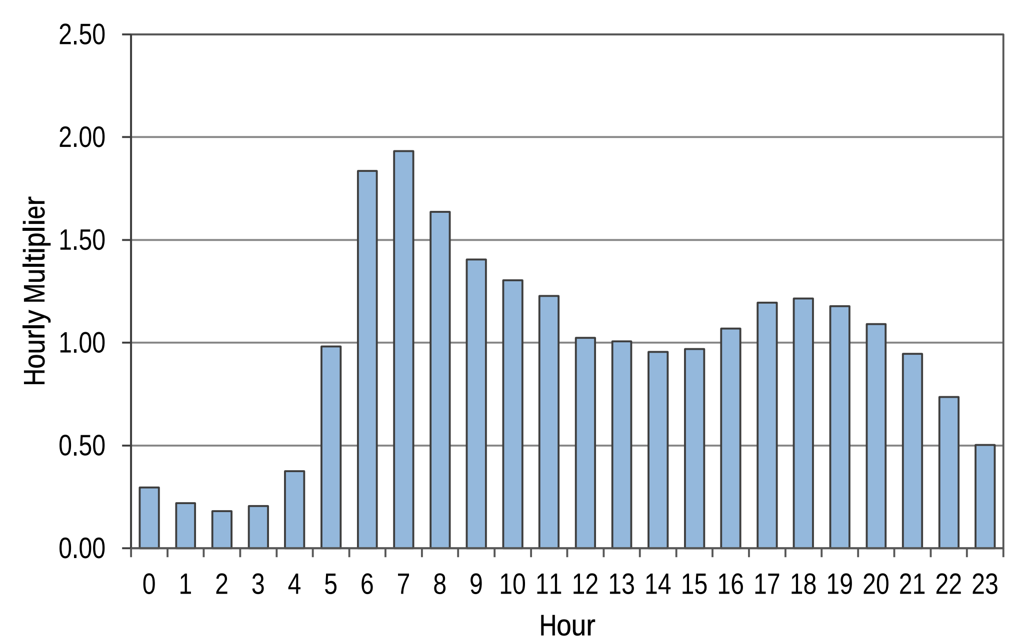
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.022	0.022	0.50	0.30	0.30
	1	0.013	0.013	0.30	0.22	0.22
	2	0.010	0.010	0.22	0.18	0.18
	3	0.008	0.008	0.18	0.21	0.21
	4	0.009	0.009	0.21	0.37	0.37
	5	0.017	0.016	0.37	0.98	0.98
	6	0.044	0.044	0.98	1.84	1.84
	7	0.082	0.082	1.84	1.93	1.93
	8	0.086	0.086	1.93	1.64	1.64
	9	0.073	0.073	1.64	1.40	1.40
	10	0.063	0.062	1.40	1.30	1.30
	11	0.058	0.058	1.30	1.23	1.23
	12	0.055	0.055	1.23	1.02	1.02
	13	0.046	0.045	1.02	1.01	1.01
	14	0.045	0.045	1.01	0.96	0.96
	15	0.043	0.043	0.96	0.97	0.97
	16	0.043	0.043	0.97	1.07	1.07
	17	0.048	0.048	1.07	1.19	1.19
	18	0.053	0.053	1.19	1.21	1.21
	19	0.054	0.054	1.21	1.18	1.18
	20	0.052	0.053	1.18	1.09	1.09
	21	0.049	0.049	1.09	0.95	0.95
	22	0.042	0.042	0.95	0.74	0.74
	23	0.033	0.033	0.74	0.50	0.50
Weekend	24	0.024	0.022	0.54	0.38	0.38
	25	0.017	0.017	0.38	0.31	0.31
	26	0.014	0.014	0.31	0.21	0.21
	27	0.010	0.009	0.21	0.20	0.20
	28	0.009	0.009	0.20	0.23	0.23
	29	0.010	0.010	0.23	0.34	0.34
	30	0.015	0.015	0.34	0.79	0.79
	31	0.035	0.035	0.79	1.37	1.37
	32	0.061	0.061	1.37	1.78	1.78
	33	0.079	0.080	1.78	2.09	2.09
	34	0.093	0.093	2.09	2.01	2.01
	35	0.089	0.089	2.01	1.80	1.80
	36	0.080	0.080	1.80	1.68	1.68
	37	0.075	0.074	1.68	1.40	1.40
	38	0.062	0.062	1.40	1.32	1.32
	39	0.059	0.059	1.32	1.23	1.23
	40	0.055	0.055	1.23	1.22	1.22
	41	0.054	0.054	1.22	1.21	1.21
	42	0.054	0.054	1.21	1.24	1.24
	43	0.055	0.055	1.24	1.21	1.21
	44	0.054	0.054	1.21	1.07	1.07
	45	0.048	0.048	1.07	0.92	0.92
	46	0.041	0.041	0.92	0.72	0.72
	47	0.032	0.032	0.72	0.54	0.54
Average						
	Weekday	0.044	0.044	0.98	0.98	0.98
	Weekend	0.047	0.047	1.05	1.05	1.05
	ADWF[(1)]	0.044	0.044	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.1%			

Notes:

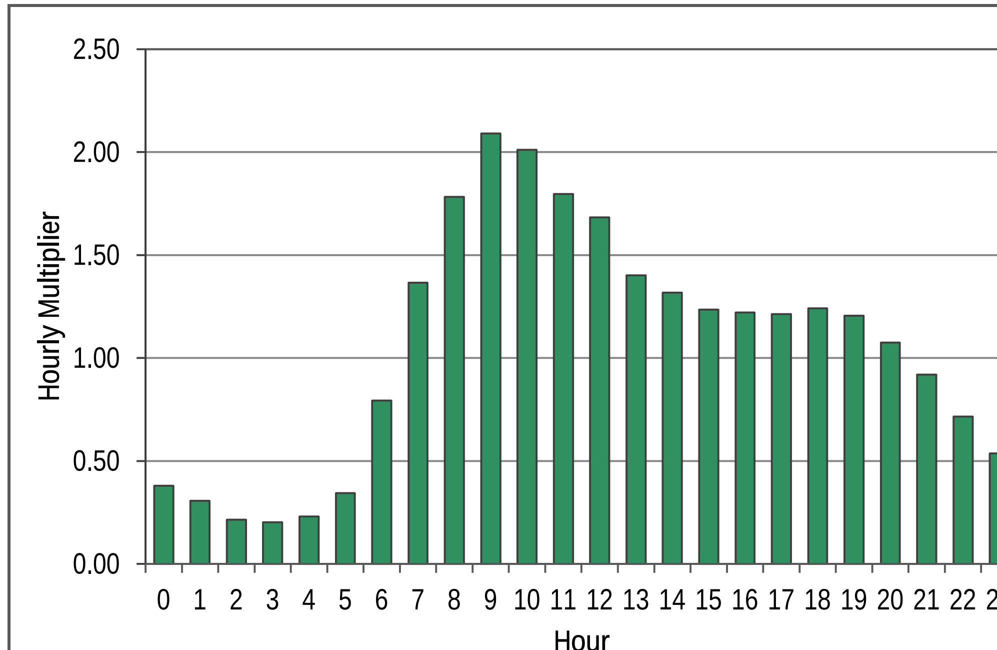
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

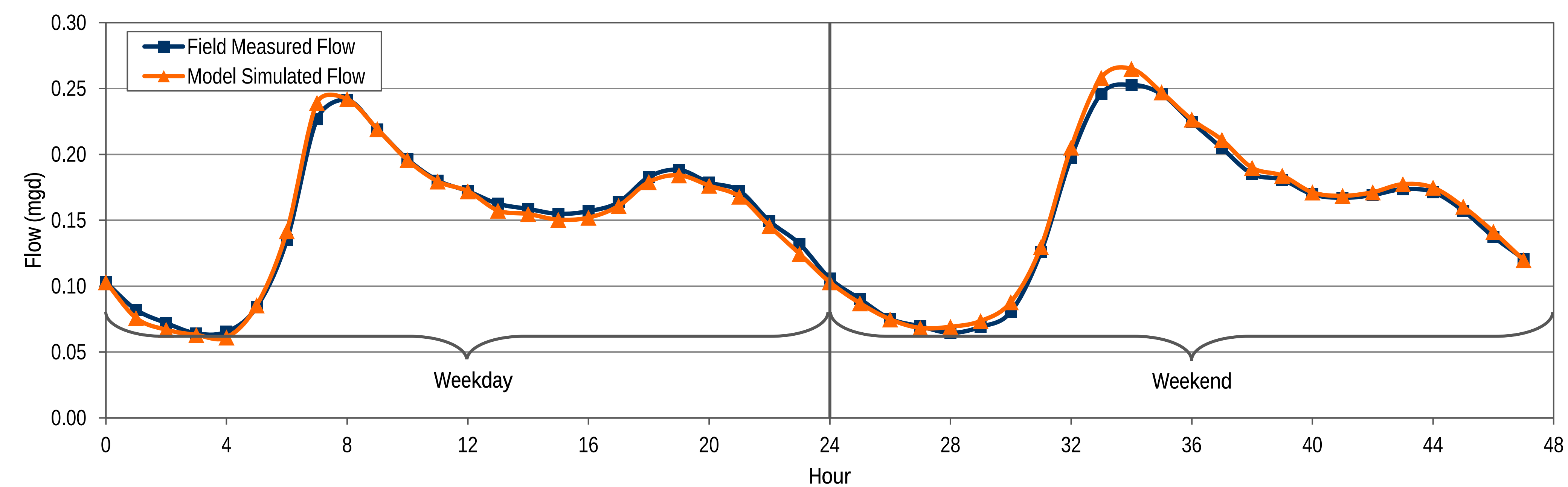
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21U-1 DRY WEATHER CALIBRATION

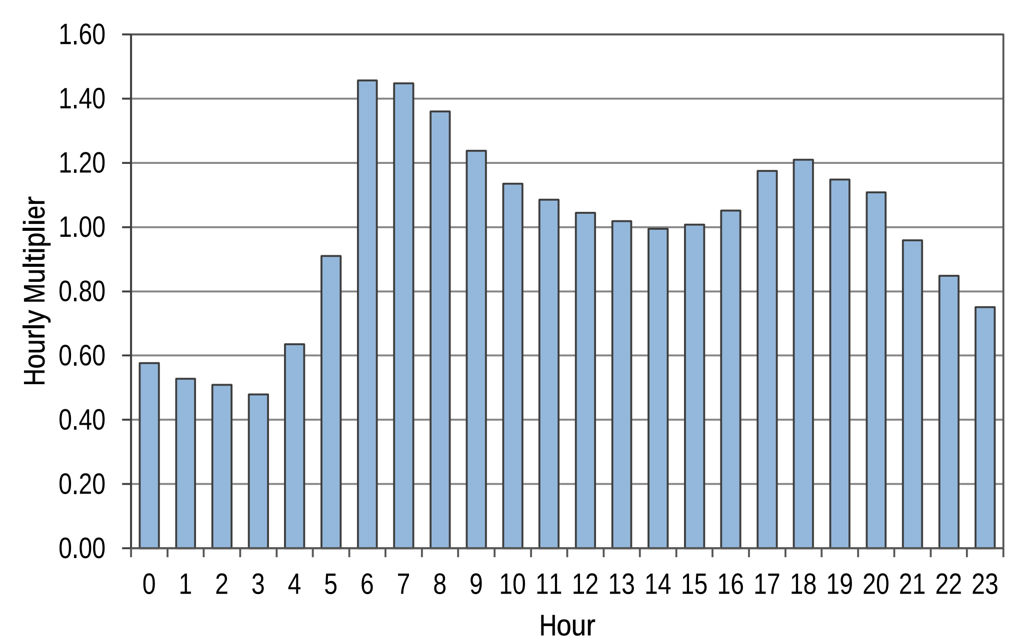
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.103	0.103	0.68	0.54	0.58
	1	0.082	0.076	0.54	0.47	0.53
	2	0.072	0.067	0.47	0.42	0.51
	3	0.064	0.063	0.42	0.43	0.48
	4	0.065	0.061	0.43	0.55	0.64
	5	0.084	0.085	0.55	0.89	0.91
	6	0.135	0.142	0.89	1.49	1.46
	7	0.227	0.239	1.49	1.59	1.45
	8	0.241	0.242	1.59	1.44	1.36
	9	0.219	0.219	1.44	1.29	1.24
	10	0.196	0.196	1.29	1.18	1.13
	11	0.180	0.179	1.18	1.13	1.09
	12	0.172	0.172	1.13	1.07	1.04
	13	0.163	0.157	1.07	1.04	1.02
	14	0.159	0.155	1.04	1.02	1.00
	15	0.155	0.150	1.02	1.03	1.01
	16	0.157	0.152	1.03	1.07	1.05
	17	0.164	0.161	1.07	1.20	1.17
	18	0.183	0.179	1.20	1.24	1.21
	19	0.188	0.184	1.24	1.17	1.15
	20	0.179	0.176	1.17	1.13	1.11
	21	0.172	0.168	1.13	0.98	0.96
	22	0.149	0.146	0.98	0.87	0.85
	23	0.132	0.124	0.87	0.68	0.75
Weekend	24	0.106	0.103	0.70	0.59	0.65
	25	0.090	0.087	0.59	0.49	0.57
	26	0.075	0.075	0.49	0.46	0.55
	27	0.070	0.068	0.46	0.42	0.56
	28	0.065	0.069	0.42	0.45	0.59
	29	0.069	0.073	0.45	0.53	0.67
	30	0.080	0.088	0.53	0.83	0.87
	31	0.126	0.130	0.83	1.30	1.34
	32	0.198	0.205	1.30	1.62	1.66
	33	0.246	0.258	1.62	1.66	1.59
	34	0.253	0.265	1.66	1.61	1.47
	35	0.246	0.247	1.61	1.48	1.36
	36	0.225	0.226	1.48	1.35	1.28
	37	0.205	0.211	1.35	1.22	1.18
	38	0.185	0.190	1.22	1.19	1.15
	39	0.181	0.184	1.19	1.11	1.08
	40	0.170	0.171	1.11	1.10	1.06
	41	0.167	0.168	1.10	1.11	1.09
	42	0.169	0.171	1.11	1.14	1.13
	43	0.174	0.177	1.14	1.13	1.12
	44	0.171	0.175	1.13	1.03	1.04
	45	0.157	0.160	1.03	0.90	0.93
	46	0.138	0.141	0.90	0.79	0.82
	47	0.121	0.120	0.79	0.70	0.72
Average						
Weekday		0.152	0.150	1.00	1.00	0.99
Weekend		0.154	0.157	1.01	1.01	1.02
ADWF[1]		0.152	0.152	1.00	1.00	1.00
% Error						
Weekday			-1.2%			
Weekend			2.2%			

Notes:

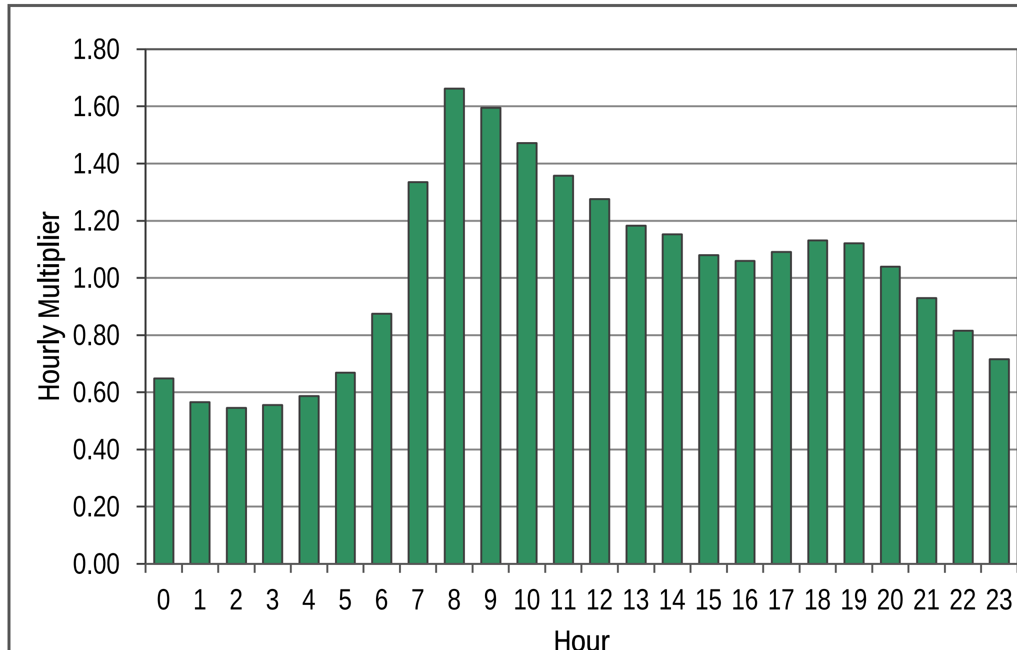
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_21.xlsx

City of Oakland

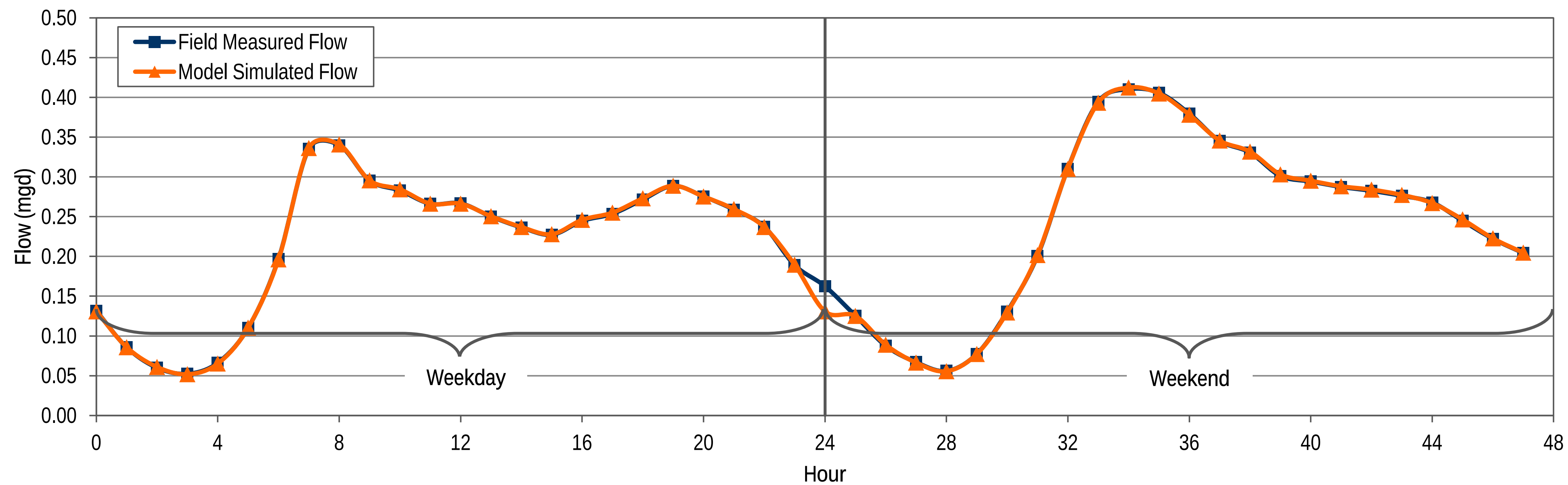
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S1 DRY WEATHER CALIBRATION

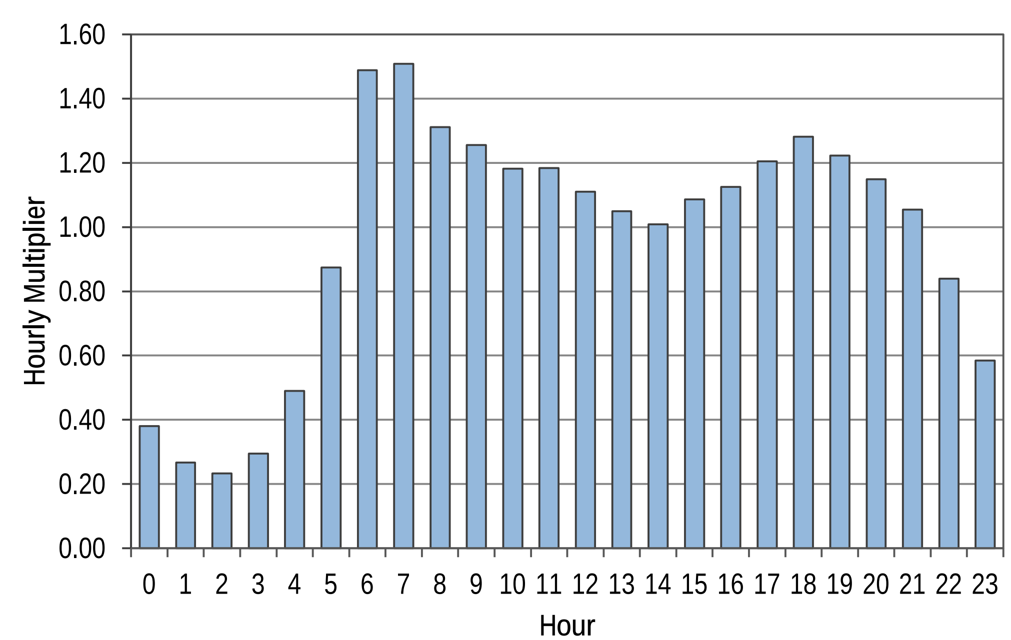
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.132	0.131	0.58	0.38	0.38
	1	0.086	0.086	0.38	0.27	0.27
	2	0.060	0.061	0.27	0.23	0.23
	3	0.053	0.052	0.23	0.29	0.29
	4	0.066	0.065	0.29	0.49	0.49
	5	0.110	0.111	0.49	0.87	0.87
	6	0.197	0.196	0.87	1.49	1.49
	7	0.335	0.336	1.49	1.51	1.51
	8	0.340	0.341	1.51	1.31	1.31
	9	0.295	0.296	1.31	1.26	1.26
	10	0.283	0.284	1.26	1.18	1.18
	11	0.266	0.266	1.18	1.18	1.18
	12	0.267	0.266	1.18	1.11	1.11
	13	0.250	0.251	1.11	1.05	1.05
	14	0.236	0.237	1.05	1.01	1.01
	15	0.227	0.228	1.01	1.09	1.09
	16	0.245	0.246	1.09	1.13	1.13
	17	0.254	0.255	1.13	1.21	1.21
	18	0.271	0.273	1.21	1.28	1.28
	19	0.289	0.289	1.28	1.22	1.22
	20	0.275	0.275	1.22	1.15	1.15
	21	0.259	0.260	1.15	1.05	1.05
	22	0.237	0.237	1.05	0.84	0.84
	23	0.189	0.190	0.84	0.58	0.58
Weekend	24	0.163	0.131	0.72	0.56	0.56
	25	0.126	0.125	0.56	0.39	0.39
	26	0.088	0.089	0.39	0.30	0.30
	27	0.067	0.067	0.30	0.25	0.25
	28	0.056	0.056	0.25	0.34	0.34
	29	0.077	0.077	0.34	0.58	0.58
	30	0.131	0.130	0.58	0.89	0.89
	31	0.201	0.202	0.89	1.38	1.38
	32	0.310	0.310	1.38	1.75	1.75
	33	0.394	0.393	1.75	1.82	1.82
	34	0.410	0.412	1.82	1.80	1.80
	35	0.406	0.405	1.80	1.68	1.68
	36	0.379	0.378	1.68	1.53	1.53
	37	0.345	0.346	1.53	1.47	1.47
	38	0.331	0.332	1.47	1.34	1.34
	39	0.301	0.303	1.34	1.31	1.31
	40	0.294	0.295	1.31	1.28	1.28
	41	0.287	0.288	1.28	1.25	1.25
	42	0.282	0.284	1.25	1.23	1.23
	43	0.276	0.277	1.23	1.19	1.19
	44	0.268	0.267	1.19	1.09	1.09
	45	0.245	0.247	1.09	0.99	0.99
	46	0.222	0.223	0.99	0.91	0.91
	47	0.204	0.205	0.91	0.72	0.72
Average						
	Weekday	0.218	0.22	0.97	0.97	0.97
	Weekend	0.244	0.24	1.08	1.08	1.08
	ADWF[(1)]	0.225	0.23	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		-0.4%			

Notes:

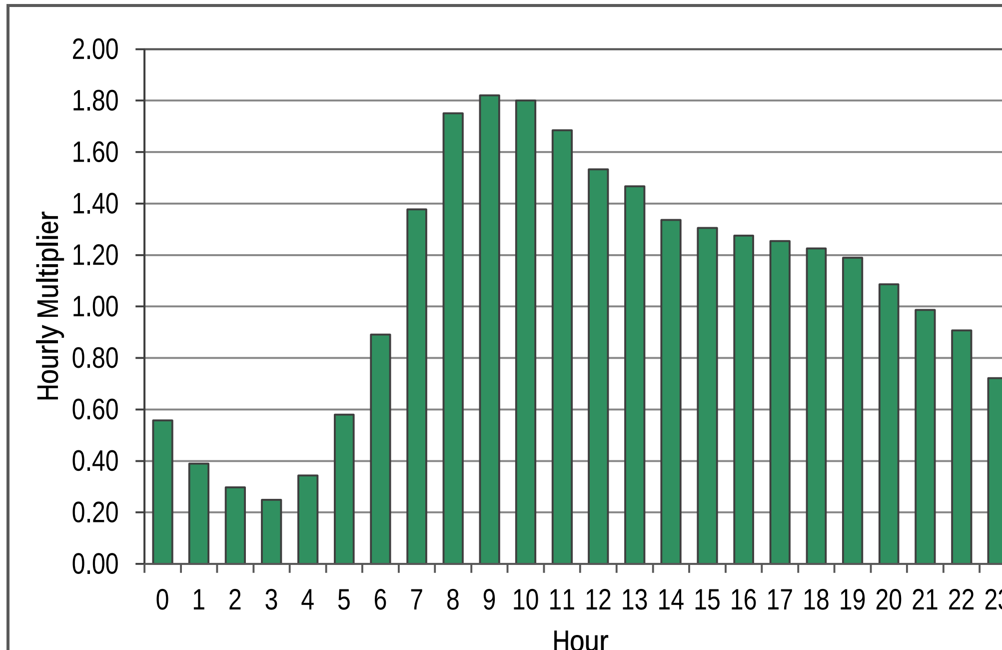
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_21.xlsx

City of Oakland

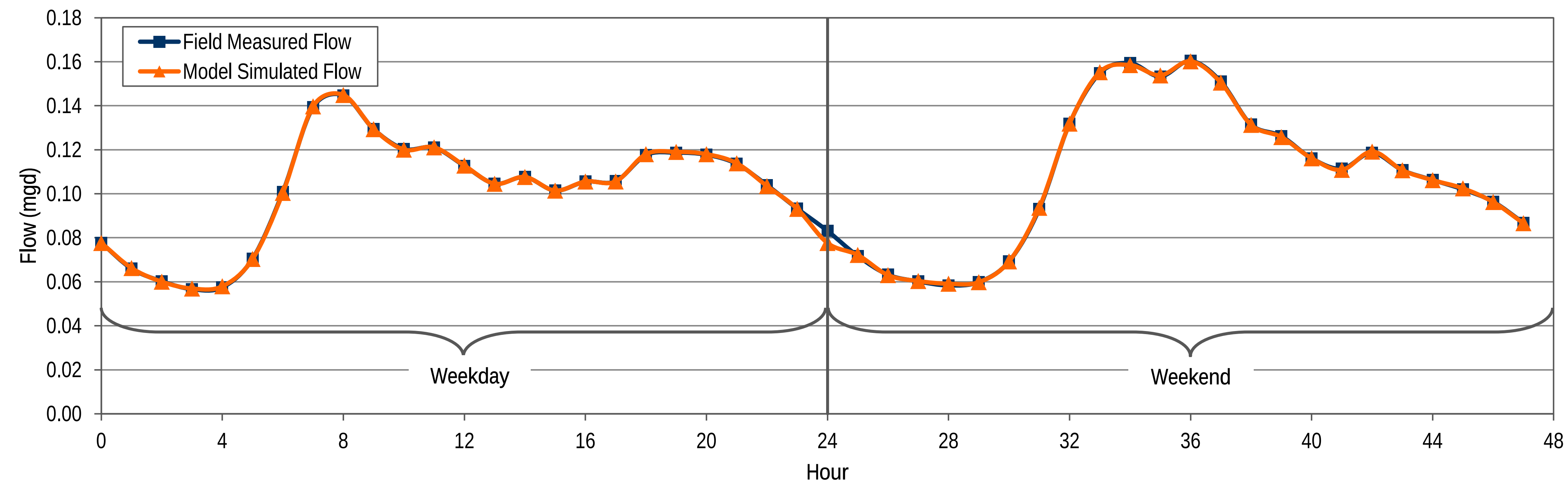
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S2 DRY WEATHER CALIBRATION

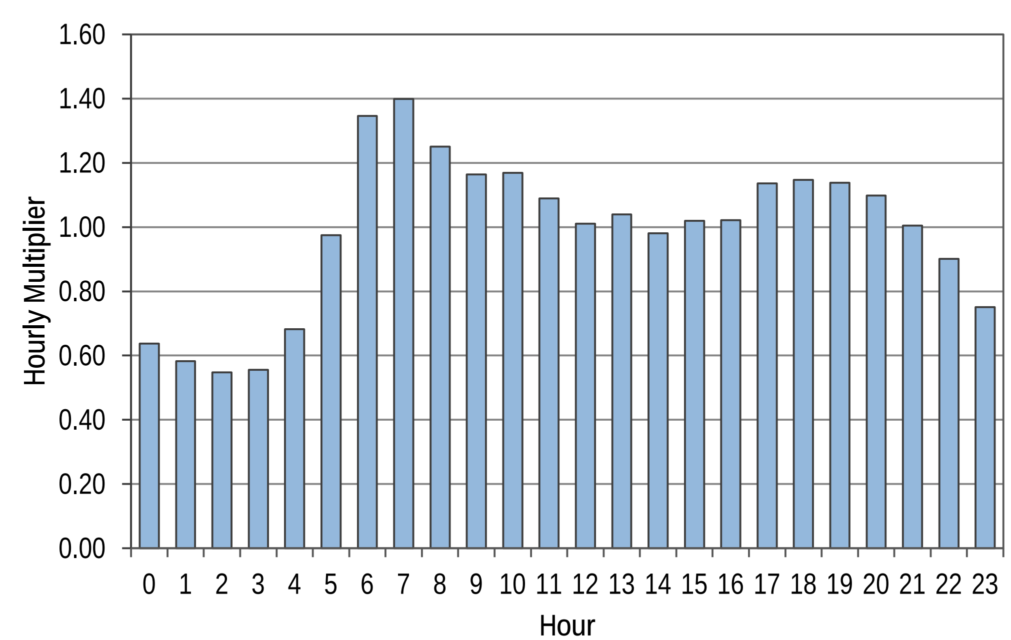
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.078	0.078	0.75	0.64	0.64
	1	0.066	0.066	0.64	0.58	0.58
	2	0.060	0.060	0.58	0.55	0.55
	3	0.057	0.057	0.55	0.56	0.56
	4	0.057	0.058	0.56	0.68	0.68
	5	0.071	0.070	0.68	0.97	0.97
	6	0.101	0.100	0.97	1.35	1.35
	7	0.139	0.140	1.35	1.40	1.40
	8	0.145	0.145	1.40	1.25	1.25
	9	0.129	0.129	1.25	1.16	1.16
	10	0.120	0.120	1.16	1.17	1.17
	11	0.121	0.121	1.17	1.09	1.09
	12	0.113	0.113	1.09	1.01	1.01
	13	0.105	0.105	1.01	1.04	1.04
	14	0.108	0.108	1.04	0.98	0.98
	15	0.101	0.101	0.98	1.02	1.02
	16	0.106	0.106	1.02	1.02	1.02
	17	0.106	0.106	1.02	1.14	1.14
	18	0.118	0.118	1.14	1.15	1.15
	19	0.119	0.119	1.15	1.14	1.14
	20	0.118	0.118	1.14	1.10	1.10
	21	0.114	0.114	1.10	1.00	1.00
	22	0.104	0.103	1.00	0.90	0.90
	23	0.093	0.093	0.90	0.75	0.75
Weekend	24	0.083	0.078	0.80	0.69	0.69
	25	0.072	0.072	0.69	0.61	0.61
	26	0.063	0.063	0.61	0.58	0.58
	27	0.060	0.060	0.58	0.56	0.56
	28	0.058	0.059	0.56	0.58	0.58
	29	0.060	0.060	0.58	0.67	0.67
	30	0.069	0.069	0.67	0.90	0.90
	31	0.093	0.094	0.90	1.27	1.27
	32	0.132	0.132	1.27	1.50	1.50
	33	0.155	0.155	1.50	1.54	1.54
	34	0.159	0.158	1.54	1.48	1.48
	35	0.153	0.154	1.48	1.55	1.55
	36	0.160	0.160	1.55	1.46	1.46
	37	0.151	0.151	1.46	1.27	1.27
	38	0.131	0.131	1.27	1.22	1.22
	39	0.126	0.126	1.22	1.12	1.12
	40	0.116	0.116	1.12	1.08	1.08
	41	0.111	0.111	1.08	1.15	1.15
	42	0.119	0.119	1.15	1.07	1.07
	43	0.111	0.111	1.07	1.03	1.03
	44	0.106	0.106	1.03	0.99	0.99
	45	0.102	0.102	0.99	0.93	0.93
	46	0.096	0.096	0.93	0.84	0.84
	47	0.087	0.087	0.84	0.80	0.80
Average						
	Weekday	0.102	0.10	0.99	0.99	0.99
	Weekend	0.107	0.11	1.04	1.04	1.04
	ADWF(1)	0.103	0.10	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.2%			

Notes:

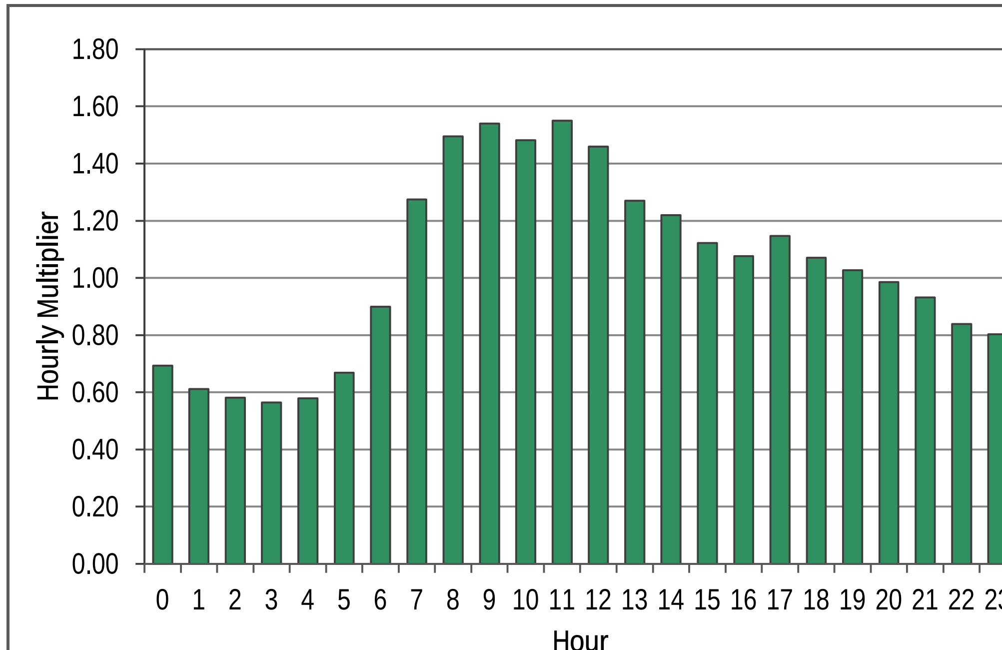
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_21.xlsx

City of Oakland

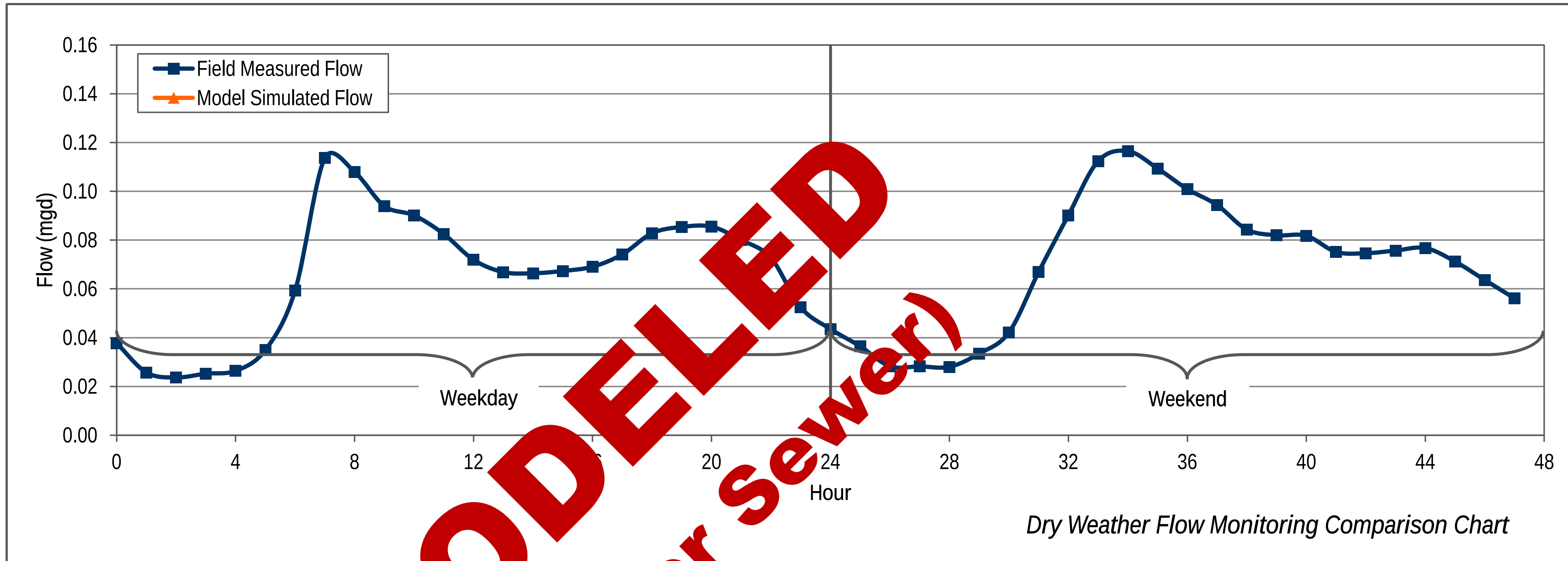
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S3 DRY WEATHER CALIBRATION

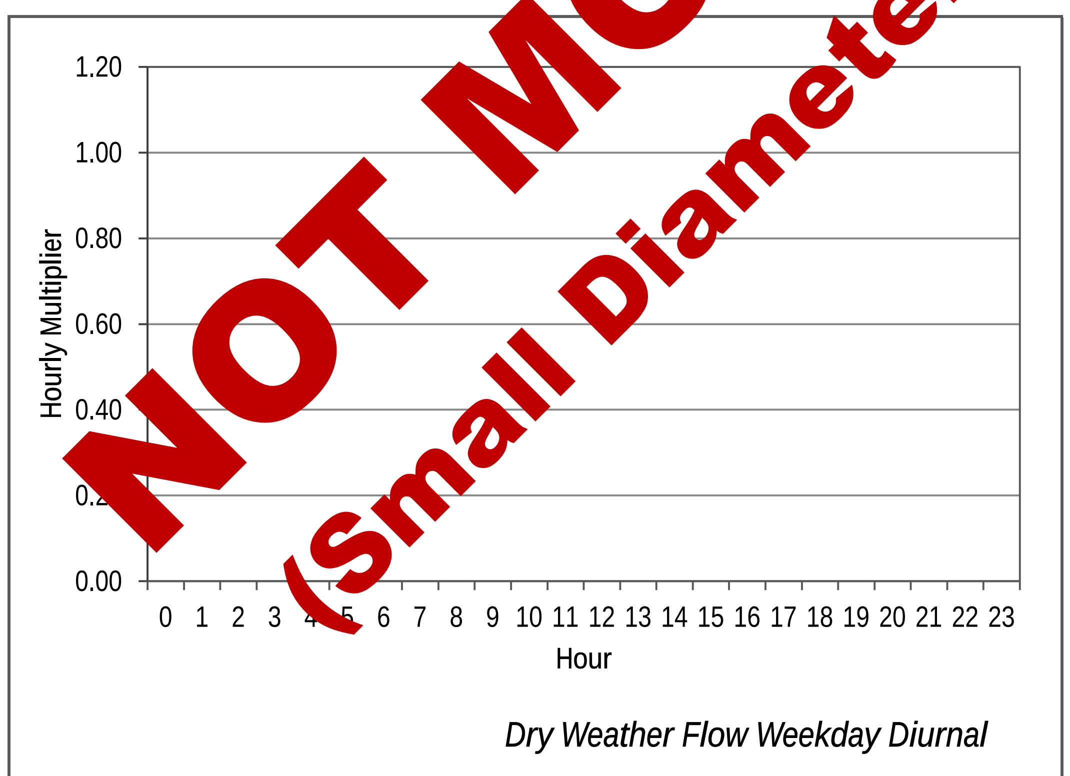
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.038		0.56		
	1	0.026		0.38		
	2	0.024		0.35		
	3	0.025		0.37		
	4	0.026		0.39		
	5	0.035		0.52		
	6	0.059		0.88		
	7	0.114		1.69		
	8	0.108		1.60		
	9	0.094		1.39		
	10	0.090		1.34		
	11	0.082		1.22		
	12	0.072		1.07		
	13	0.067		0.99		
	14	0.066		0.99		
	15	0.067		1.00		
	16	0.069		1.02		
	17	0.074		1.10		
	18	0.083		1.23		
	19	0.085		1.27		
	20	0.085		1.27		
	21	0.080		1.19		
	22	0.073		1.08		
	23	0.052		0.78		
Weekend	24	0.044		0.65		
	25	0.036		0.54		
	26	0.028		0.42		
	27	0.028		0.42		
	28	0.028		0.42		
	29	0.033		0.50		
	30	0.042		0.62		
	31	0.067		0.99		
	32	0.090		1.34		
	33	0.112		1.67		
	34	0.116		1.73		
	35	0.109		1.62		
	36	0.101		1.50		
	37	0.094		1.40		
	38	0.084		1.25		
	39	0.082		1.22		
	40	0.082		1.21		
	41	0.075		1.12		
	42	0.075		1.11		
	43	0.076		1.12		
	44	0.077		1.14		
	45	0.071		1.06		
	46	0.064		0.94		
	47	0.056		0.83		
Average						
Weekday		0.066	#DIV/0!	0.99	#DIV/0!	#DIV/0!
Weekend		0.070	#DIV/0!	1.03	#DIV/0!	#DIV/0!
ADWF[1]		0.067	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
Weekday			#DIV/0!			
Weekend			#DIV/0!			

Notes:

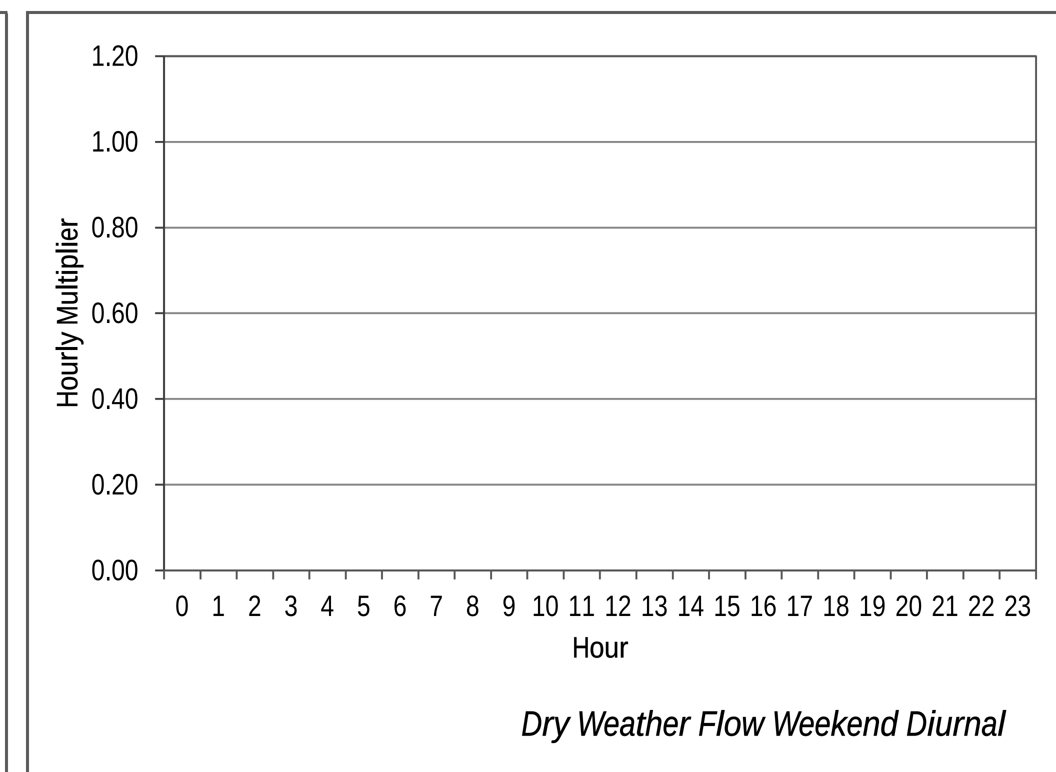
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

NOT MODELED (Small Diameter Sewer)

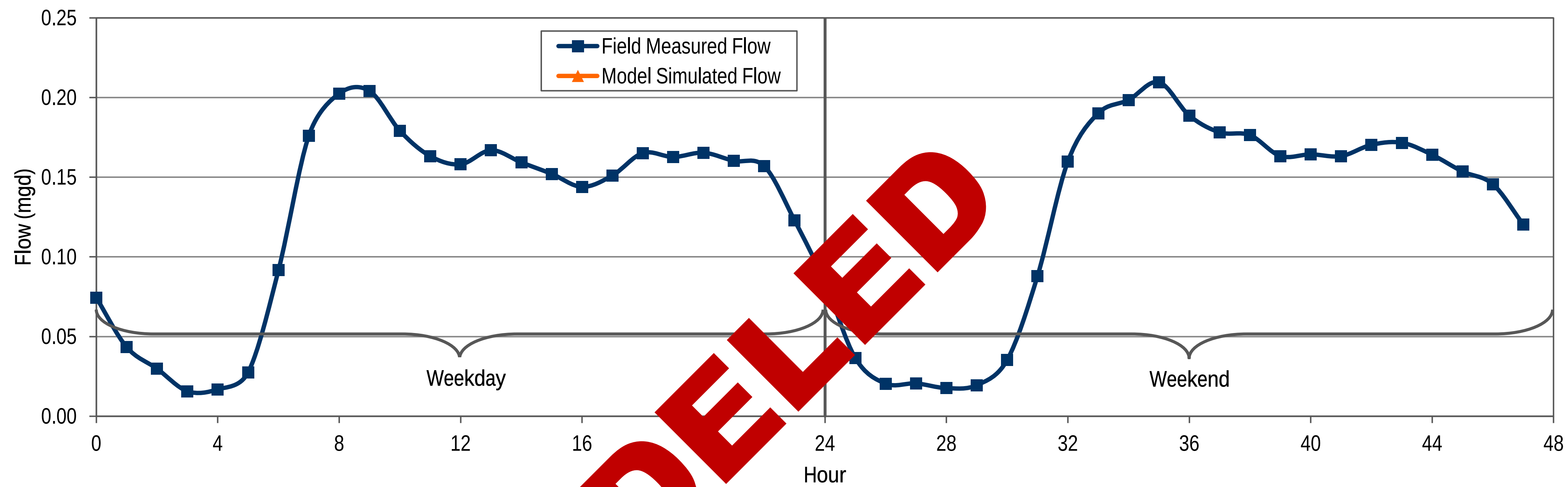
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_21.xlsx

FLOW MONITORING SITE 23-1 DRY WEATHER CALIBRATION

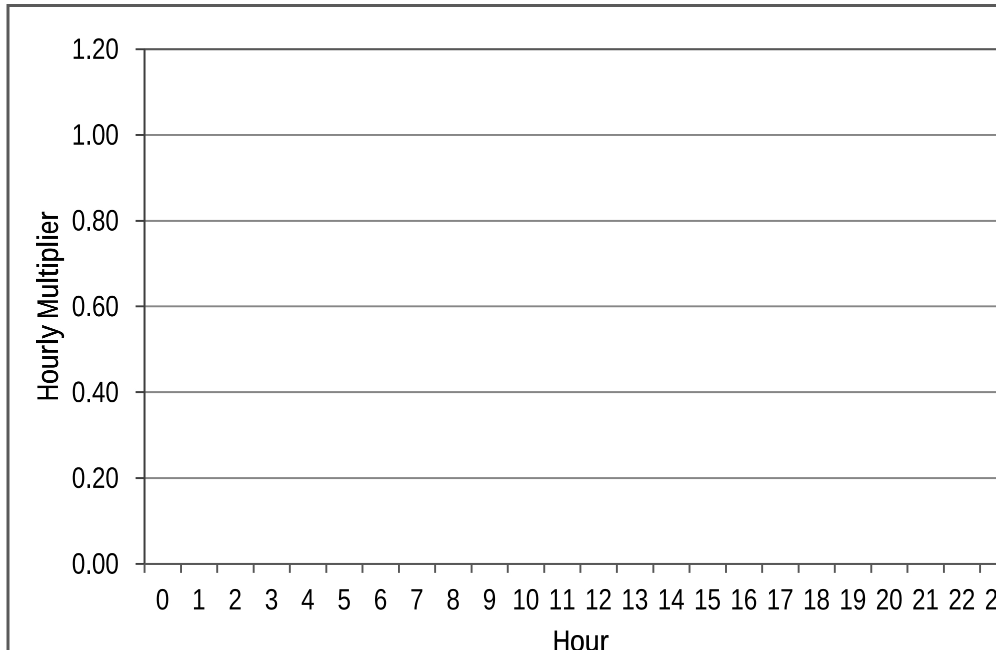
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.074		0.58		
	1	0.043		0.34		
	2	0.030		0.23		
	3	0.016		0.12		
	4	0.017		0.13		
	5	0.028		0.22		
	6	0.092		0.72		
	7	0.176		1.37		
	8	0.202		1.58		
	9	0.204		1.59		
	10	0.179		1.40		
	11	0.163		1.27		
	12	0.158		1.23		
	13	0.167		1.30		
	14	0.159		1.24		
	15	0.152		1.19		
	16	0.144		1.12		
	17	0.151		1.18		
	18	0.165		1.29		
	19	0.163		1.27		
	20	0.165		1.29		
	21	0.160		1.25		
	22	0.157		1.22		
	23	0.123		0.96		
Weekend	24	0.084		0.66		
	25	0.037		0.29		
	26	0.020		0.16		
	27	0.021		0.16		
	28	0.018		0.14		
	29	0.019		0.15		
	30	0.035		0.28		
	31	0.088		0.69		
	32	0.160		1.25		
	33	0.190		1.48		
	34	0.198		1.55		
	35	0.210		1.64		
	36	0.189		1.47		
	37	0.178		1.39		
	38	0.176		1.38		
	39	0.163		1.27		
	40	0.164		1.28		
	41	0.163		1.27		
	42	0.170		1.33		
	43	0.172		1.34		
	44	0.164		1.28		
	45	0.154		1.20		
	46	0.146		1.14		
	47	0.120		0.94		
Average						
	Weekday	0.129	#DIV/0!	1.00	#DIV/0!	#DIV/0!
	Weekend	0.127	#DIV/0!	0.99	#DIV/0!	#DIV/0!
	ADWF(1)	0.128	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

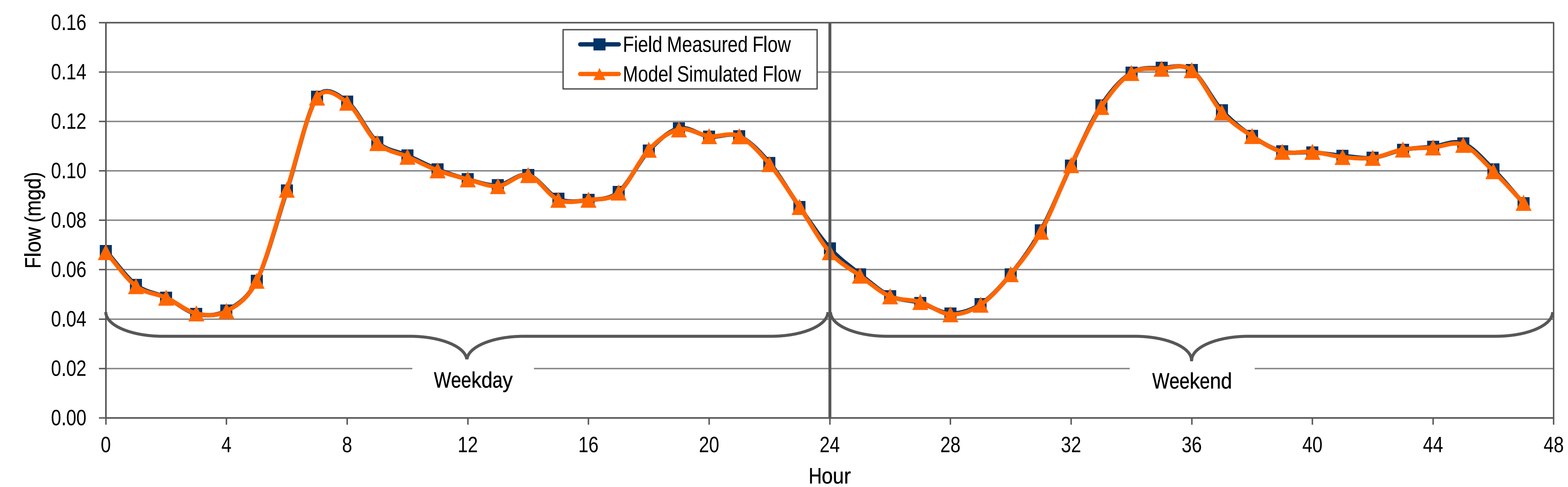
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50L-S1 DRY WEATHER CALIBRATION

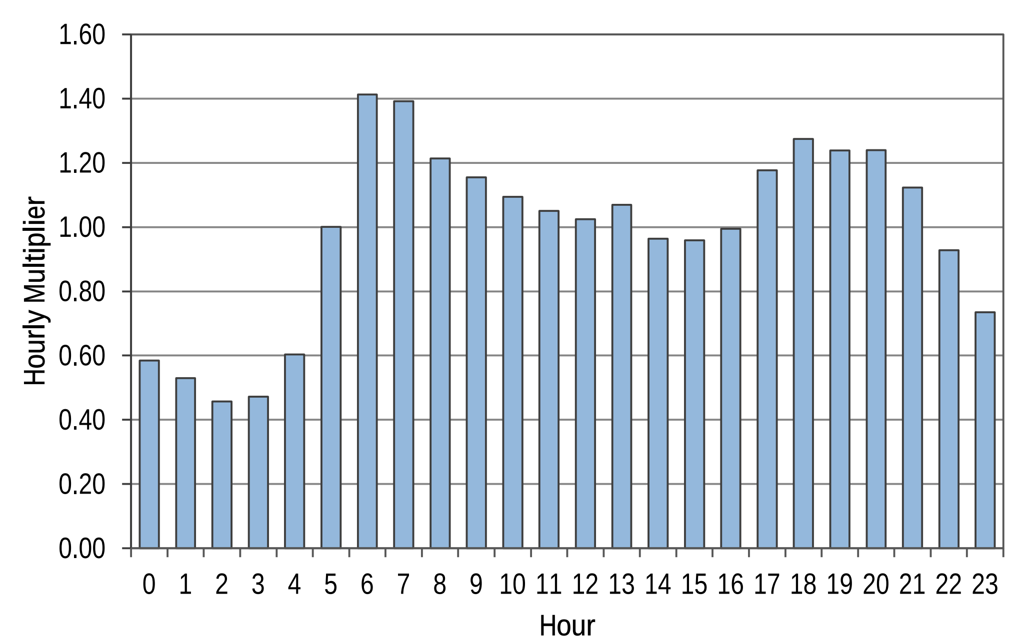
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.068	0.067	0.73	0.58	0.58
	1	0.054	0.053	0.58	0.53	0.53
	2	0.049	0.049	0.53	0.46	0.46
	3	0.042	0.042	0.46	0.47	0.47
	4	0.043	0.043	0.47	0.60	0.60
	5	0.055	0.056	0.60	1.00	1.00
	6	0.092	0.092	1.00	1.41	1.41
	7	0.130	0.130	1.41	1.39	1.39
	8	0.128	0.128	1.39	1.21	1.21
	9	0.112	0.111	1.21	1.15	1.15
	10	0.106	0.106	1.15	1.09	1.09
	11	0.101	0.100	1.09	1.05	1.05
	12	0.097	0.097	1.05	1.02	1.02
	13	0.094	0.094	1.02	1.07	1.07
	14	0.098	0.098	1.07	0.96	0.96
	15	0.089	0.088	0.96	0.96	0.96
	16	0.088	0.088	0.96	0.99	0.99
	17	0.091	0.091	0.99	1.18	1.18
	18	0.108	0.109	1.18	1.27	1.27
	19	0.117	0.117	1.27	1.24	1.24
	20	0.114	0.114	1.24	1.24	1.24
	21	0.114	0.114	1.24	1.12	1.12
	22	0.103	0.103	1.12	0.93	0.93
	23	0.085	0.085	0.93	0.73	0.73
Weekend	24	0.069	0.067	0.75	0.63	0.63
	25	0.058	0.058	0.63	0.54	0.54
	26	0.049	0.049	0.54	0.51	0.51
	27	0.047	0.047	0.51	0.46	0.46
	28	0.042	0.042	0.46	0.50	0.50
	29	0.046	0.046	0.50	0.63	0.63
	30	0.058	0.058	0.63	0.82	0.82
	31	0.076	0.075	0.82	1.11	1.11
	32	0.102	0.102	1.11	1.37	1.37
	33	0.126	0.126	1.37	1.52	1.52
	34	0.140	0.140	1.52	1.54	1.54
	35	0.142	0.141	1.54	1.53	1.53
	36	0.141	0.141	1.53	1.35	1.35
	37	0.124	0.124	1.35	1.24	1.24
	38	0.114	0.114	1.24	1.17	1.17
	39	0.108	0.108	1.17	1.17	1.17
	40	0.108	0.108	1.17	1.15	1.15
	41	0.106	0.106	1.15	1.15	1.15
	42	0.105	0.105	1.15	1.18	1.18
	43	0.109	0.109	1.18	1.19	1.19
	44	0.110	0.109	1.19	1.21	1.21
	45	0.111	0.111	1.21	1.09	1.09
	46	0.101	0.100	1.09	0.94	0.94
	47	0.087	0.087	0.94	0.75	0.75
Average						
	Weekday	0.091	0.091	0.99	0.99	0.99
	Weekend	0.095	0.095	1.03	1.03	1.03
	ADWF[1]	0.092	0.092	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		-0.3%			

Notes:

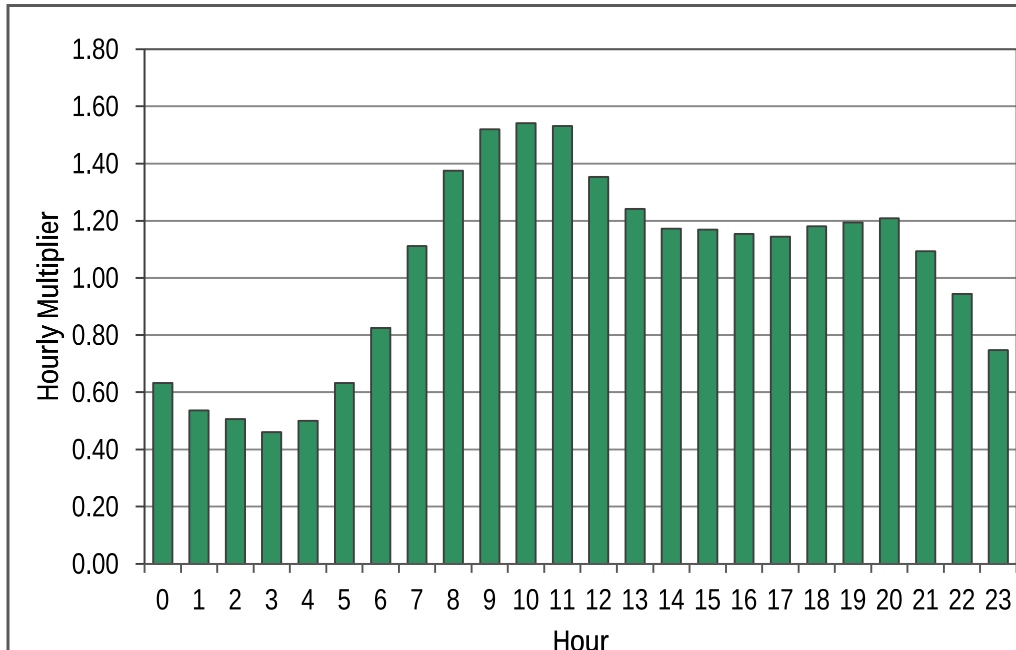
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

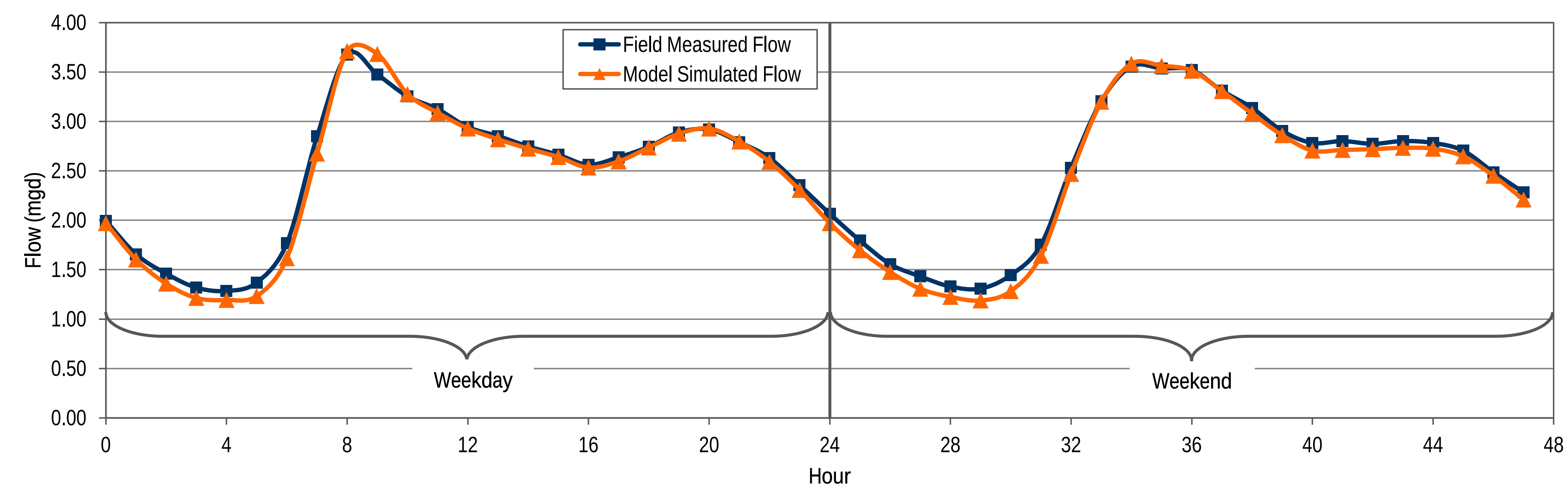
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration

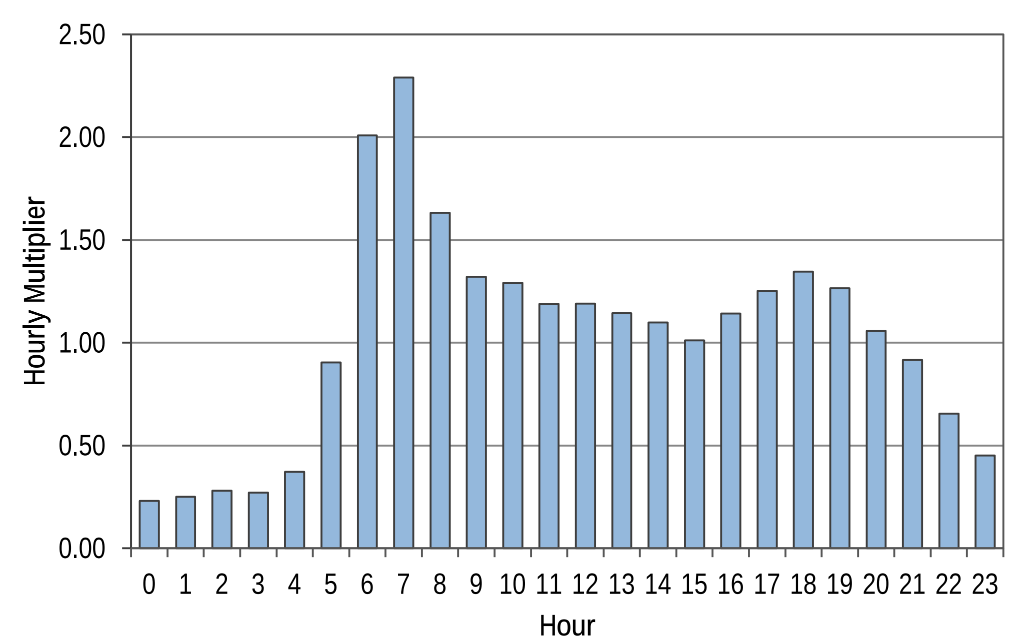
FLOW MONITORING SITE 50 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.993	1.971	0.80	0.66	0.23
	1	1.656	1.603	0.66	0.58	0.25
	2	1.460	1.360	0.58	0.53	0.28
	3	1.319	1.214	0.53	0.51	0.27
	4	1.285	1.194	0.51	0.55	0.37
	5	1.370	1.234	0.55	0.71	0.90
	6	1.768	1.617	0.71	1.14	2.01
	7	2.848	2.675	1.14	1.47	2.29
	8	3.677	3.712	1.47	1.39	1.63
	9	3.475	3.683	1.39	1.30	1.32
	10	3.253	3.277	1.30	1.25	1.29
	11	3.124	3.088	1.25	1.18	1.19
	12	2.943	2.929	1.18	1.14	1.19
	13	2.852	2.819	1.14	1.10	1.14
	14	2.747	2.725	1.10	1.07	1.10
	15	2.662	2.640	1.07	1.03	1.01
	16	2.562	2.534	1.03	1.06	1.14
	17	2.638	2.596	1.06	1.10	1.25
	18	2.743	2.736	1.10	1.16	1.35
	19	2.889	2.876	1.16	1.17	1.27
	20	2.919	2.928	1.17	1.12	1.06
	21	2.791	2.797	1.12	1.05	0.92
	22	2.630	2.591	1.05	0.94	0.65
	23	2.353	2.307	0.94	0.80	0.45
Weekend	24	2.065	1.971	0.83	0.72	0.40
	25	1.794	1.697	0.72	0.62	0.26
	26	1.556	1.477	0.62	0.57	0.22
	27	1.432	1.308	0.57	0.53	0.20
	28	1.329	1.225	0.53	0.52	0.26
	29	1.309	1.189	0.52	0.58	0.42
	30	1.446	1.283	0.58	0.70	0.87
	31	1.752	1.640	0.70	1.01	1.74
	32	2.531	2.469	1.01	1.28	1.92
	33	3.205	3.200	1.28	1.42	1.72
	34	3.556	3.584	1.42	1.42	1.50
	35	3.536	3.563	1.42	1.41	1.52
	36	3.520	3.513	1.41	1.33	1.30
	37	3.311	3.307	1.33	1.26	1.19
	38	3.136	3.080	1.26	1.16	0.98
	39	2.904	2.861	1.16	1.11	0.95
	40	2.782	2.705	1.11	1.12	1.03
	41	2.801	2.712	1.12	1.11	1.00
	42	2.773	2.720	1.11	1.12	1.05
	43	2.801	2.733	1.12	1.11	1.05
	44	2.782	2.724	1.11	1.08	1.03
	45	2.704	2.647	1.08	1.00	0.84
	46	2.486	2.451	1.00	0.91	0.69
	47	2.283	2.210	0.91	0.83	0.44
Average						
	Weekday	2.498	2.463	1.00	1.00	1.02
	Weekend	2.491	2.428	1.00	1.00	0.94
	ADWF[1]	2.496	2.453	1.00	1.00	1.00
% Error						
	Weekday		-1.4%			
	Weekend		-2.5%			

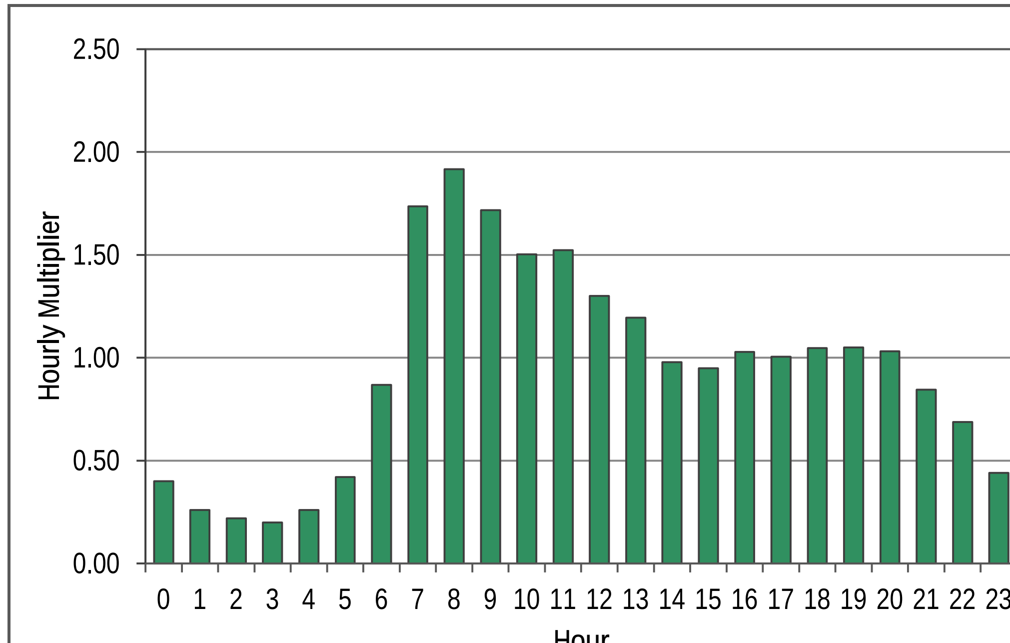
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

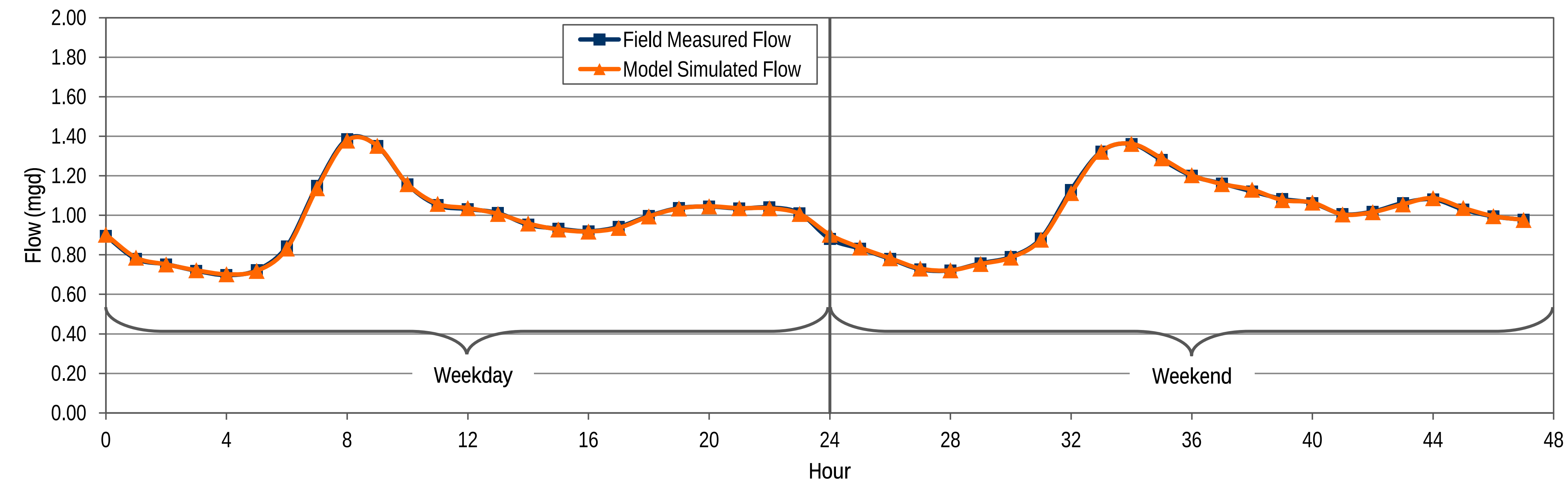
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50A DRY WEATHER CALIBRATION

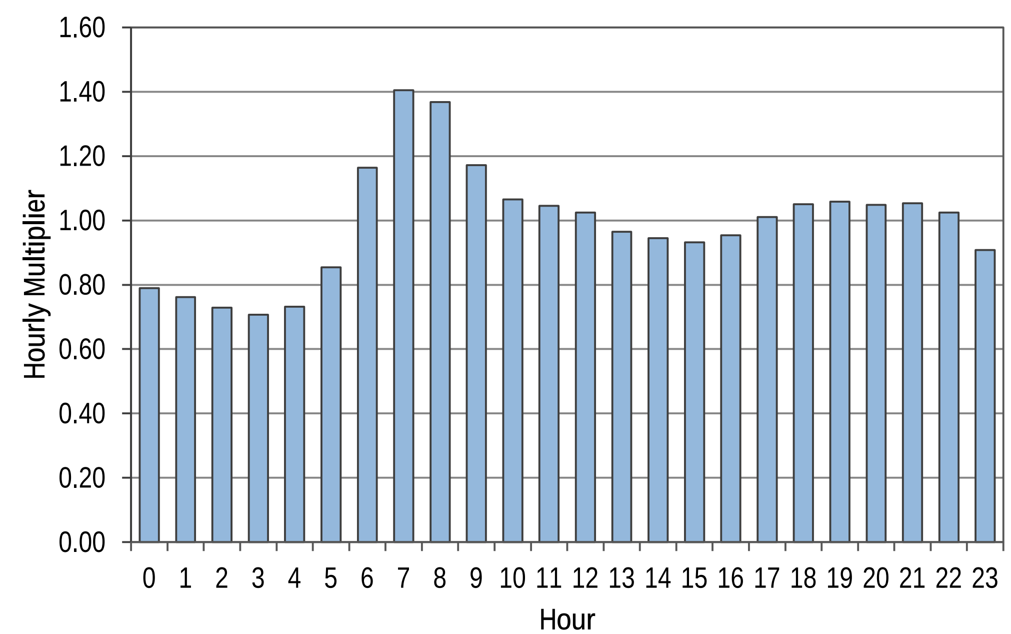
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.895	0.902	0.91	0.79	0.79
	1	0.779	0.786	0.79	0.76	0.76
	2	0.752	0.752	0.76	0.73	0.73
	3	0.719	0.722	0.73	0.71	0.71
	4	0.697	0.702	0.71	0.73	0.73
	5	0.722	0.719	0.73	0.85	0.85
	6	0.843	0.832	0.85	1.16	1.16
	7	1.148	1.137	1.16	1.40	1.40
	8	1.386	1.378	1.40	1.37	1.37
	9	1.350	1.352	1.37	1.17	1.17
	10	1.156	1.158	1.17	1.07	1.07
	11	1.051	1.058	1.07	1.05	1.05
	12	1.031	1.036	1.05	1.02	1.02
	13	1.011	1.007	1.02	0.97	0.97
	14	0.952	0.959	0.97	0.94	0.94
	15	0.932	0.928	0.94	0.93	0.93
	16	0.919	0.918	0.93	0.95	0.95
	17	0.941	0.936	0.95	1.01	1.01
	18	0.996	0.994	1.01	1.05	1.05
	19	1.036	1.035	1.05	1.06	1.06
	20	1.044	1.045	1.06	1.05	1.05
	21	1.034	1.036	1.05	1.05	1.05
	22	1.040	1.036	1.05	1.02	1.02
	23	1.010	1.007	1.02	0.91	0.91
Weekend	24	0.880	0.902	0.89	0.84	0.84
	25	0.831	0.837	0.84	0.79	0.79
	26	0.779	0.783	0.79	0.74	0.74
	27	0.726	0.731	0.74	0.73	0.73
	28	0.721	0.722	0.73	0.77	0.77
	29	0.757	0.754	0.77	0.80	0.80
	30	0.789	0.786	0.80	0.89	0.89
	31	0.883	0.877	0.89	1.14	1.14
	32	1.128	1.113	1.14	1.34	1.34
	33	1.323	1.322	1.34	1.38	1.38
	34	1.361	1.362	1.38	1.30	1.30
	35	1.280	1.289	1.30	1.22	1.22
	36	1.200	1.203	1.22	1.18	1.18
	37	1.160	1.158	1.18	1.14	1.14
	38	1.121	1.130	1.14	1.10	1.10
	39	1.083	1.077	1.10	1.08	1.08
	40	1.062	1.065	1.08	1.02	1.02
	41	1.006	1.005	1.02	1.03	1.03
	42	1.019	1.016	1.03	1.08	1.08
	43	1.062	1.055	1.08	1.10	1.10
	44	1.081	1.087	1.10	1.04	1.04
	45	1.030	1.037	1.04	1.01	1.01
	46	0.994	0.996	1.01	0.99	0.99
	47	0.977	0.977	0.99	0.89	0.89
Average						
	Weekday	0.977	0.976	0.99	0.99	0.99
	Weekend	1.010	1.012	1.02	1.02	1.02
	ADWF[(1)]	0.986	0.987	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.1%			

Notes:

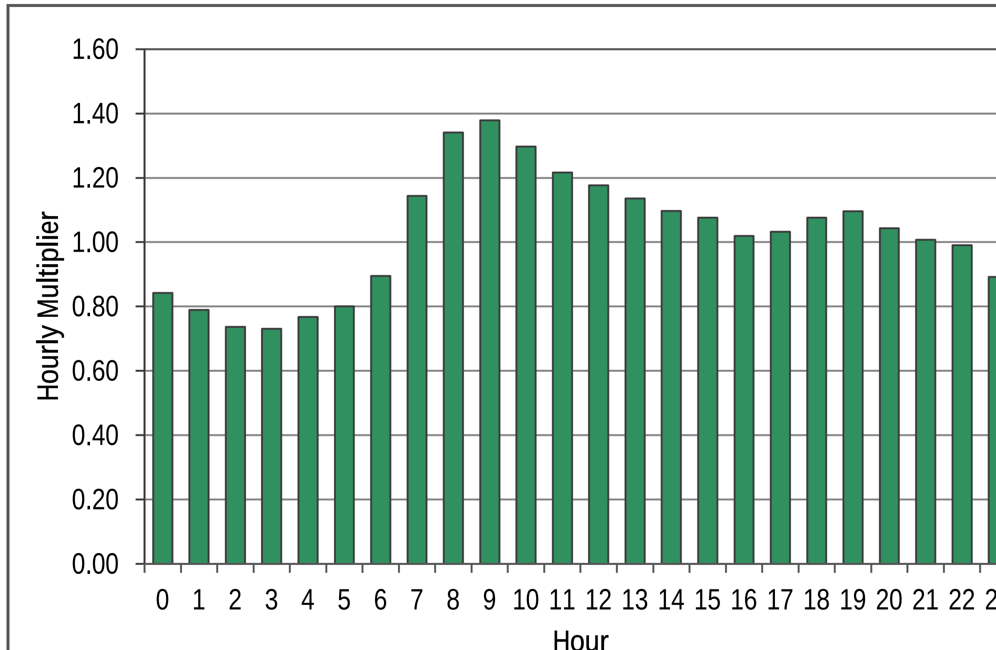
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

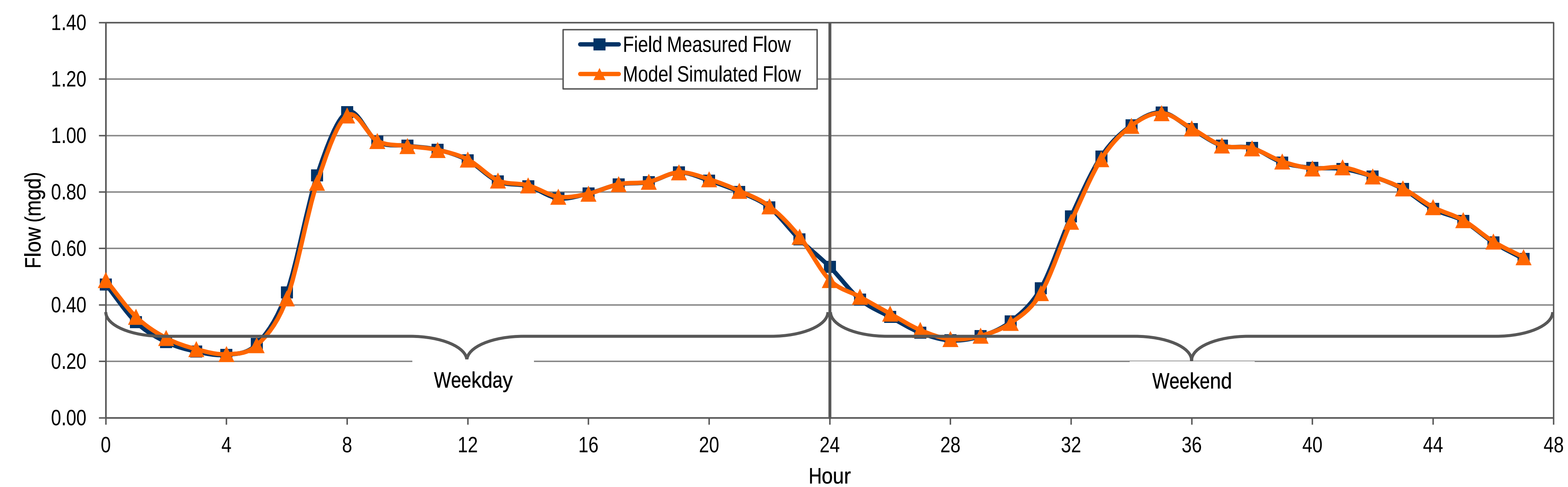
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50B DRY WEATHER CALIBRATION

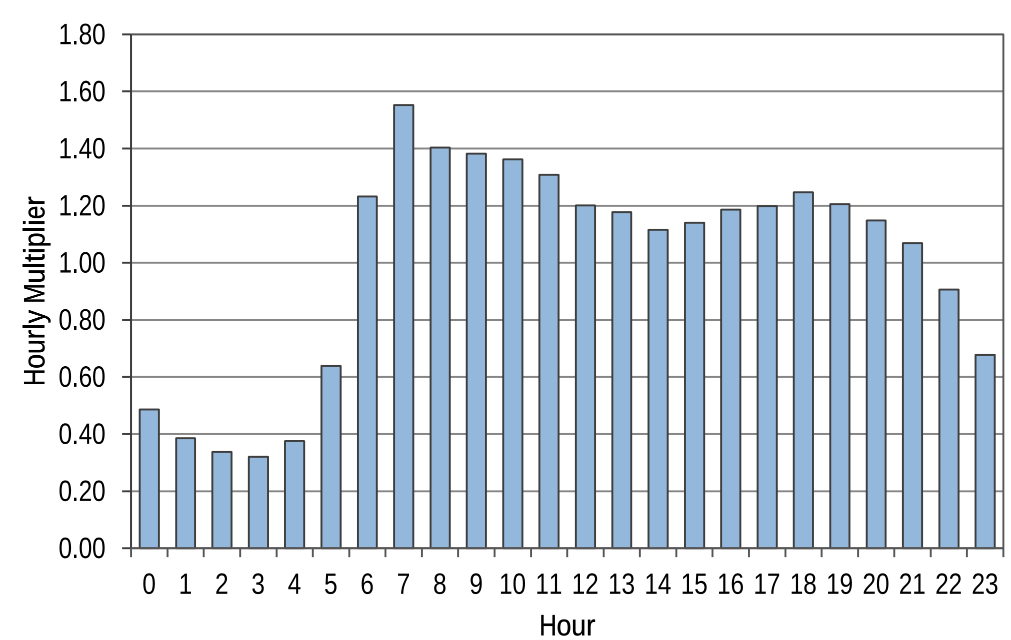
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.473	0.488	0.68	0.49	0.49
	1	0.339	0.358	0.49	0.39	0.39
	2	0.269	0.283	0.39	0.34	0.34
	3	0.235	0.244	0.34	0.32	0.32
	4	0.224	0.226	0.32	0.38	0.38
	5	0.262	0.258	0.38	0.64	0.64
	6	0.445	0.423	0.64	1.23	1.23
	7	0.859	0.833	1.23	1.55	1.55
	8	1.083	1.071	1.55	1.40	1.40
	9	0.978	0.981	1.40	1.38	1.38
	10	0.964	0.963	1.38	1.36	1.36
	11	0.950	0.949	1.36	1.31	1.31
	12	0.912	0.915	1.31	1.20	1.20
	13	0.837	0.841	1.20	1.18	1.18
	14	0.821	0.823	1.18	1.12	1.12
	15	0.778	0.783	1.12	1.14	1.14
	16	0.795	0.794	1.14	1.19	1.19
	17	0.827	0.828	1.19	1.20	1.20
	18	0.835	0.836	1.20	1.25	1.25
	19	0.869	0.870	1.25	1.21	1.21
	20	0.840	0.845	1.21	1.15	1.15
	21	0.801	0.804	1.15	1.07	1.07
	22	0.745	0.749	1.07	0.91	0.91
	23	0.632	0.642	0.91	0.68	0.68
Weekend	24	0.535	0.488	0.77	0.60	0.60
	25	0.420	0.429	0.60	0.51	0.51
	26	0.358	0.369	0.51	0.43	0.43
	27	0.302	0.312	0.43	0.39	0.39
	28	0.275	0.279	0.39	0.42	0.42
	29	0.289	0.291	0.42	0.49	0.49
	30	0.342	0.337	0.49	0.66	0.66
	31	0.459	0.442	0.66	1.02	1.02
	32	0.713	0.695	1.02	1.33	1.33
	33	0.926	0.916	1.33	1.49	1.49
	34	1.036	1.034	1.49	1.55	1.55
	35	1.082	1.079	1.55	1.47	1.47
	36	1.023	1.025	1.47	1.38	1.38
	37	0.964	0.965	1.38	1.37	1.37
	38	0.956	0.955	1.37	1.30	1.30
	39	0.904	0.908	1.30	1.27	1.27
	40	0.885	0.883	1.27	1.26	1.26
	41	0.882	0.887	1.26	1.23	1.23
	42	0.855	0.855	1.23	1.16	1.16
	43	0.811	0.813	1.16	1.06	1.06
	44	0.740	0.746	1.06	1.00	1.00
	45	0.698	0.700	1.00	0.89	0.89
	46	0.621	0.625	0.89	0.81	0.81
	47	0.563	0.569	0.81	0.77	0.77
Average						
	Weekday	0.699	0.700	1.00	1.00	1.00
	Weekend	0.693	0.692	0.99	0.99	0.99
	ADWF(1)	0.697	0.698	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		-0.2%			

Notes:

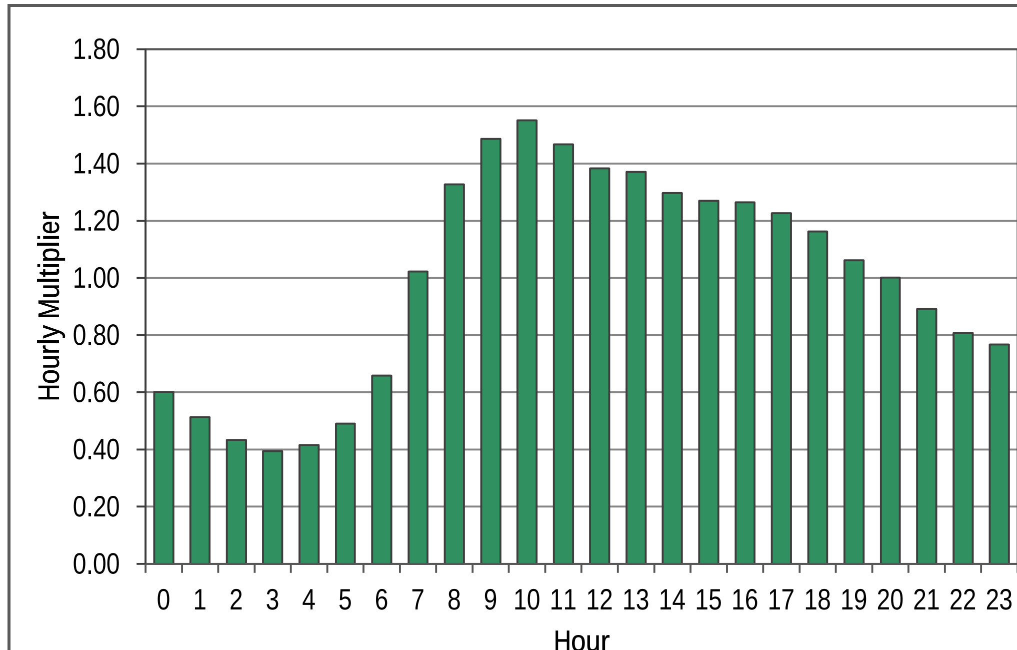
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

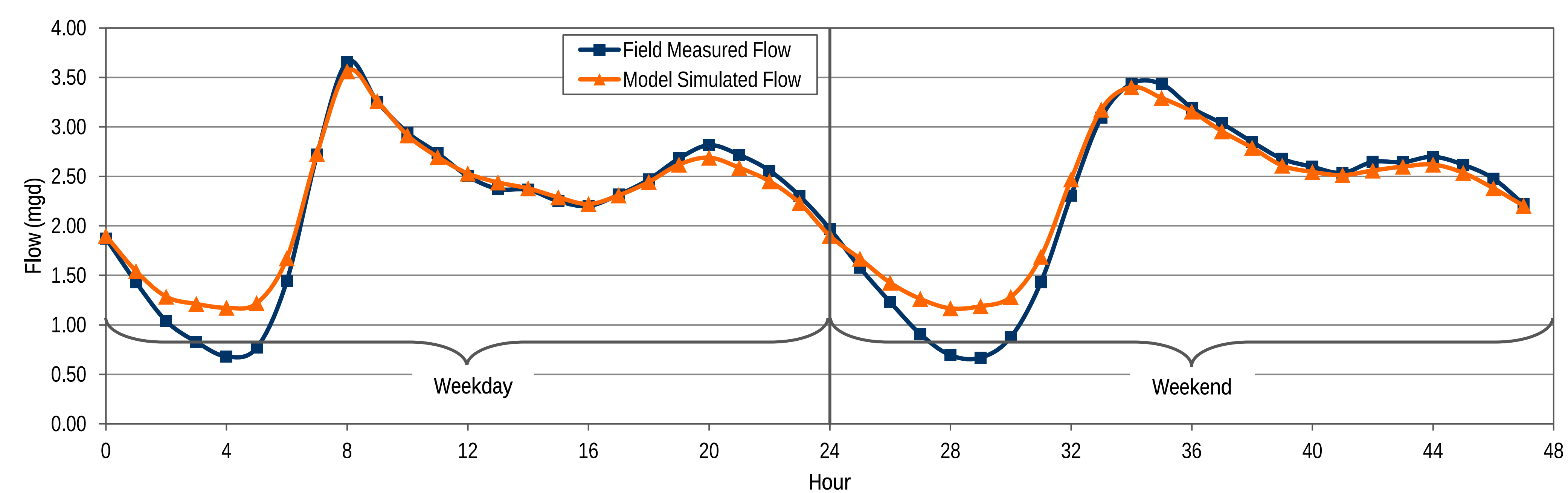
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50U-1 DRY WEATHER CALIBRATION

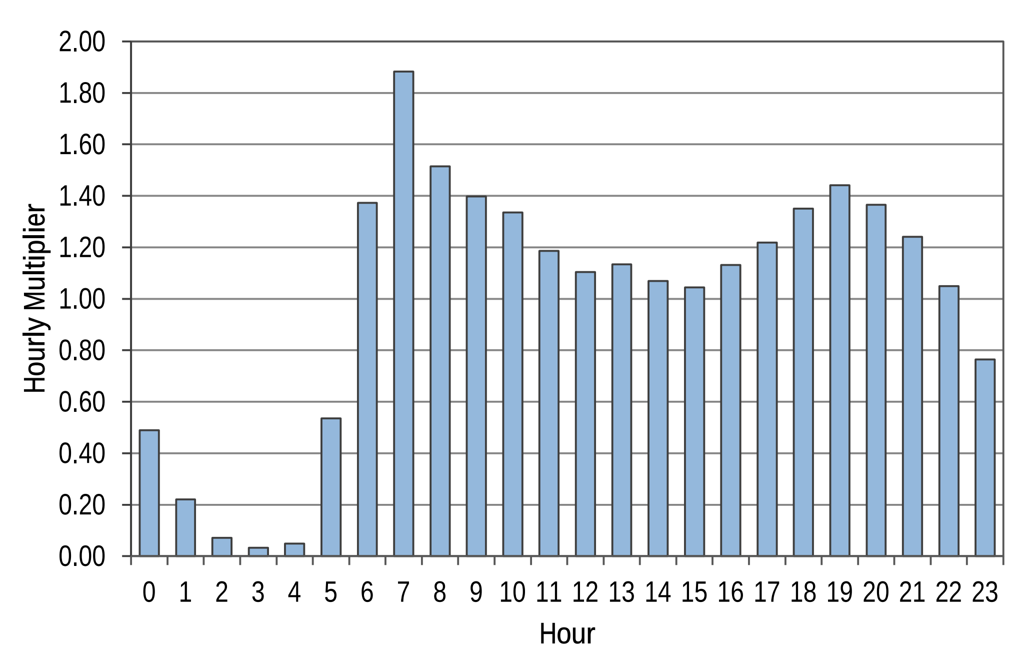
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.873	1.900	0.85	0.65	0.49
	1	1.429	1.542	0.65	0.47	0.22
	2	1.038	1.285	0.47	0.37	0.07
	3	0.826	1.212	0.37	0.31	0.03
	4	0.680	1.173	0.31	0.35	0.05
	5	0.769	1.220	0.35	0.65	0.54
	6	1.446	1.673	0.65	1.23	1.37
	7	2.720	2.730	1.23	1.65	1.88
	8	3.657	3.562	1.65	1.47	1.51
	9	3.254	3.260	1.47	1.33	1.40
	10	2.942	2.915	1.33	1.23	1.34
	11	2.735	2.696	1.23	1.13	1.19
	12	2.502	2.529	1.13	1.07	1.10
	13	2.373	2.439	1.07	1.07	1.13
	14	2.365	2.379	1.07	1.02	1.07
	15	2.250	2.288	1.02	0.99	1.04
	16	2.202	2.221	0.99	1.04	1.13
	17	2.315	2.308	1.04	1.11	1.22
	18	2.469	2.444	1.11	1.21	1.35
	19	2.681	2.620	1.21	1.27	1.44
	20	2.816	2.689	1.27	1.23	1.37
	21	2.718	2.587	1.23	1.15	1.24
	22	2.559	2.451	1.15	1.04	1.05
	23	2.302	2.231	1.04	0.85	0.76
Weekend	24	1.970	1.900	0.89	0.71	0.59
	25	1.577	1.668	0.71	0.56	0.35
	26	1.231	1.426	0.56	0.41	0.12
	27	0.908	1.263	0.41	0.31	0.05
	28	0.694	1.167	0.31	0.30	0.04
	29	0.669	1.189	0.30	0.39	0.08
	30	0.875	1.282	0.39	0.65	0.48
	31	1.431	1.688	0.65	1.04	1.04
	32	2.307	2.470	1.04	1.40	1.47
	33	3.095	3.175	1.40	1.55	1.65
	34	3.436	3.401	1.55	1.55	1.70
	35	3.433	3.292	1.55	1.44	1.57
	36	3.194	3.155	1.44	1.37	1.49
	37	3.035	2.955	1.37	1.29	1.38
	38	2.849	2.790	1.29	1.21	1.28
	39	2.678	2.609	1.21	1.17	1.24
	40	2.597	2.545	1.17	1.14	1.23
	41	2.535	2.513	1.14	1.19	1.33
	42	2.647	2.559	1.19	1.19	1.30
	43	2.644	2.598	1.19	1.22	1.31
	44	2.698	2.620	1.22	1.18	1.27
	45	2.618	2.536	1.18	1.12	1.20
	46	2.478	2.380	1.12	1.00	1.01
	47	2.221	2.204	1.00	0.89	0.84
Average						
	Weekday	2.205	2.265	1.00	1.00	1.00
	Weekend	2.243	2.308	1.01	1.01	1.00
	ADWF[1]	2.216	2.277	1.00	1.00	1.00
% Error						
	Weekday		2.7%			
	Weekend		2.9%			

Notes:

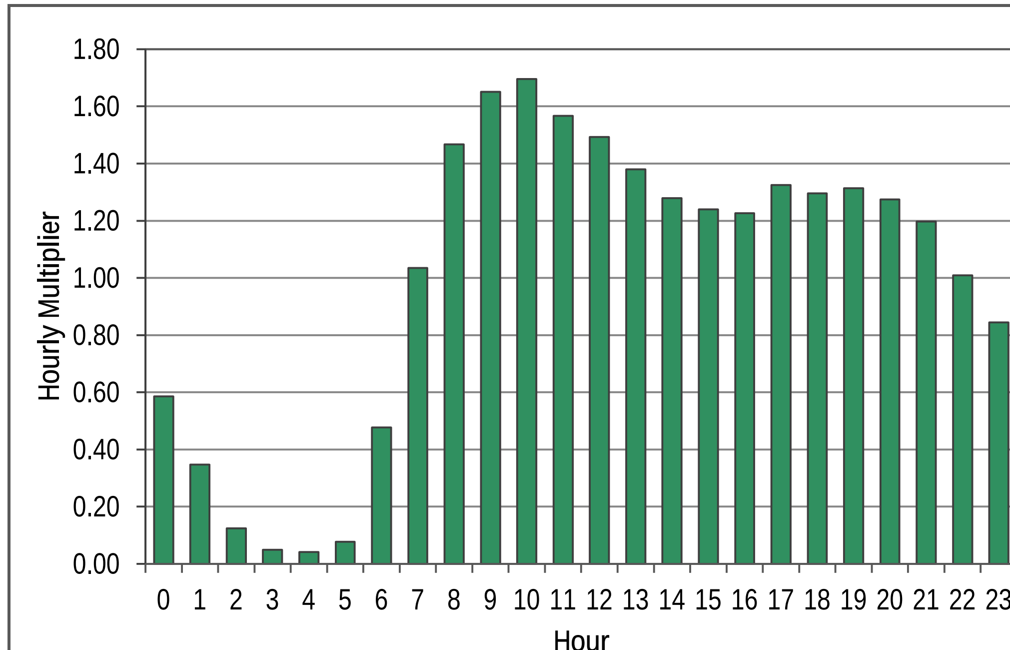
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

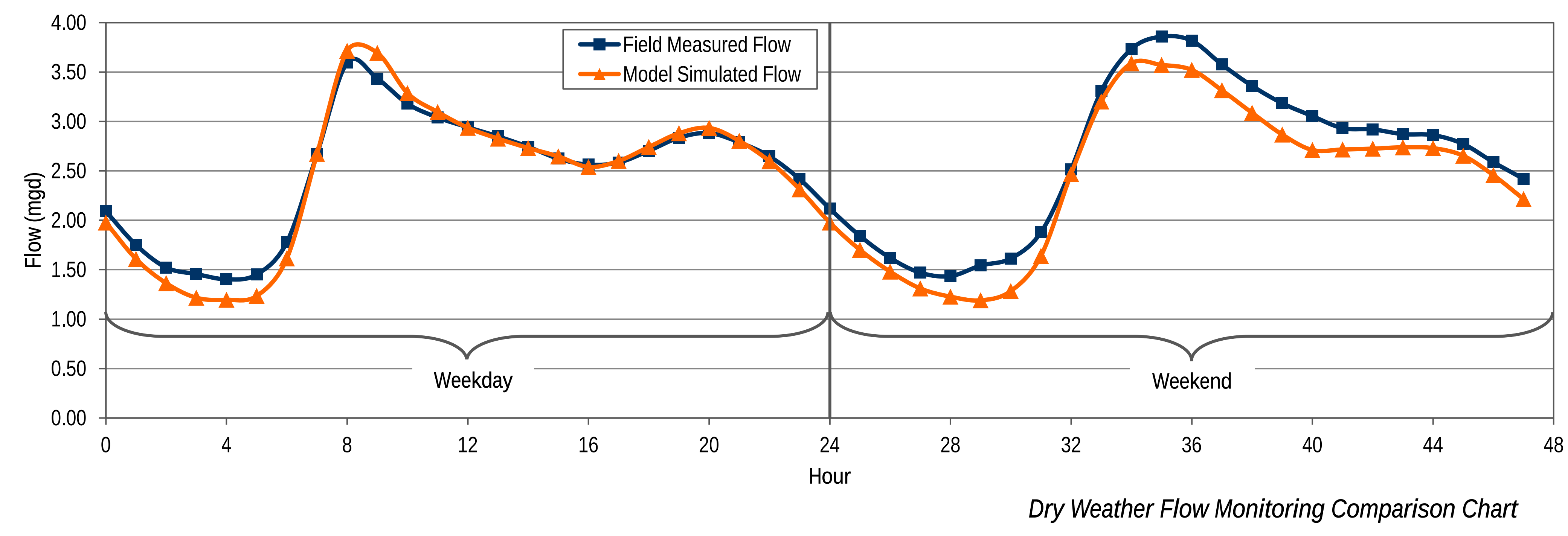
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50L-1 DRY WEATHER CALIBRATION

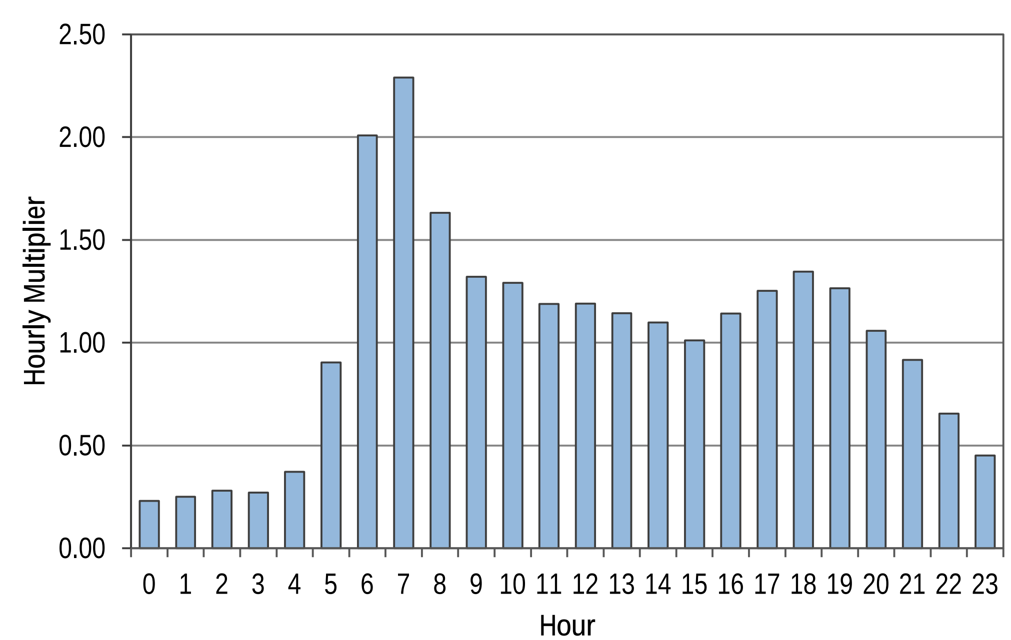
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	2.091	1.977	0.82	0.69	0.23
	1	1.750	1.609	0.69	0.60	0.25
	2	1.522	1.364	0.60	0.57	0.28
	3	1.456	1.217	0.57	0.55	0.27
	4	1.403	1.196	0.55	0.57	0.37
	5	1.452	1.235	0.57	0.70	0.90
	6	1.780	1.615	0.70	1.05	2.01
	7	2.670	2.673	1.05	1.42	2.29
	8	3.596	3.715	1.42	1.35	1.63
	9	3.434	3.693	1.35	1.25	1.32
	10	3.180	3.286	1.25	1.20	1.29
	11	3.040	3.096	1.20	1.16	1.19
	12	2.942	2.936	1.16	1.12	1.19
	13	2.849	2.827	1.12	1.08	1.14
	14	2.744	2.732	1.08	1.03	1.10
	15	2.624	2.647	1.03	1.01	1.01
	16	2.563	2.540	1.01	1.02	1.14
	17	2.585	2.601	1.02	1.07	1.25
	18	2.703	2.742	1.07	1.12	1.35
	19	2.836	2.881	1.12	1.14	1.27
	20	2.882	2.935	1.14	1.10	1.06
	21	2.789	2.804	1.10	1.04	0.92
	22	2.648	2.598	1.04	0.95	0.65
	23	2.417	2.313	0.95	0.82	0.45
Weekend	24	2.118	1.978	0.83	0.73	0.40
	25	1.842	1.701	0.73	0.64	0.26
	26	1.620	1.481	0.64	0.58	0.22
	27	1.470	1.311	0.58	0.57	0.20
	28	1.436	1.228	0.57	0.61	0.26
	29	1.542	1.191	0.61	0.64	0.42
	30	1.614	1.284	0.64	0.74	0.87
	31	1.878	1.639	0.74	0.99	1.74
	32	2.515	2.469	0.99	1.30	1.92
	33	3.307	3.202	1.30	1.47	1.72
	34	3.734	3.589	1.47	1.52	1.50
	35	3.859	3.572	1.52	1.50	1.52
	36	3.818	3.522	1.50	1.41	1.30
	37	3.577	3.316	1.41	1.32	1.19
	38	3.360	3.088	1.32	1.25	0.98
	39	3.185	2.868	1.25	1.20	0.95
	40	3.055	2.711	1.20	1.16	1.03
	41	2.933	2.716	1.16	1.15	1.00
	42	2.920	2.725	1.15	1.13	1.05
	43	2.873	2.739	1.13	1.13	1.05
	44	2.863	2.731	1.13	1.09	1.03
	45	2.773	2.654	1.09	1.02	0.84
	46	2.589	2.457	1.02	0.95	0.69
	47	2.420	2.216	0.95	0.83	0.44
Average						
	Weekday	2.498	2.468	0.98	0.98	1.02
	Weekend	2.637	2.433	1.04	1.04	0.94
	ADWF[(1)]	2.538	2.458	1.00	1.00	1.00
% Error						
	Weekday		-1.2%			
	Weekend		-7.8%			

Notes:

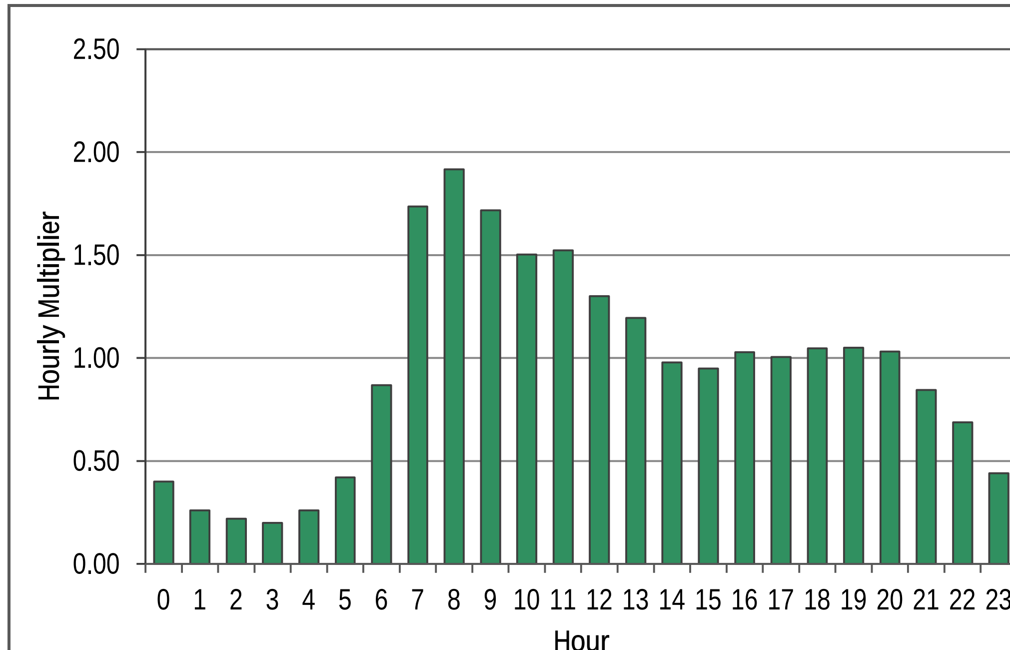
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

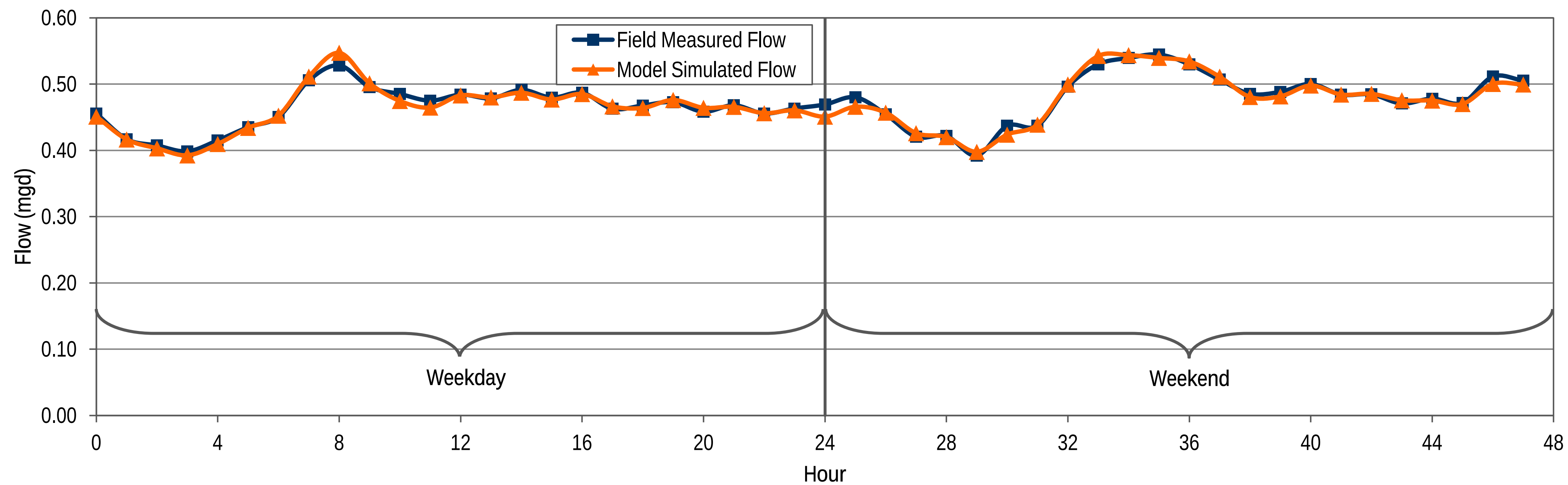
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50C.1 DRY WEATHER CALIBRATION

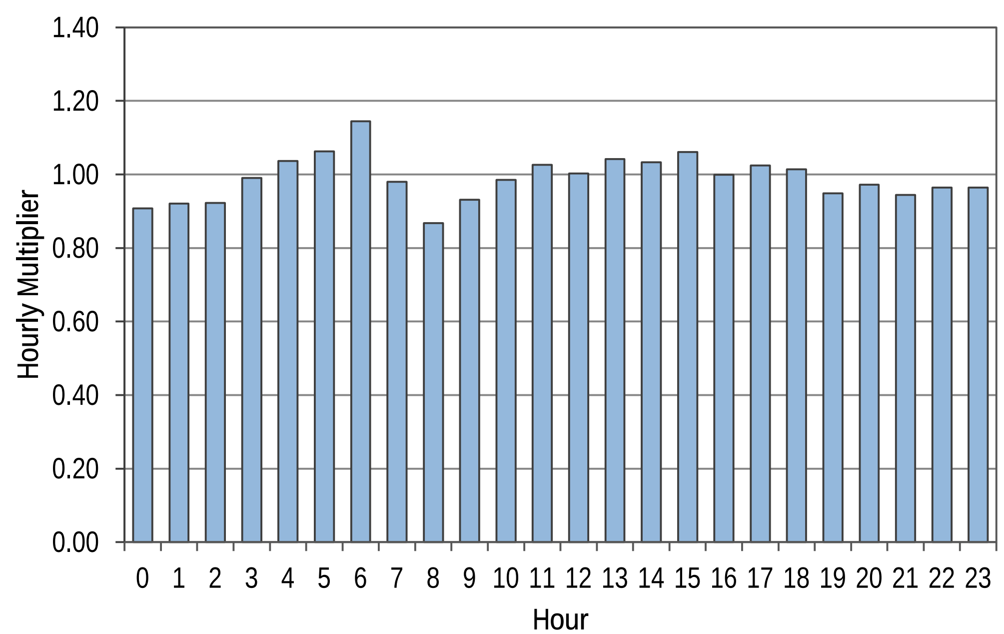
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.455	0.451	0.97	0.89	0.91
	1	0.417	0.416	0.89	0.87	0.92
	2	0.407	0.403	0.87	0.85	0.92
	3	0.399	0.392	0.85	0.89	0.99
	4	0.415	0.410	0.89	0.93	1.04
	5	0.435	0.434	0.93	0.96	1.06
	6	0.451	0.452	0.96	1.08	1.14
	7	0.506	0.511	1.08	1.13	0.98
	8	0.528	0.547	1.13	1.06	0.87
	9	0.496	0.501	1.06	1.03	0.93
	10	0.485	0.475	1.03	1.01	0.98
	11	0.475	0.465	1.01	1.03	1.03
	12	0.484	0.483	1.03	1.02	1.00
	13	0.479	0.480	1.02	1.05	1.04
	14	0.491	0.487	1.05	1.02	1.03
	15	0.479	0.477	1.02	1.04	1.06
	16	0.487	0.485	1.04	0.99	1.00
	17	0.463	0.466	0.99	1.00	1.02
	18	0.468	0.464	1.00	1.01	1.01
	19	0.473	0.476	1.01	0.98	0.95
	20	0.458	0.464	0.98	1.00	0.97
	21	0.468	0.466	1.00	0.97	0.94
	22	0.456	0.456	0.97	0.99	0.96
	23	0.463	0.460	0.99	0.97	0.96
Weekend	24	0.469	0.451	1.00	1.02	1.09
	25	0.480	0.466	1.02	0.97	1.05
	26	0.455	0.457	0.97	0.90	0.96
	27	0.421	0.426	0.90	0.90	0.97
	28	0.422	0.420	0.90	0.84	0.90
	29	0.392	0.398	0.84	0.93	1.04
	30	0.437	0.424	0.93	0.93	1.04
	31	0.437	0.439	0.93	1.06	1.16
	32	0.496	0.499	1.06	1.13	1.11
	33	0.530	0.542	1.13	1.15	1.06
	34	0.539	0.544	1.15	1.16	1.10
	35	0.544	0.540	1.16	1.13	1.06
	36	0.530	0.534	1.13	1.08	0.98
	37	0.507	0.511	1.08	1.04	0.96
	38	0.485	0.481	1.04	1.04	1.01
	39	0.488	0.481	1.04	1.07	1.04
	40	0.500	0.498	1.07	1.03	1.02
	41	0.484	0.484	1.03	1.03	1.01
	42	0.484	0.485	1.03	1.00	0.95
	43	0.471	0.476	1.00	1.02	0.97
	44	0.478	0.475	1.02	1.01	0.96
	45	0.472	0.470	1.01	1.09	1.09
	46	0.511	0.500	1.09	1.08	1.11
	47	0.505	0.499	1.08	1.00	1.00
Average						
	Weekday	0.464	0.463	0.99	0.99	0.99
	Weekend	0.481	0.479	1.03	1.03	1.03
	ADWF[1]	0.469	0.468	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.3%			

Notes:

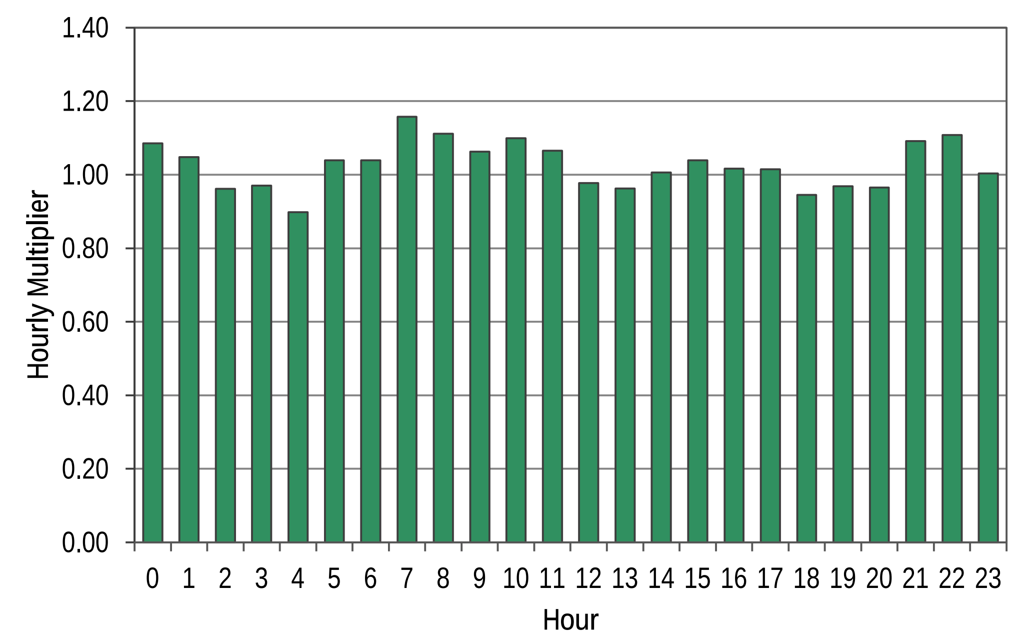
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

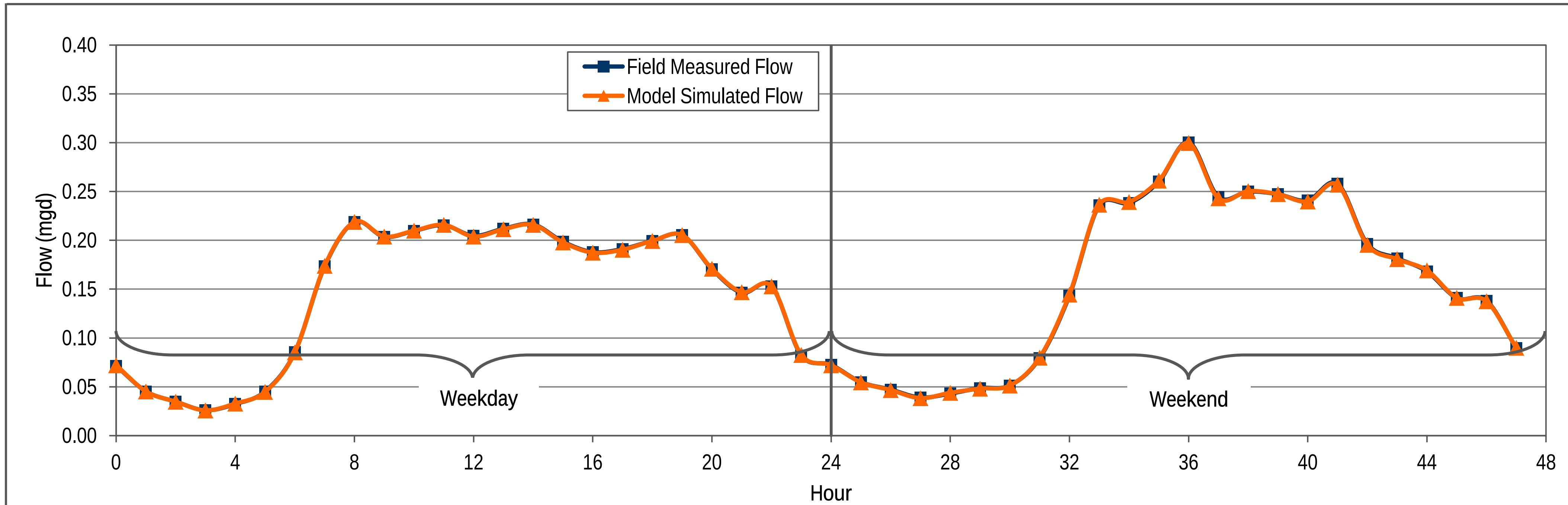
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50C.2 DRY WEATHER CALIBRATION

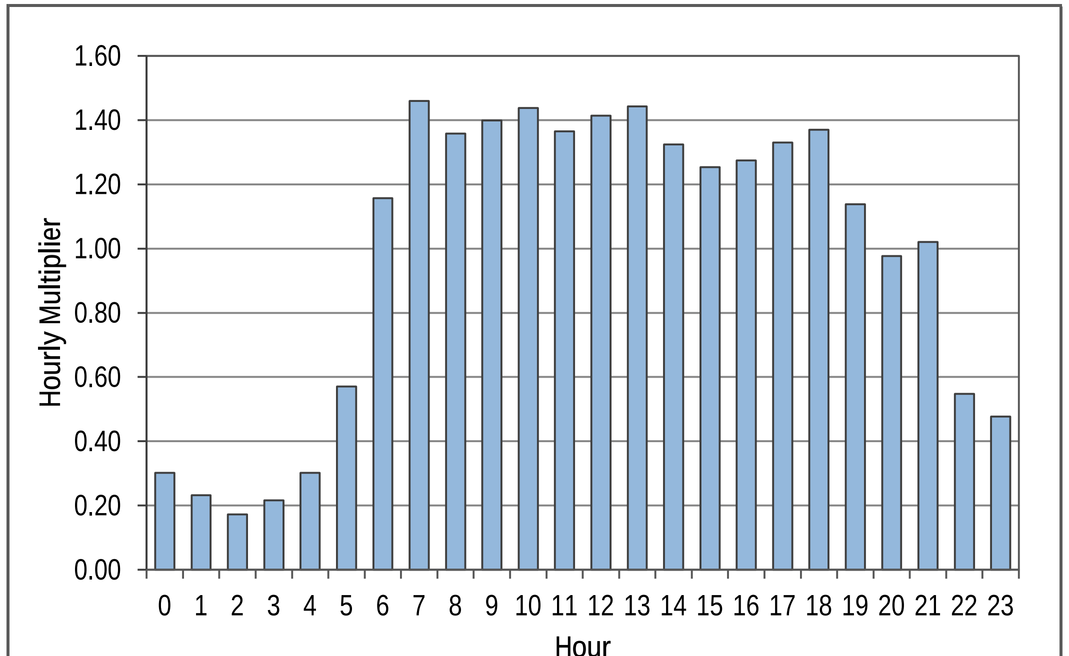
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.072	0.072	0.48	0.30	0.30
	1	0.045	0.045	0.30	0.23	0.23
	2	0.035	0.035	0.23	0.17	0.17
	3	0.026	0.026	0.17	0.22	0.22
	4	0.032	0.033	0.22	0.30	0.30
	5	0.045	0.045	0.30	0.57	0.57
	6	0.085	0.085	0.57	1.16	1.16
	7	0.173	0.174	1.16	1.46	1.46
	8	0.219	0.219	1.46	1.36	1.36
	9	0.204	0.204	1.36	1.40	1.40
	10	0.210	0.210	1.40	1.44	1.44
	11	0.215	0.216	1.44	1.36	1.36
	12	0.204	0.204	1.36	1.41	1.41
	13	0.212	0.211	1.41	1.44	1.44
	14	0.216	0.216	1.44	1.32	1.32
	15	0.198	0.198	1.32	1.25	1.25
	16	0.188	0.187	1.25	1.27	1.27
	17	0.191	0.190	1.27	1.33	1.33
	18	0.199	0.199	1.33	1.37	1.37
	19	0.205	0.205	1.37	1.14	1.14
	20	0.170	0.171	1.14	0.98	0.98
	21	0.146	0.147	0.98	1.02	1.02
	22	0.153	0.153	1.02	0.55	0.55
	23	0.082	0.083	0.55	0.48	0.48
Weekend	24	0.072	0.072	0.48	0.37	0.37
	25	0.055	0.055	0.37	0.31	0.31
	26	0.047	0.047	0.31	0.26	0.26
	27	0.039	0.038	0.26	0.29	0.29
	28	0.043	0.044	0.29	0.32	0.32
	29	0.049	0.048	0.32	0.34	0.34
	30	0.051	0.051	0.34	0.53	0.53
	31	0.079	0.080	0.53	0.96	0.96
	32	0.143	0.144	0.96	1.57	1.57
	33	0.236	0.236	1.57	1.59	1.59
	34	0.238	0.239	1.59	1.74	1.74
	35	0.260	0.261	1.74	2.00	2.00
	36	0.300	0.300	2.00	1.63	1.63
	37	0.244	0.243	1.63	1.67	1.67
	38	0.250	0.250	1.67	1.65	1.65
	39	0.247	0.247	1.65	1.61	1.61
	40	0.241	0.240	1.61	1.72	1.72
	41	0.258	0.257	1.72	1.31	1.31
	42	0.196	0.195	1.31	1.21	1.21
	43	0.182	0.181	1.21	1.12	1.12
	44	0.168	0.169	1.12	0.94	0.94
	45	0.141	0.141	0.94	0.92	0.92
	46	0.138	0.138	0.92	0.60	0.60
	47	0.090	0.090	0.60	0.48	0.48
Average						
	Weekday	0.147	0.147	0.98	0.98	0.98
	Weekend	0.157	0.157	1.05	1.05	1.05
	ADWF[1]	0.150	0.150	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

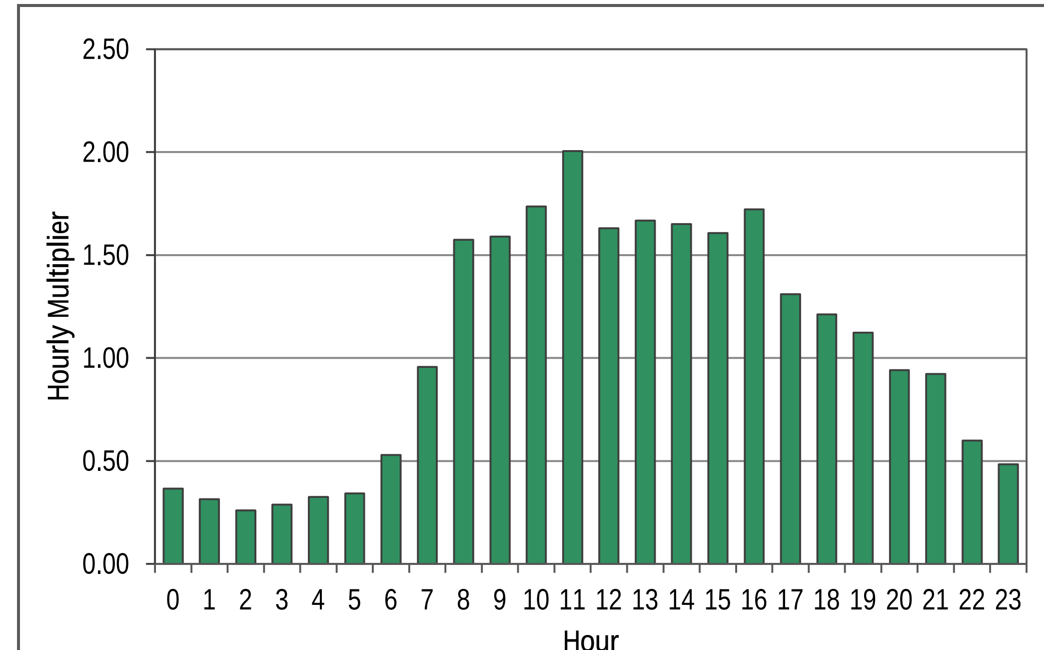
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

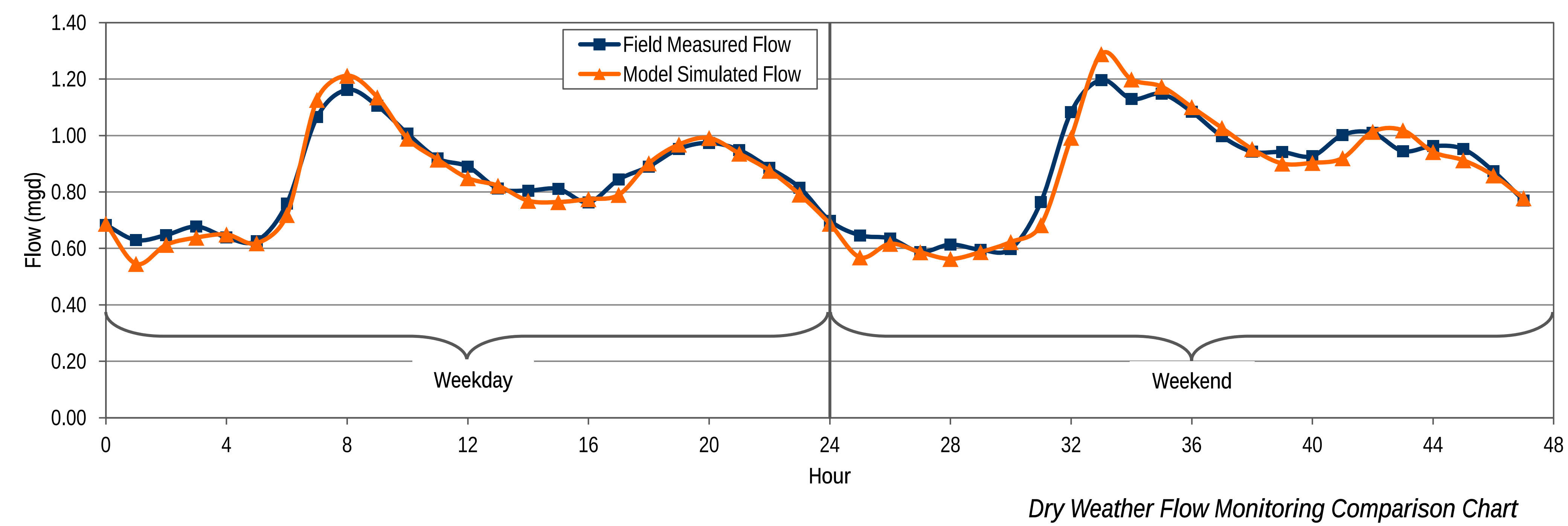
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50D DRY WEATHER CALIBRATION

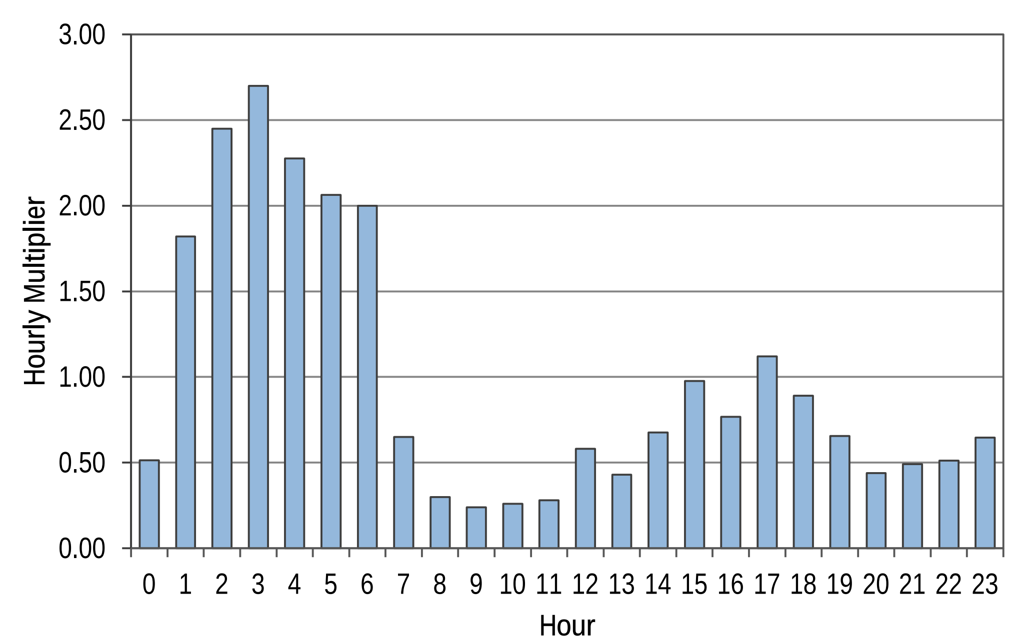
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.683	0.687	0.80	0.74	0.51
	1	0.629	0.545	0.74	0.76	1.82
	2	0.647	0.613	0.76	0.79	2.45
	3	0.677	0.638	0.79	0.75	2.70
	4	0.638	0.649	0.75	0.73	2.27
	5	0.626	0.618	0.73	0.89	2.06
	6	0.760	0.718	0.89	1.24	2.00
	7	1.065	1.126	1.24	1.36	0.65
	8	1.162	1.212	1.36	1.29	0.30
	9	1.105	1.135	1.29	1.18	0.24
	10	1.006	0.989	1.18	1.07	0.26
	11	0.919	0.915	1.07	1.04	0.28
	12	0.890	0.849	1.04	0.95	0.58
	13	0.812	0.822	0.95	0.94	0.43
	14	0.805	0.769	0.94	0.95	0.68
	15	0.811	0.764	0.95	0.89	0.98
	16	0.763	0.774	0.89	0.99	0.77
	17	0.844	0.790	0.99	1.04	1.12
	18	0.890	0.901	1.04	1.11	0.89
	19	0.953	0.968	1.11	1.14	0.66
	20	0.974	0.991	1.14	1.11	0.44
	21	0.949	0.936	1.11	1.03	0.49
	22	0.885	0.875	1.03	0.95	0.51
	23	0.815	0.791	0.95	0.80	0.65
Weekend	24	0.698	0.687	0.82	0.76	0.67
	25	0.646	0.568	0.76	0.74	1.45
	26	0.635	0.616	0.74	0.69	1.63
	27	0.587	0.586	0.69	0.72	1.69
	28	0.613	0.563	0.72	0.70	2.04
	29	0.595	0.587	0.70	0.70	2.04
	30	0.598	0.623	0.70	0.89	1.74
	31	0.764	0.682	0.89	1.27	2.45
	32	1.083	0.992	1.27	1.40	2.45
	33	1.197	1.288	1.40	1.32	0.61
	34	1.130	1.199	1.32	1.34	0.36
	35	1.148	1.173	1.34	1.27	0.34
	36	1.084	1.101	1.27	1.17	0.17
	37	0.997	1.027	1.17	1.10	0.13
	38	0.943	0.952	1.10	1.10	0.17
	39	0.941	0.901	1.10	1.08	0.49
	40	0.927	0.903	1.08	1.17	0.64
	41	1.002	0.920	1.17	1.18	1.27
	42	1.009	1.013	1.18	1.10	1.10
	43	0.945	1.018	1.10	1.13	0.37
	44	0.963	0.941	1.13	1.11	0.52
	45	0.952	0.912	1.11	1.02	0.80
	46	0.874	0.859	1.02	0.90	0.84
	47	0.770	0.778	0.90	0.82	0.68
Average						
	Weekday	0.846	0.836	0.99	0.99	0.99
	Weekend	0.879	0.870	1.03	1.03	1.03
	ADWF[(1)]	0.856	0.846	1.00	1.00	1.00
% Error						
	Weekday		-1.2%			
	Weekend		-1.0%			

Notes:

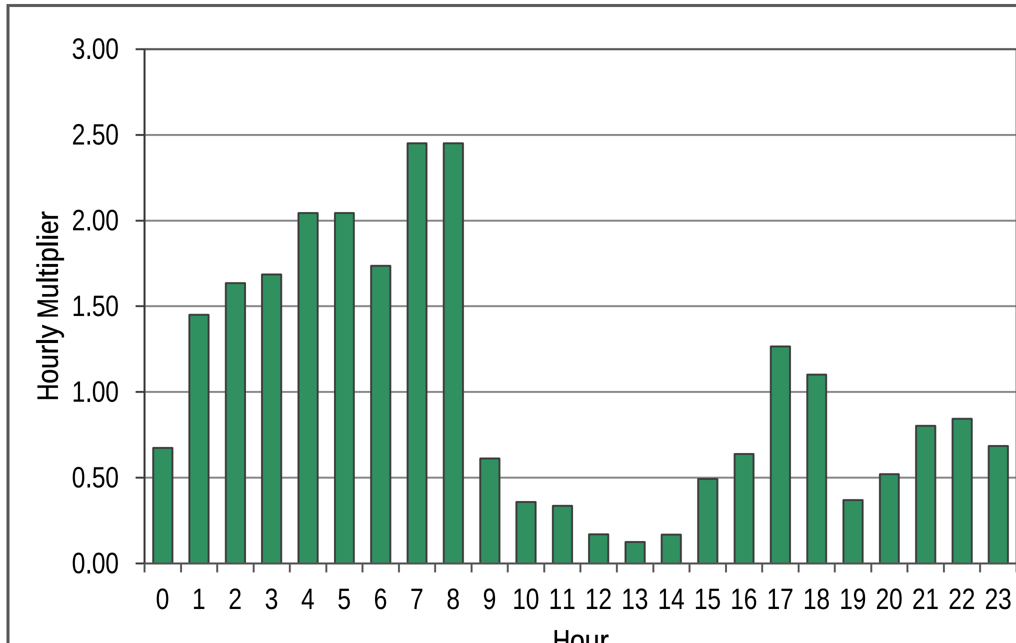
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

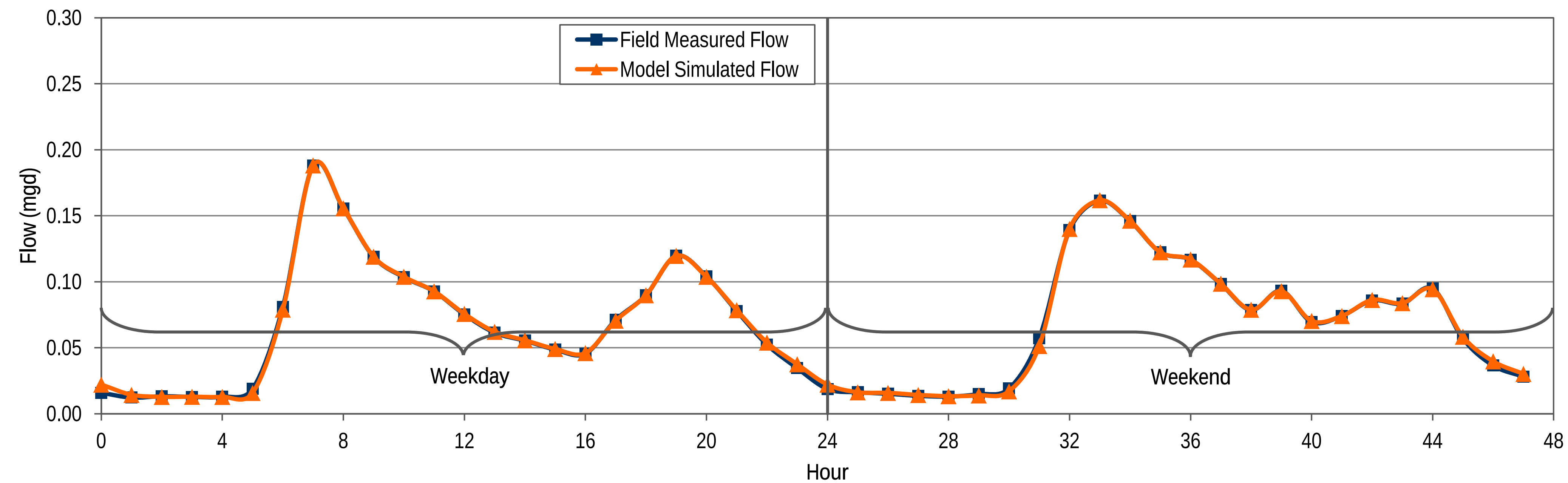
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50E DRY WEATHER CALIBRATION

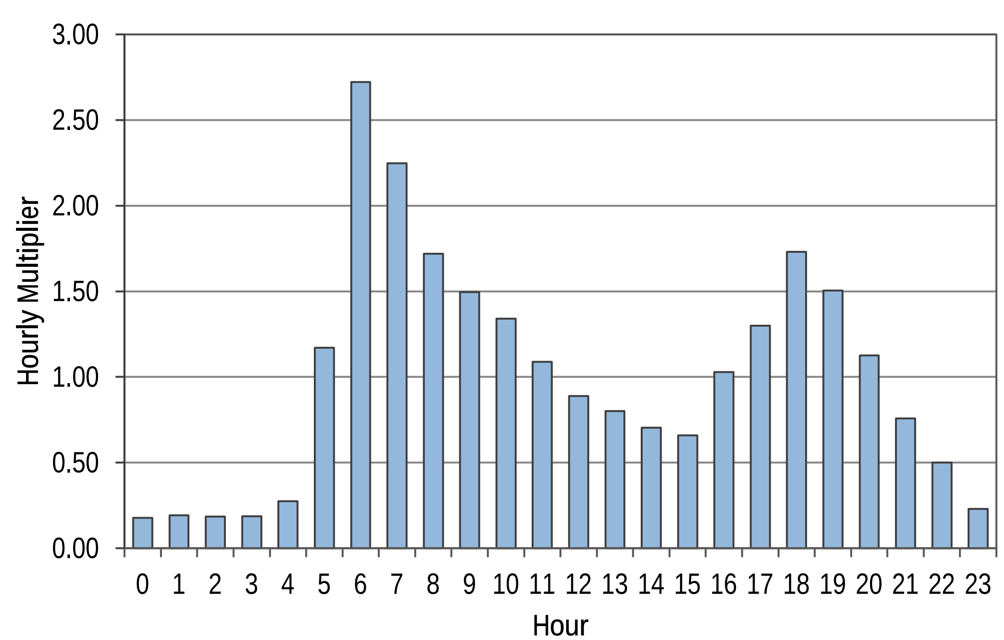
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.016	0.022	0.23	0.18	0.18
	1	0.012	0.014	0.18	0.19	0.19
	2	0.013	0.013	0.19	0.18	0.18
	3	0.013	0.013	0.18	0.19	0.19
	4	0.013	0.013	0.19	0.27	0.27
	5	0.019	0.016	0.27	1.17	1.17
	6	0.081	0.079	1.17	2.72	2.72
	7	0.188	0.188	2.72	2.25	2.25
	8	0.155	0.156	2.25	1.72	1.72
	9	0.119	0.119	1.72	1.50	1.50
	10	0.103	0.104	1.50	1.34	1.34
	11	0.093	0.093	1.34	1.09	1.09
	12	0.075	0.076	1.09	0.89	0.89
	13	0.061	0.062	0.89	0.80	0.80
	14	0.055	0.056	0.80	0.70	0.70
	15	0.049	0.049	0.70	0.66	0.66
	16	0.046	0.046	0.66	1.03	1.03
	17	0.071	0.070	1.03	1.30	1.30
	18	0.090	0.090	1.30	1.73	1.73
	19	0.120	0.120	1.73	1.50	1.50
	20	0.104	0.104	1.50	1.13	1.13
	21	0.078	0.078	1.13	0.76	0.76
	22	0.052	0.054	0.76	0.50	0.50
	23	0.035	0.037	0.50	0.23	0.23
Weekend	24	0.019	0.022	0.27	0.24	0.24
	25	0.016	0.016	0.24	0.22	0.22
	26	0.015	0.016	0.22	0.20	0.20
	27	0.014	0.014	0.20	0.19	0.19
	28	0.013	0.013	0.19	0.21	0.21
	29	0.015	0.014	0.21	0.28	0.28
	30	0.019	0.017	0.28	0.83	0.83
	31	0.057	0.051	0.83	2.01	2.01
	32	0.139	0.140	2.01	2.34	2.34
	33	0.162	0.162	2.34	2.11	2.11
	34	0.146	0.146	2.11	1.77	1.77
	35	0.122	0.122	1.77	1.69	1.69
	36	0.117	0.117	1.69	1.42	1.42
	37	0.098	0.099	1.42	1.14	1.14
	38	0.079	0.079	1.14	1.35	1.35
	39	0.093	0.093	1.35	1.01	1.01
	40	0.070	0.070	1.01	1.07	1.07
	41	0.074	0.074	1.07	1.24	1.24
	42	0.086	0.086	1.24	1.21	1.21
	43	0.084	0.084	1.21	1.37	1.37
	44	0.095	0.094	1.37	0.82	0.82
	45	0.057	0.058	0.82	0.53	0.53
	46	0.037	0.040	0.53	0.41	0.41
	47	0.028	0.030	0.41	0.27	0.27
Average						
	Weekday	0.069	0.070	1.00	1.00	1.00
	Weekend	0.069	0.069	1.00	1.00	1.00
	ADWF[(1)]	0.069	0.069	1.00	1.00	1.00
% Error						
	Weekday		0.5%			
	Weekend		0.2%			

Notes:

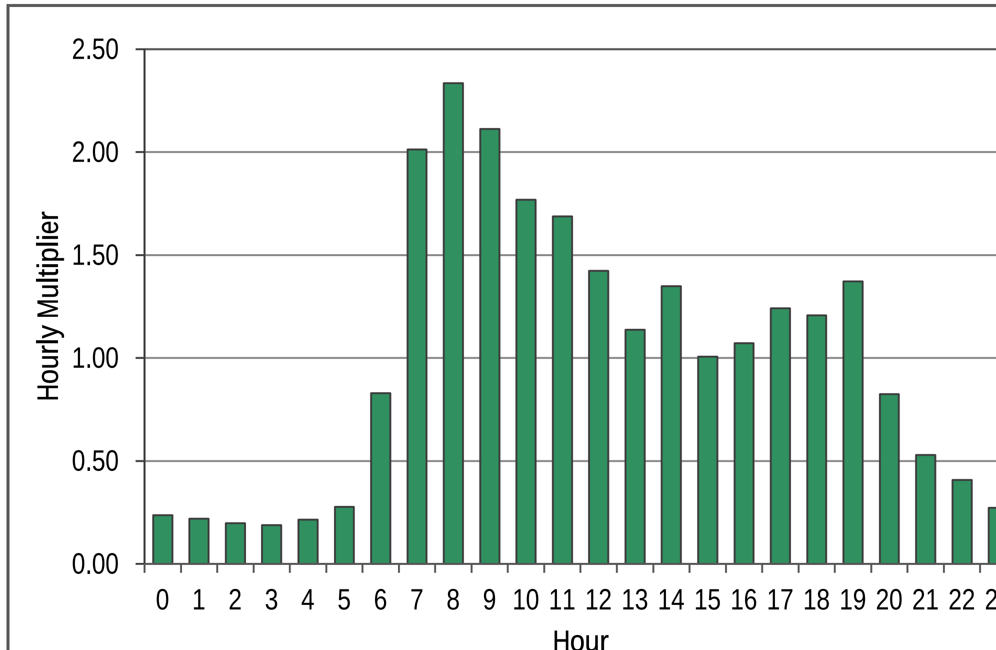
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

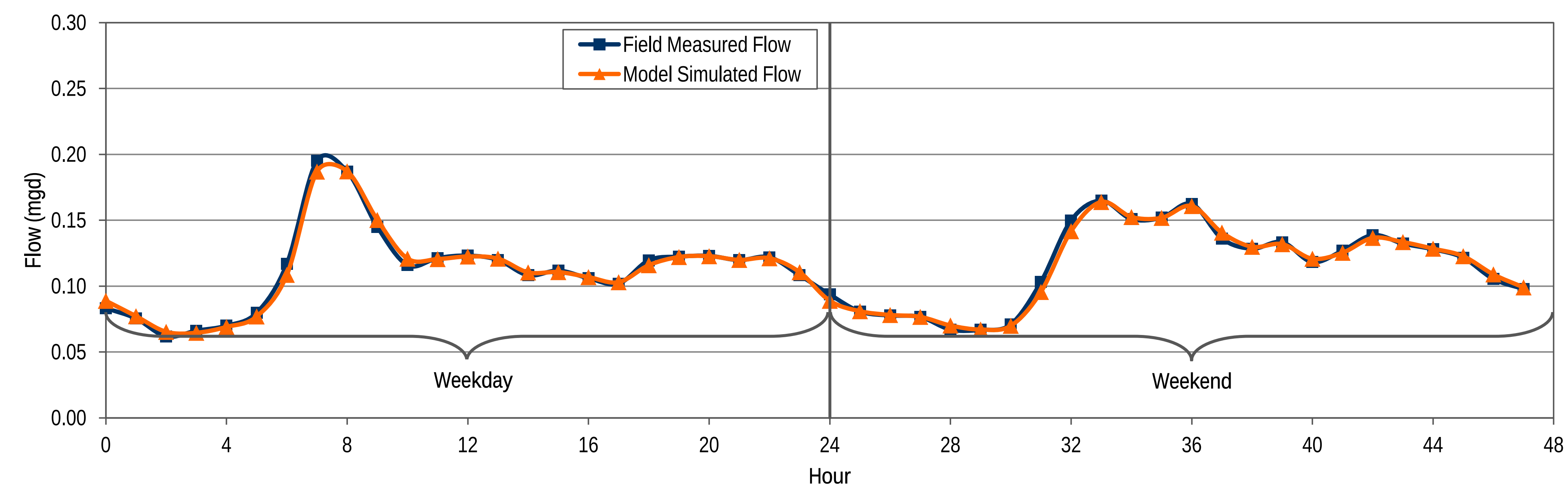
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50F DRY WEATHER CALIBRATION

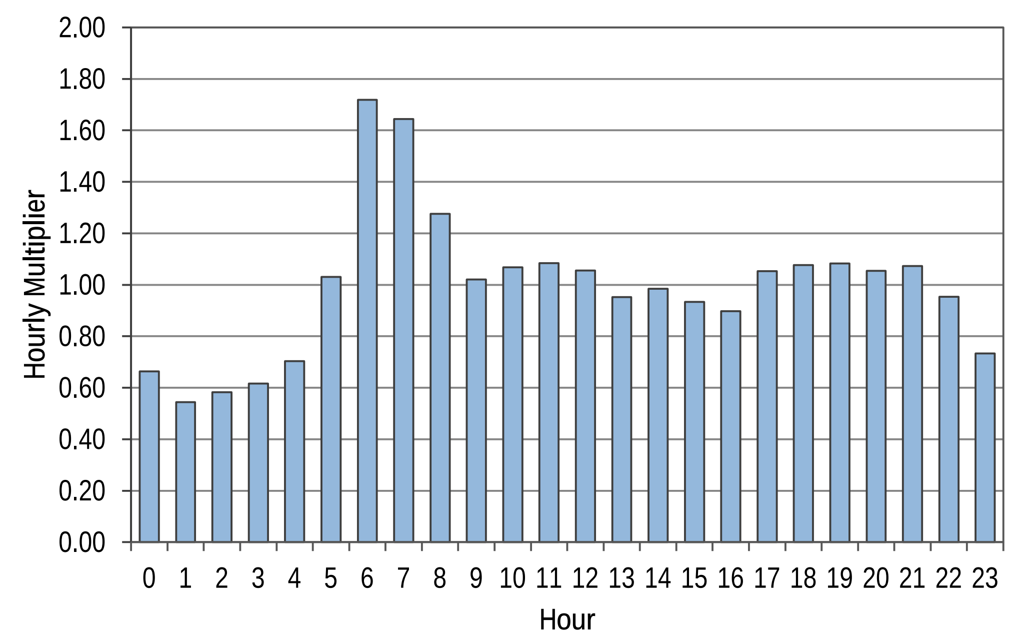
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.083	0.089	0.73	0.66	0.66
	1	0.075	0.077	0.66	0.54	0.54
	2	0.062	0.065	0.54	0.58	0.58
	3	0.066	0.065	0.58	0.62	0.62
	4	0.070	0.069	0.62	0.70	0.70
	5	0.080	0.077	0.70	1.03	1.03
	6	0.117	0.109	1.03	1.72	1.72
	7	0.195	0.187	1.72	1.64	1.64
	8	0.187	0.187	1.64	1.28	1.28
	9	0.145	0.150	1.28	1.02	1.02
	10	0.116	0.121	1.02	1.07	1.07
	11	0.121	0.121	1.07	1.08	1.08
	12	0.123	0.123	1.08	1.06	1.06
	13	0.120	0.121	1.06	0.95	0.95
	14	0.108	0.110	0.95	0.98	0.98
	15	0.112	0.111	0.98	0.93	0.93
	16	0.106	0.107	0.93	0.90	0.90
	17	0.102	0.103	0.90	1.05	1.05
	18	0.120	0.116	1.05	1.08	1.08
	19	0.122	0.122	1.08	1.08	1.08
	20	0.123	0.123	1.08	1.05	1.05
	21	0.120	0.120	1.05	1.07	1.07
	22	0.122	0.121	1.07	0.95	0.95
	23	0.108	0.111	0.95	0.73	0.73
Weekend	24	0.094	0.089	0.82	0.71	0.71
	25	0.081	0.081	0.71	0.68	0.68
	26	0.078	0.078	0.68	0.67	0.67
	27	0.077	0.077	0.67	0.59	0.59
	28	0.067	0.070	0.59	0.59	0.59
	29	0.067	0.067	0.59	0.62	0.62
	30	0.071	0.070	0.62	0.91	0.91
	31	0.103	0.096	0.91	1.32	1.32
	32	0.150	0.142	1.32	1.45	1.45
	33	0.165	0.164	1.45	1.33	1.33
	34	0.151	0.152	1.33	1.34	1.34
	35	0.152	0.152	1.34	1.43	1.43
	36	0.162	0.161	1.43	1.20	1.20
	37	0.136	0.141	1.20	1.13	1.13
	38	0.128	0.130	1.13	1.17	1.17
	39	0.133	0.132	1.17	1.04	1.04
	40	0.118	0.121	1.04	1.12	1.12
	41	0.127	0.125	1.12	1.22	1.22
	42	0.139	0.137	1.22	1.16	1.16
	43	0.132	0.133	1.16	1.13	1.13
	44	0.128	0.128	1.13	1.07	1.07
	45	0.122	0.123	1.07	0.93	0.93
	46	0.105	0.109	0.93	0.86	0.86
	47	0.098	0.099	0.86	0.82	0.82
Average						
Weekday		0.113	0.113	0.99	0.99	0.99
Weekend		0.116	0.116	1.02	1.02	1.02
ADWF[(1)]		0.114	0.113	1.00	1.00	1.00
% Error						
Weekday			0.0%			
Weekend			-0.3%			

Notes:

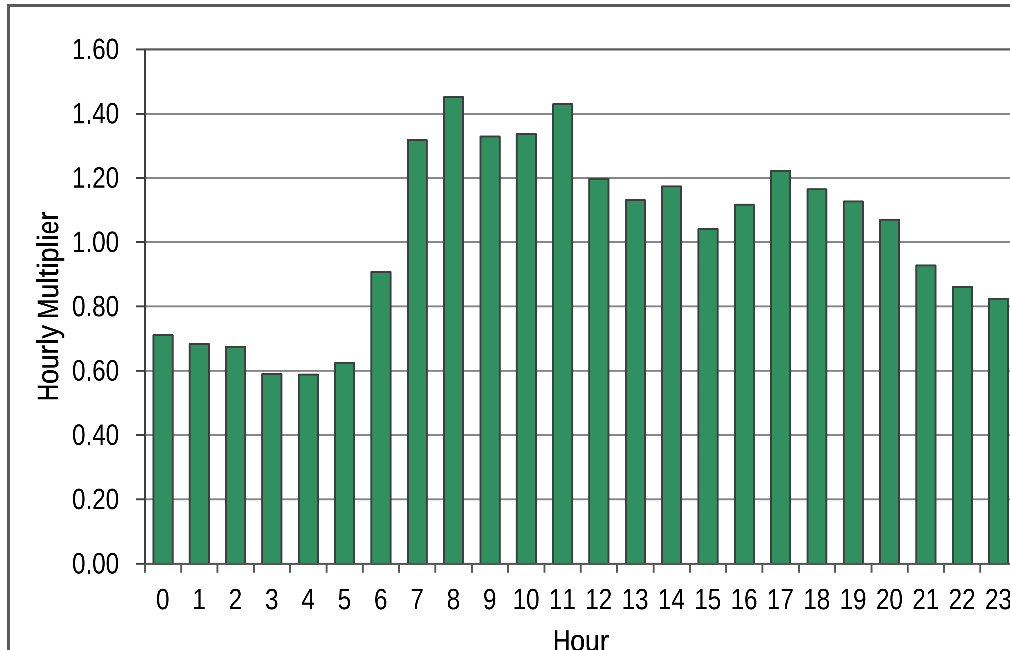
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_50.xlsx

City of Oakland

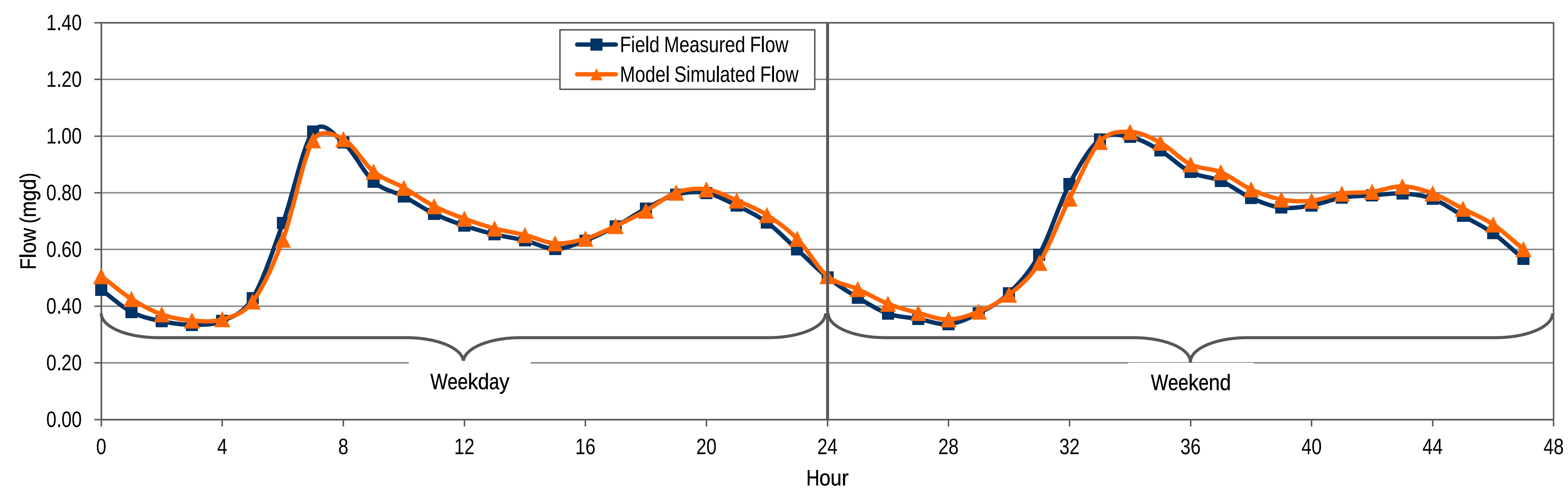
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50G DRY WEATHER CALIBRATION

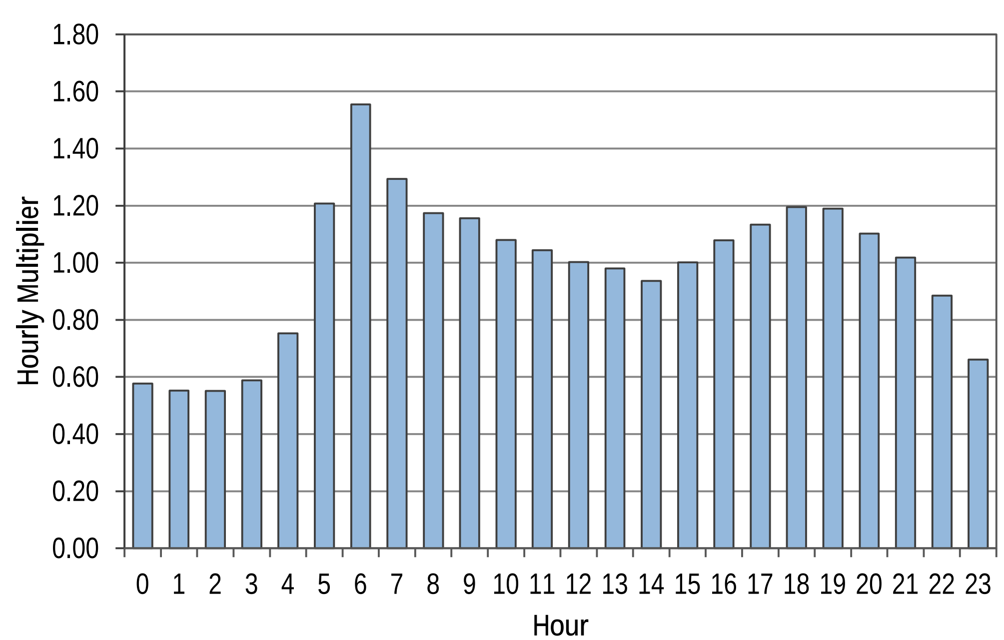
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.458	0.506	0.70	0.58	0.58
	1	0.379	0.425	0.58	0.53	0.55
	2	0.347	0.371	0.53	0.51	0.55
	3	0.334	0.350	0.51	0.53	0.59
	4	0.348	0.354	0.53	0.65	0.75
	5	0.428	0.417	0.65	1.05	1.21
	6	0.693	0.635	1.05	1.54	1.56
	7	1.017	0.985	1.54	1.49	1.29
	8	0.977	0.989	1.49	1.28	1.17
	9	0.840	0.875	1.28	1.20	1.16
	10	0.787	0.818	1.20	1.10	1.08
	11	0.726	0.753	1.10	1.04	1.04
	12	0.684	0.709	1.04	0.99	1.00
	13	0.653	0.674	0.99	0.96	0.98
	14	0.632	0.651	0.96	0.92	0.94
	15	0.602	0.622	0.92	0.96	1.00
	16	0.632	0.638	0.96	1.04	1.08
	17	0.682	0.683	1.04	1.13	1.13
	18	0.745	0.737	1.13	1.21	1.20
	19	0.794	0.801	1.21	1.21	1.19
	20	0.799	0.812	1.21	1.15	1.10
	21	0.755	0.773	1.15	1.06	1.02
	22	0.696	0.721	1.06	0.91	0.89
	23	0.600	0.638	0.91	0.70	0.66
Weekend	24	0.502	0.506	0.76	0.65	0.66
	25	0.430	0.461	0.65	0.57	0.60
	26	0.374	0.409	0.57	0.54	0.59
	27	0.355	0.376	0.54	0.51	0.57
	28	0.337	0.354	0.51	0.57	0.67
	29	0.375	0.381	0.57	0.68	0.82
	30	0.446	0.441	0.68	0.88	1.04
	31	0.582	0.553	0.88	1.26	1.39
	32	0.831	0.780	1.26	1.50	1.52
	33	0.988	0.979	1.50	1.52	1.39
	34	0.997	1.015	1.52	1.44	1.32
	35	0.949	0.977	1.44	1.33	1.19
	36	0.873	0.900	1.33	1.28	1.22
	37	0.842	0.872	1.28	1.19	1.16
	38	0.782	0.812	1.19	1.14	1.14
	39	0.748	0.776	1.14	1.15	1.15
	40	0.756	0.772	1.15	1.19	1.18
	41	0.783	0.797	1.19	1.20	1.17
	42	0.791	0.804	1.20	1.21	1.19
	43	0.797	0.823	1.21	1.18	1.14
	44	0.779	0.798	1.18	1.09	1.05
	45	0.719	0.744	1.09	1.00	0.98
	46	0.657	0.688	1.00	0.86	0.84
	47	0.567	0.602	0.86	0.76	0.75
Average						
	Weekday	0.650	0.664	0.99	0.99	0.99
	Weekend	0.677	0.692	1.03	1.03	1.03
	ADWF[1]	0.658	0.672	1.00	1.00	1.00
% Error						
	Weekday		2.1%			
	Weekend		2.2%			

Notes:

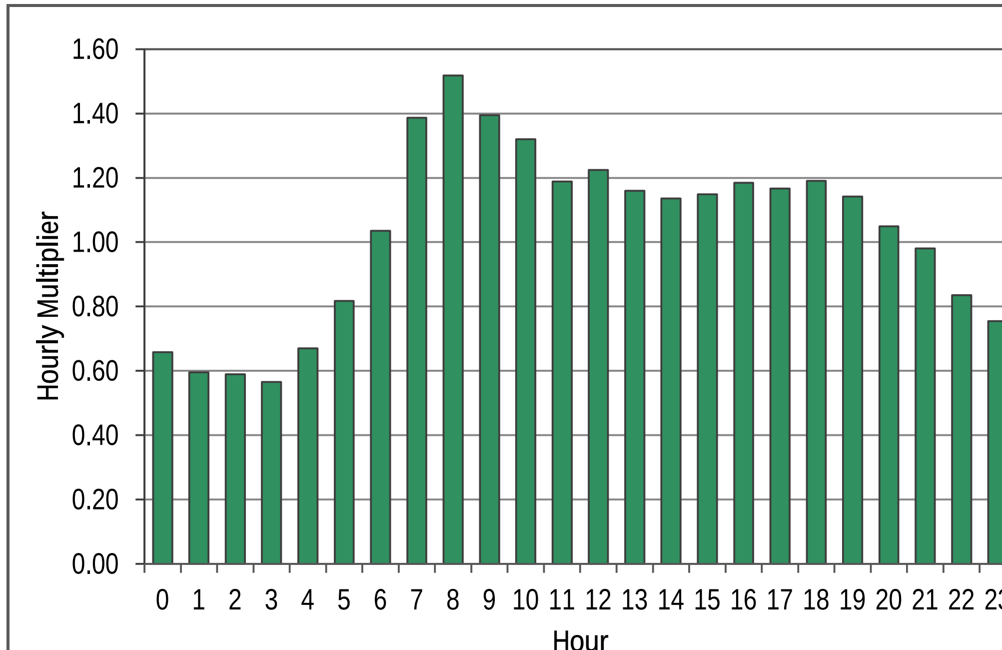
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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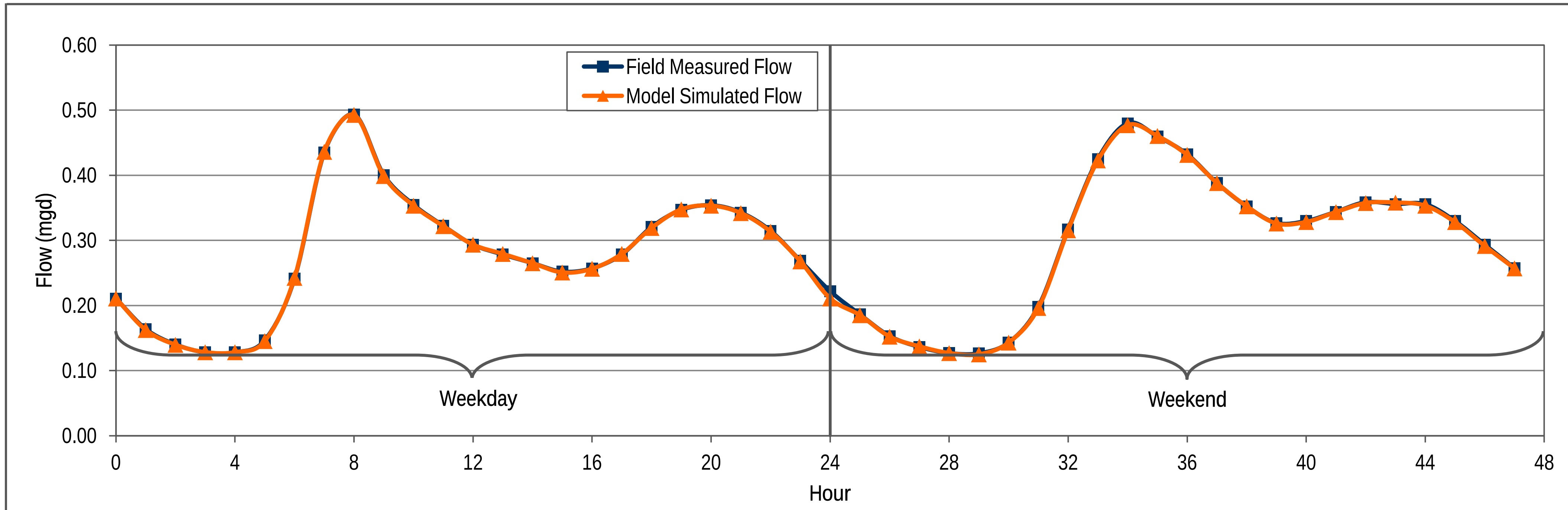
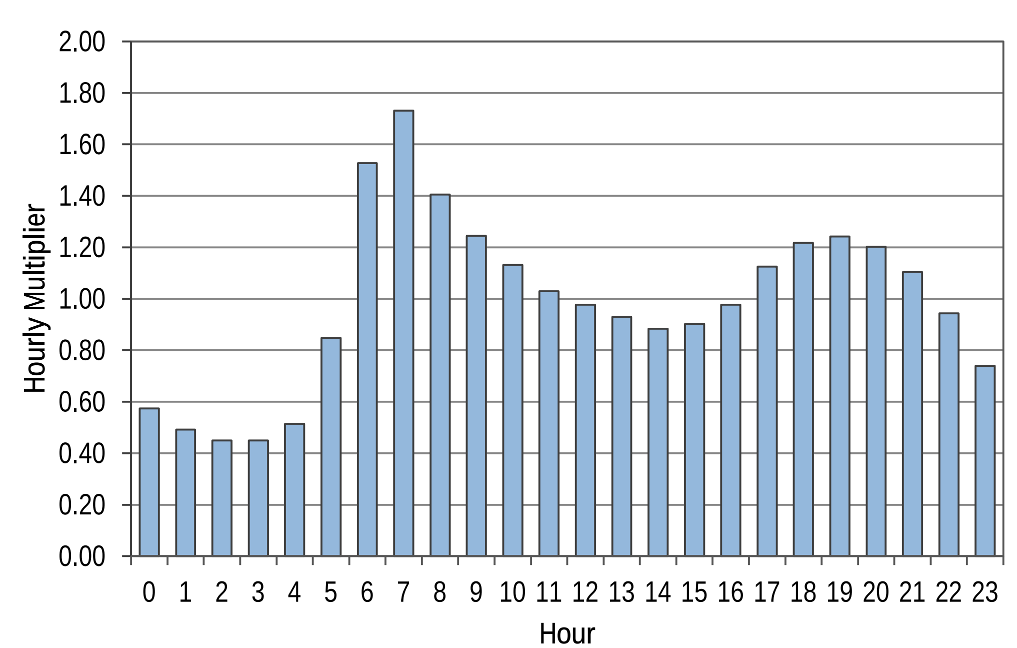
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 50H DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.211	0.211	0.74	0.57	0.57
	1	0.164	0.162	0.57	0.49	0.49
	2	0.140	0.140	0.49	0.45	0.45
	3	0.128	0.128	0.45	0.45	0.45
	4	0.128	0.128	0.45	0.51	0.51
	5	0.147	0.145	0.51	0.85	0.85
	6	0.241	0.242	0.85	1.53	1.53
	7	0.435	0.436	1.53	1.73	1.73
	8	0.493	0.493	1.73	1.40	1.40
	9	0.400	0.399	1.40	1.24	1.24
	10	0.355	0.353	1.24	1.13	1.13
	11	0.322	0.322	1.13	1.03	1.03
	12	0.293	0.293	1.03	0.98	0.98
	13	0.278	0.279	0.98	0.93	0.93
	14	0.265	0.265	0.93	0.88	0.88
	15	0.252	0.251	0.88	0.90	0.90
	16	0.257	0.256	0.90	0.98	0.98
	17	0.278	0.279	0.98	1.12	1.12
	18	0.320	0.319	1.12	1.22	1.22
	19	0.347	0.348	1.22	1.24	1.24
	20	0.354	0.353	1.24	1.20	1.20
	21	0.343	0.342	1.20	1.10	1.10
	22	0.315	0.313	1.10	0.94	0.94
	23	0.269	0.268	0.94	0.74	0.74
Weekend	24	0.222	0.211	0.78	0.65	0.65
	25	0.186	0.185	0.65	0.54	0.54
	26	0.153	0.152	0.54	0.48	0.48
	27	0.136	0.137	0.48	0.45	0.45
	28	0.127	0.127	0.45	0.44	0.44
	29	0.126	0.125	0.44	0.50	0.50
	30	0.143	0.143	0.50	0.69	0.69
	31	0.198	0.196	0.69	1.11	1.11
	32	0.317	0.315	1.11	1.49	1.49
	33	0.425	0.423	1.49	1.68	1.68
	34	0.480	0.477	1.68	1.61	1.61
	35	0.460	0.460	1.61	1.52	1.52
	36	0.432	0.431	1.52	1.36	1.36
	37	0.388	0.388	1.36	1.24	1.24
	38	0.352	0.352	1.24	1.15	1.15
	39	0.327	0.326	1.15	1.16	1.16
	40	0.330	0.328	1.16	1.21	1.21
	41	0.344	0.343	1.21	1.26	1.26
	42	0.358	0.357	1.26	1.25	1.25
	43	0.356	0.358	1.25	1.25	1.25
	44	0.356	0.353	1.25	1.16	1.16
	45	0.330	0.328	1.16	1.03	1.03
	46	0.294	0.291	1.03	0.90	0.90
	47	0.257	0.257	0.90	0.78	0.78
Average						
	Weekday	0.281	0.280	0.98	0.98	0.98
	Weekend	0.296	0.294	1.04	1.04	1.04
	ADWF[1]	0.285	0.284	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.4%			

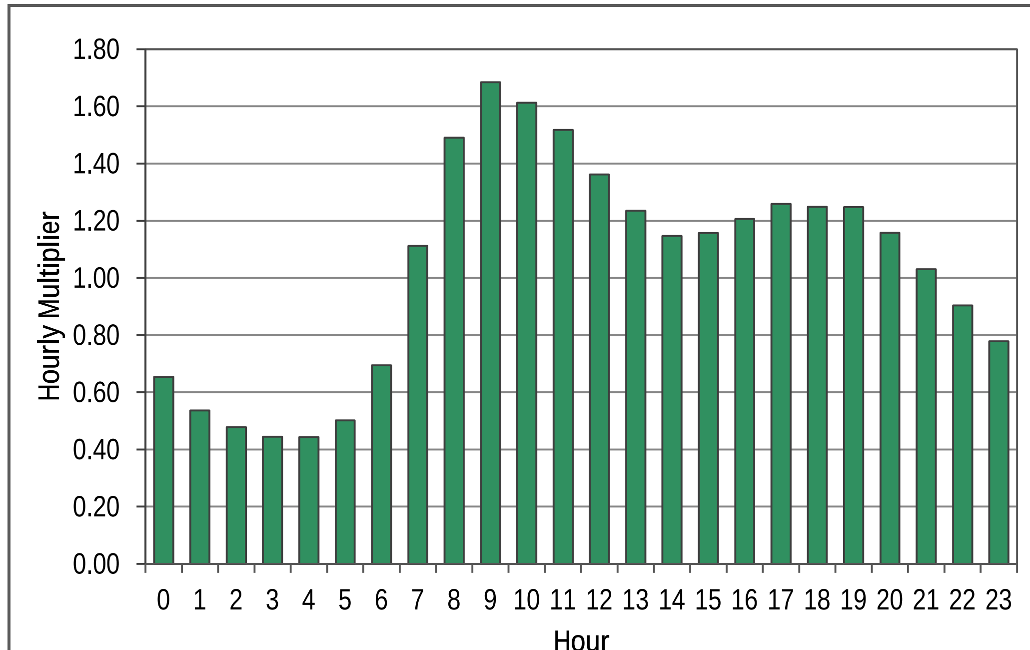
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012
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City of Oakland

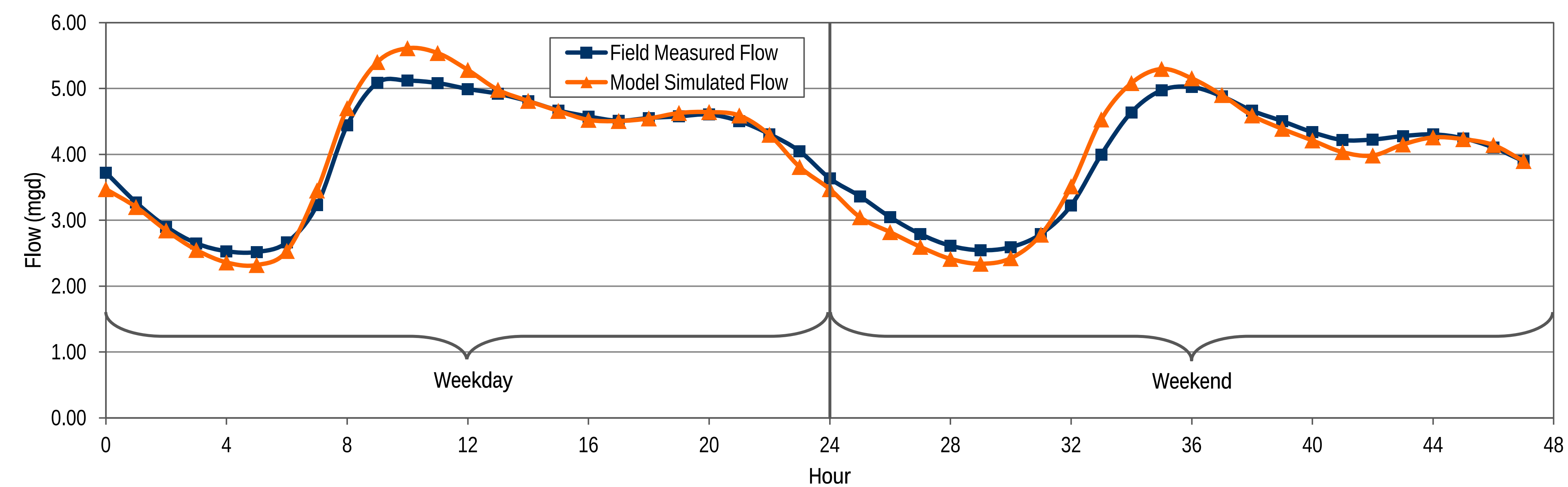
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52A DRY WEATHER CALIBRATION

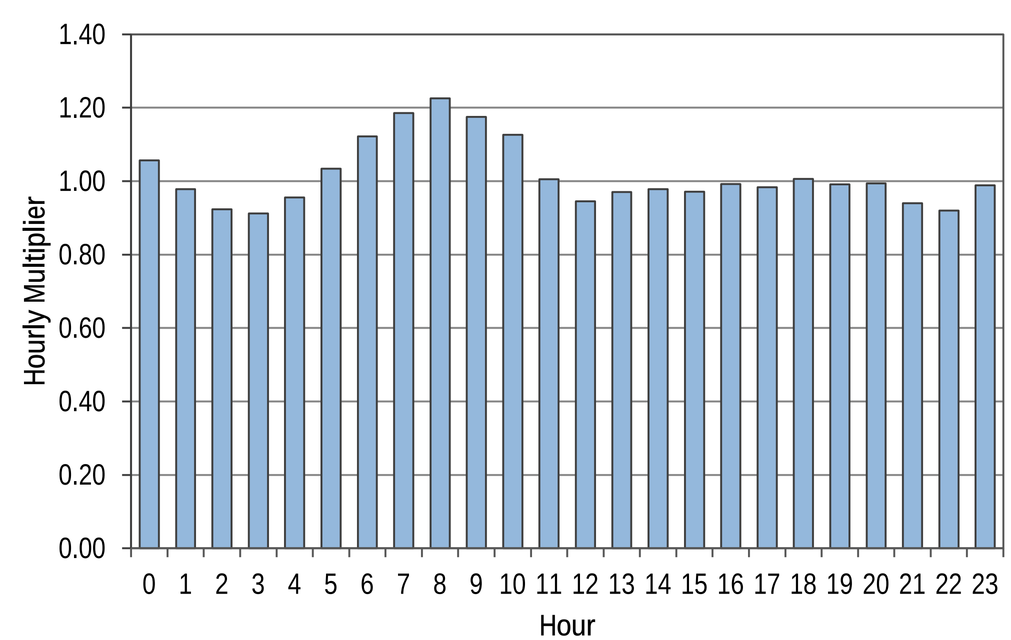
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	3.722	3.472	0.92	0.81	1.06
	1	3.269	3.201	0.81	0.72	0.98
	2	2.901	2.846	0.72	0.66	0.92
	3	2.649	2.550	0.66	0.63	0.91
	4	2.528	2.360	0.63	0.62	0.96
	5	2.517	2.321	0.62	0.66	1.03
	6	2.662	2.534	0.66	0.80	1.12
	7	3.229	3.452	0.80	1.10	1.19
	8	4.441	4.701	1.10	1.26	1.23
	9	5.084	5.402	1.26	1.27	1.18
	10	5.118	5.611	1.27	1.26	1.13
	11	5.082	5.539	1.26	1.24	1.01
	12	4.991	5.282	1.24	1.22	0.95
	13	4.919	4.981	1.22	1.19	0.97
	14	4.807	4.812	1.19	1.16	0.98
	15	4.666	4.660	1.16	1.14	0.97
	16	4.574	4.524	1.14	1.12	0.99
	17	4.509	4.507	1.12	1.13	0.98
	18	4.551	4.546	1.13	1.14	1.01
	19	4.575	4.629	1.14	1.14	0.99
	20	4.604	4.643	1.14	1.12	0.99
	21	4.504	4.590	1.12	1.07	0.94
	22	4.306	4.298	1.07	1.00	0.92
	23	4.047	3.809	1.00	0.92	0.99
Weekend	24	3.634	3.472	0.90	0.83	0.91
	25	3.363	3.047	0.83	0.76	0.97
	26	3.046	2.820	0.76	0.69	0.95
	27	2.789	2.597	0.69	0.65	0.93
	28	2.612	2.414	0.65	0.63	0.93
	29	2.544	2.340	0.63	0.64	0.97
	30	2.591	2.424	0.64	0.69	1.01
	31	2.790	2.782	0.69	0.80	1.03
	32	3.223	3.515	0.80	0.99	1.01
	33	3.995	4.531	0.99	1.15	0.97
	34	4.637	5.082	1.15	1.23	0.96
	35	4.971	5.297	1.23	1.25	0.94
	36	5.021	5.155	1.25	1.21	0.94
	37	4.881	4.901	1.21	1.16	0.93
	38	4.662	4.592	1.16	1.12	0.92
	39	4.504	4.388	1.12	1.08	0.93
	40	4.336	4.212	1.08	1.05	0.92
	41	4.217	4.035	1.05	1.05	0.95
	42	4.224	3.983	1.05	1.06	1.03
	43	4.277	4.151	1.06	1.07	1.05
	44	4.303	4.258	1.07	1.05	1.03
	45	4.243	4.231	1.05	1.02	0.98
	46	4.104	4.143	1.02	0.97	0.92
	47	3.896	3.900	0.97	0.90	0.87
Average						
Weekday		4.094	4.136	1.02	1.02	1.02
Weekend		3.869	3.845	0.96	0.96	0.96
ADWF[1]		4.030	4.053	1.00	1.00	1.00
% Error						
Weekday			1.0%			
Weekend			-0.6%			

Notes:

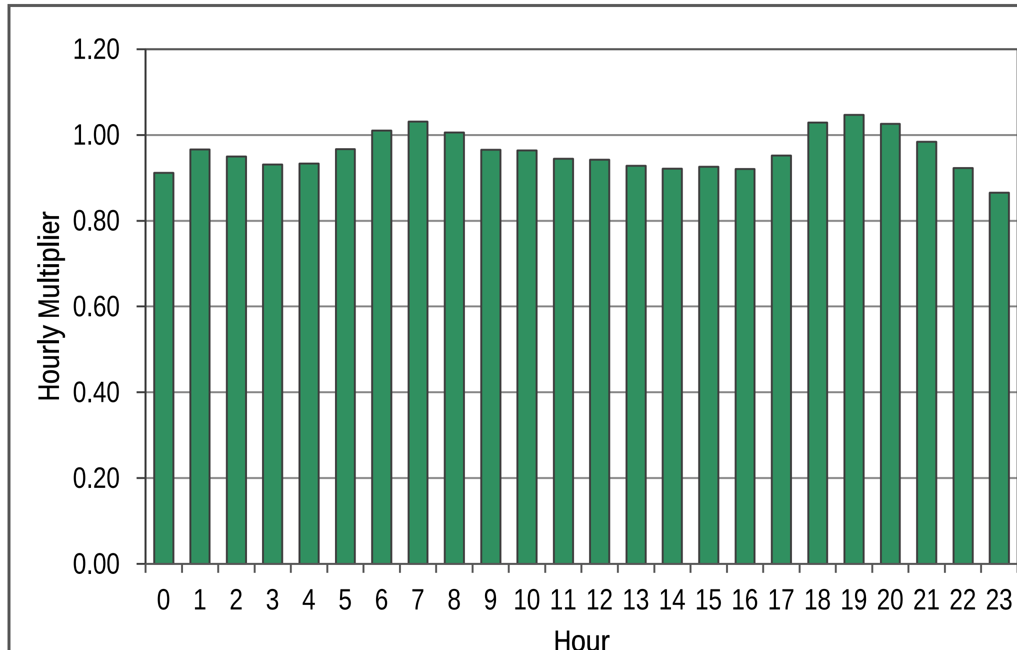
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

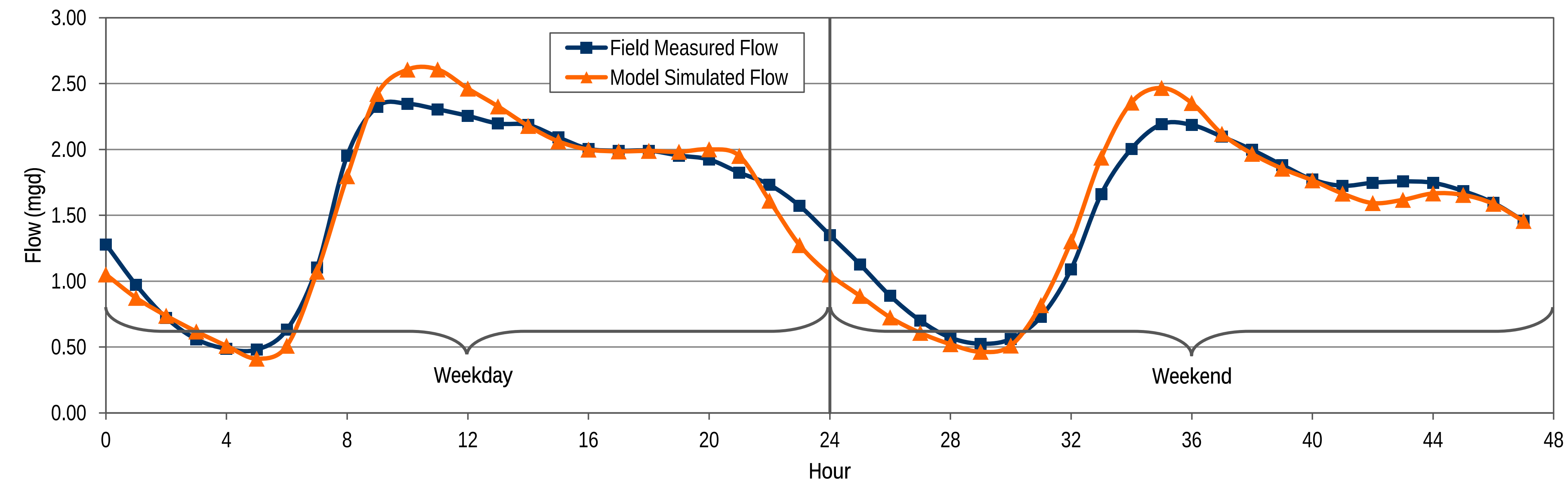
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52B DRY WEATHER CALIBRATION

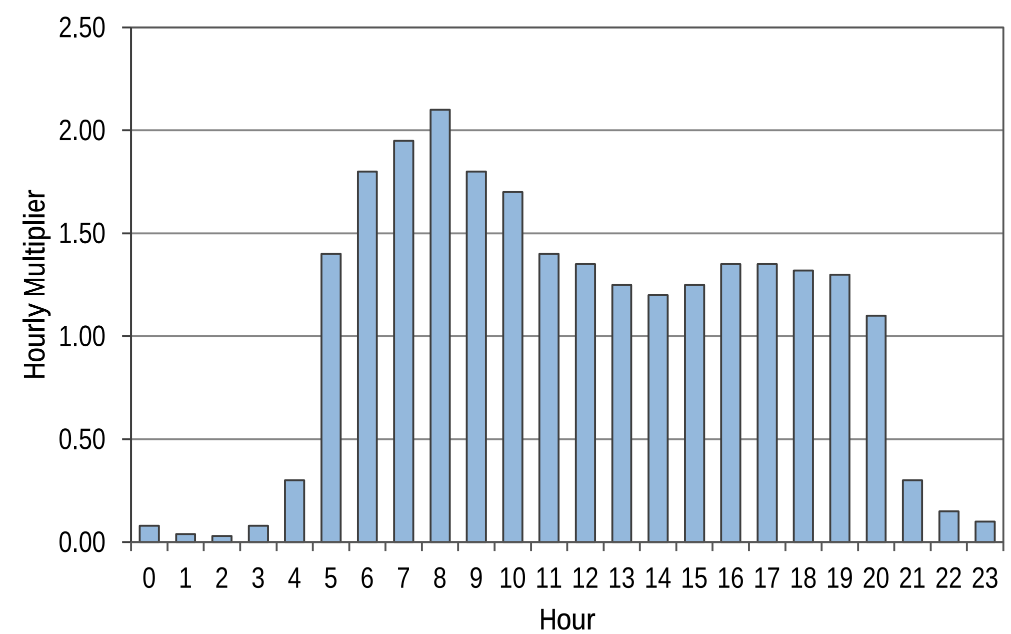
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.279	1.051	0.81	0.62	0.08
	1	0.971	0.874	0.62	0.46	0.04
	2	0.721	0.738	0.46	0.35	0.03
	3	0.559	0.618	0.35	0.31	0.08
	4	0.487	0.509	0.31	0.31	0.30
	5	0.480	0.412	0.31	0.40	1.40
	6	0.632	0.510	0.40	0.70	1.80
	7	1.104	1.072	0.70	1.24	1.95
	8	1.953	1.797	1.24	1.48	2.10
	9	2.324	2.421	1.48	1.49	1.80
	10	2.346	2.606	1.49	1.46	1.70
	11	2.304	2.607	1.46	1.43	1.40
	12	2.254	2.462	1.43	1.40	1.35
	13	2.196	2.327	1.40	1.39	1.25
	14	2.186	2.179	1.39	1.33	1.20
	15	2.091	2.061	1.33	1.27	1.25
	16	2.004	1.999	1.27	1.26	1.35
	17	1.990	1.986	1.26	1.26	1.35
	18	1.990	1.989	1.26	1.24	1.32
	19	1.953	1.982	1.24	1.22	1.30
	20	1.923	2.001	1.22	1.16	1.10
	21	1.823	1.951	1.16	1.10	0.30
	22	1.731	1.611	1.10	1.00	0.15
	23	1.571	1.274	1.00	0.81	0.10
Weekend	24	1.350	1.051	0.86	0.72	0.08
	25	1.127	0.889	0.72	0.56	0.04
	26	0.889	0.725	0.56	0.44	0.05
	27	0.700	0.608	0.44	0.36	0.15
	28	0.571	0.522	0.36	0.33	0.30
	29	0.525	0.464	0.33	0.36	0.80
	30	0.560	0.512	0.36	0.46	1.30
	31	0.729	0.818	0.46	0.69	1.90
	32	1.090	1.303	0.69	1.05	2.00
	33	1.660	1.938	1.05	1.27	1.90
	34	2.004	2.356	1.27	1.39	1.60
	35	2.191	2.467	1.39	1.39	1.30
	36	2.185	2.352	1.39	1.33	1.00
	37	2.097	2.118	1.33	1.27	1.05
	38	1.997	1.967	1.27	1.19	1.00
	39	1.881	1.854	1.19	1.13	0.95
	40	1.771	1.766	1.13	1.09	0.92
	41	1.724	1.665	1.09	1.11	1.05
	42	1.747	1.593	1.11	1.12	1.15
	43	1.757	1.617	1.12	1.11	1.09
	44	1.746	1.666	1.11	1.07	1.00
	45	1.684	1.655	1.07	1.01	0.84
	46	1.594	1.588	1.01	0.93	0.50
	47	1.458	1.458	0.93	0.86	0.30
Average						
Weekday		1.620	1.627	1.03	1.03	1.03
Weekend		1.460	1.456	0.93	0.93	0.93
ADWF[1]		1.574	1.578	1.00	1.00	1.00
% Error						
Weekday			0.4%			
Weekend			-0.2%			

Notes:

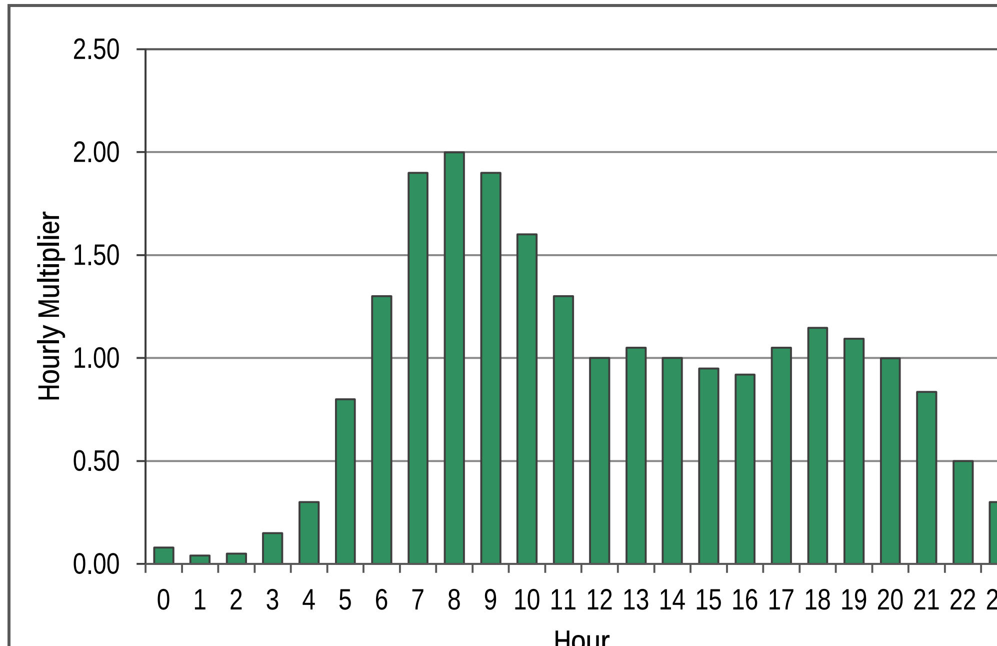
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

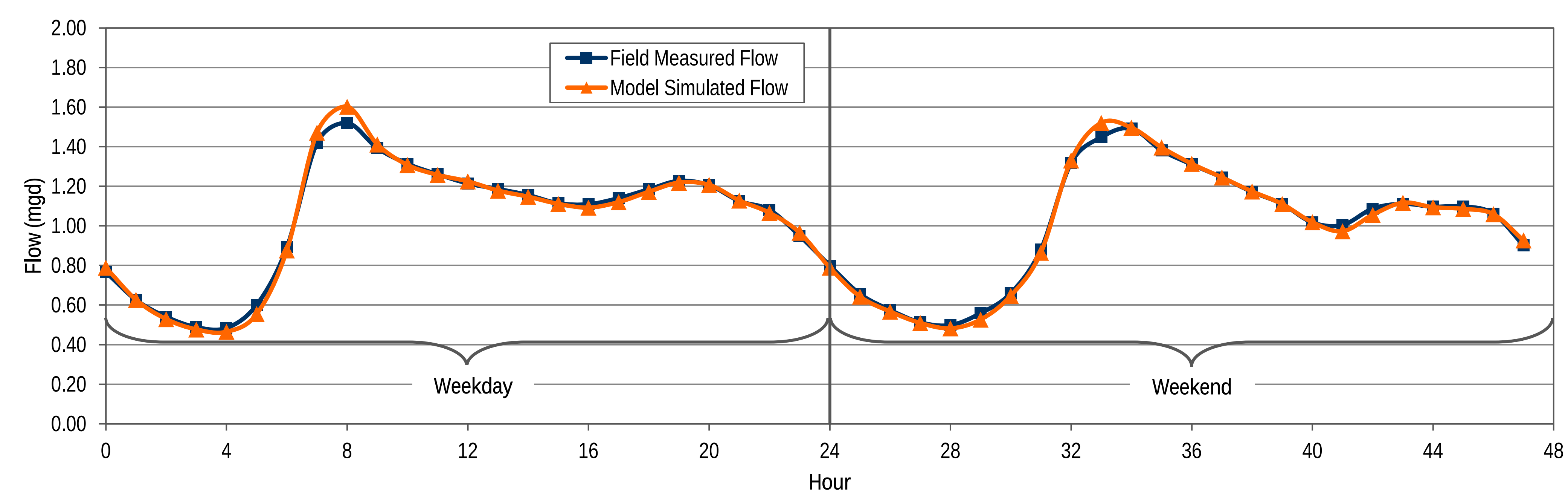
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52C DRY WEATHER CALIBRATION

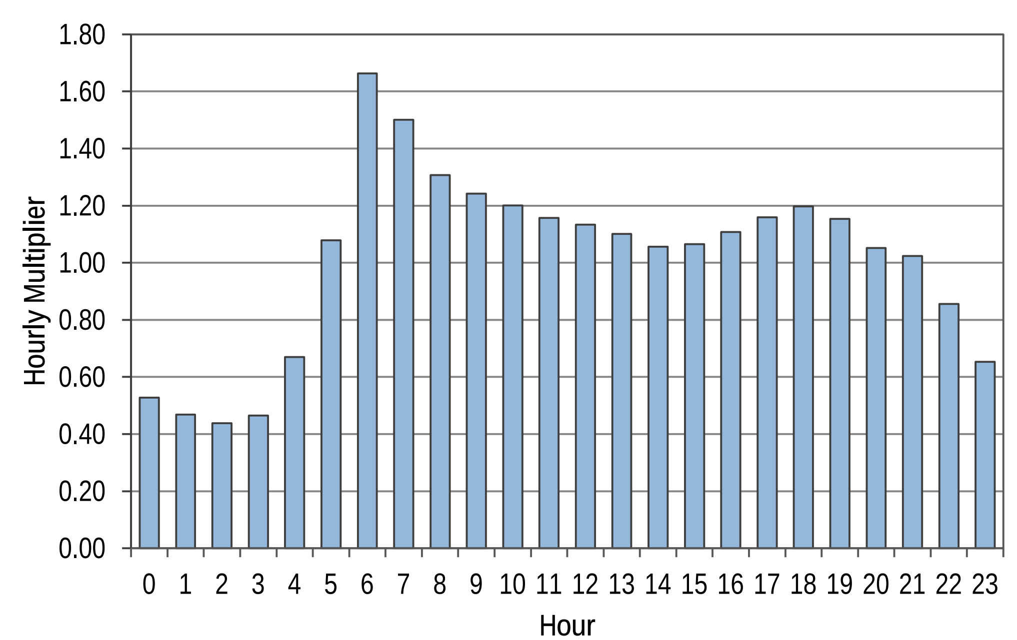
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.766	0.788	0.74	0.61	0.53
	1	0.626	0.626	0.61	0.52	0.47
	2	0.540	0.529	0.52	0.47	0.44
	3	0.488	0.476	0.47	0.47	0.47
	4	0.484	0.465	0.47	0.58	0.67
	5	0.601	0.555	0.58	0.87	1.08
	6	0.891	0.876	0.87	1.38	1.66
	7	1.419	1.471	1.38	1.48	1.50
	8	1.520	1.601	1.48	1.35	1.31
	9	1.393	1.411	1.35	1.28	1.24
	10	1.314	1.307	1.28	1.22	1.20
	11	1.261	1.257	1.22	1.18	1.16
	12	1.214	1.225	1.18	1.15	1.13
	13	1.186	1.178	1.15	1.12	1.10
	14	1.156	1.147	1.12	1.08	1.06
	15	1.114	1.111	1.08	1.08	1.06
	16	1.109	1.092	1.08	1.11	1.11
	17	1.140	1.120	1.11	1.15	1.16
	18	1.184	1.172	1.15	1.19	1.20
	19	1.227	1.218	1.19	1.17	1.15
	20	1.205	1.207	1.17	1.09	1.05
	21	1.125	1.128	1.09	1.05	1.02
	22	1.081	1.066	1.05	0.92	0.86
	23	0.950	0.965	0.92	0.74	0.65
Weekend	24	0.799	0.789	0.78	0.64	0.57
	25	0.656	0.642	0.64	0.56	0.51
	26	0.575	0.567	0.56	0.50	0.46
	27	0.512	0.509	0.50	0.48	0.47
	28	0.499	0.482	0.48	0.54	0.58
	29	0.559	0.526	0.54	0.64	0.71
	30	0.660	0.647	0.64	0.86	1.00
	31	0.881	0.864	0.86	1.28	1.52
	32	1.317	1.330	1.28	1.41	1.45
	33	1.448	1.520	1.41	1.45	1.46
	34	1.492	1.496	1.45	1.34	1.30
	35	1.382	1.396	1.34	1.27	1.24
	36	1.311	1.314	1.27	1.21	1.18
	37	1.245	1.244	1.21	1.14	1.11
	38	1.172	1.174	1.14	1.08	1.05
	39	1.111	1.110	1.08	0.99	0.93
	40	1.017	1.018	0.99	0.98	0.96
	41	1.004	0.972	0.98	1.06	1.09
	42	1.087	1.055	1.06	1.08	1.08
	43	1.111	1.117	1.08	1.07	1.05
	44	1.097	1.094	1.07	1.07	1.06
	45	1.098	1.085	1.07	1.03	1.01
	46	1.062	1.059	1.03	0.88	0.80
	47	0.902	0.926	0.88	0.78	0.71
Average						
	Weekday	1.041	1.041	1.01	1.01	1.01
	Weekend	1.000	0.997	0.97	0.97	0.97
	ADWF[1]	1.030	1.029	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.2%			

Notes:

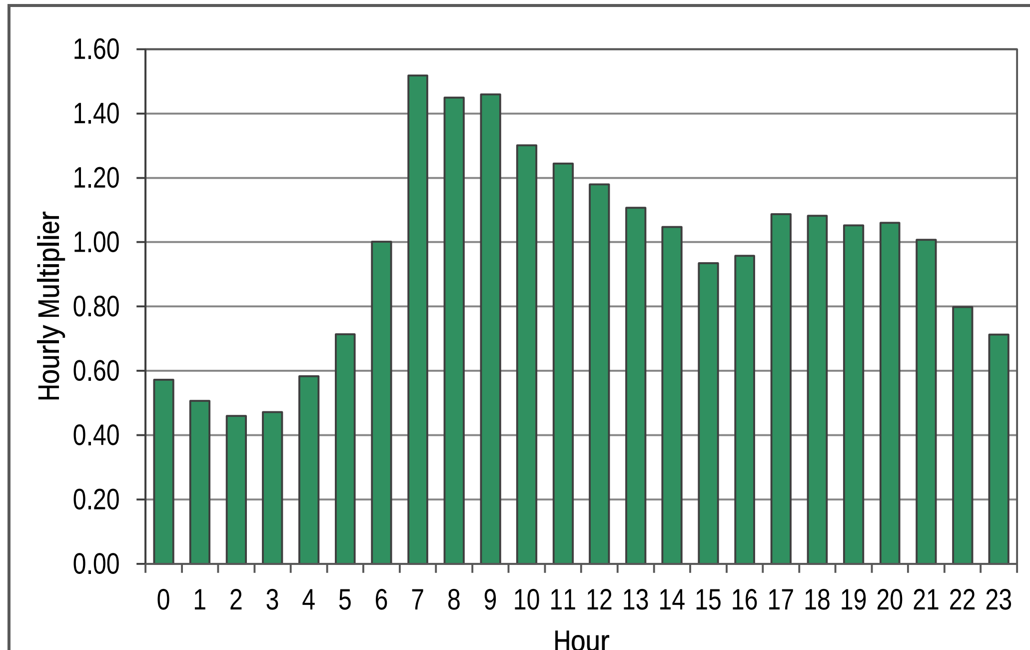
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

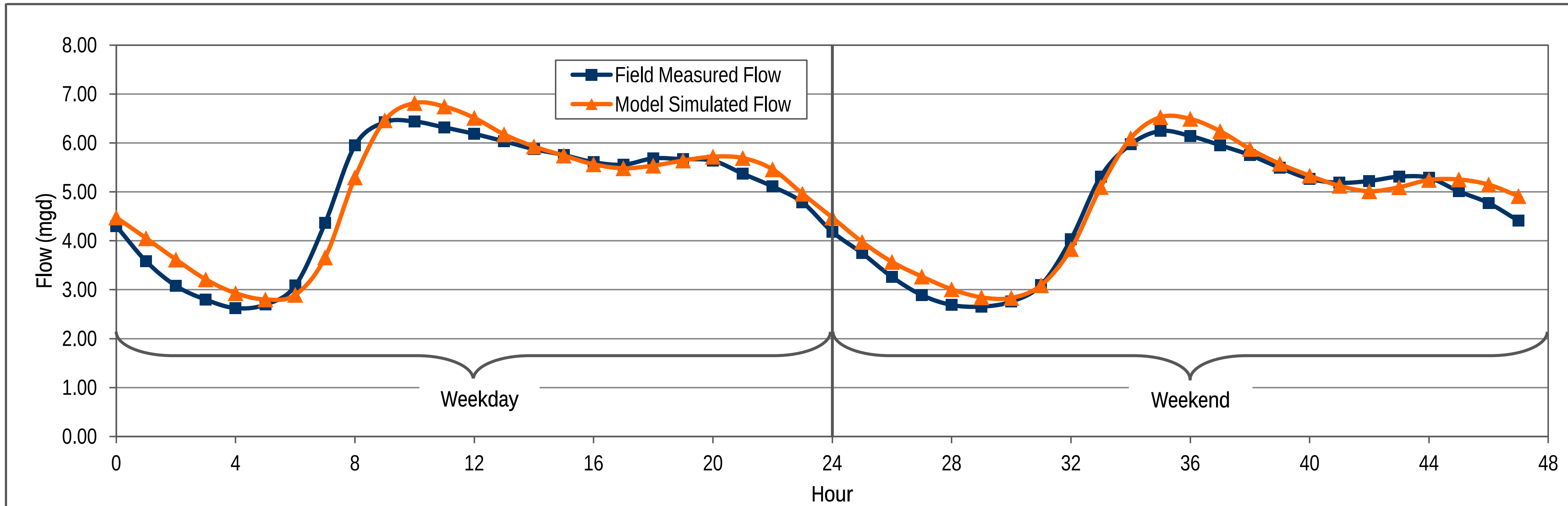
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52-1 DRY WEATHER CALIBRATION

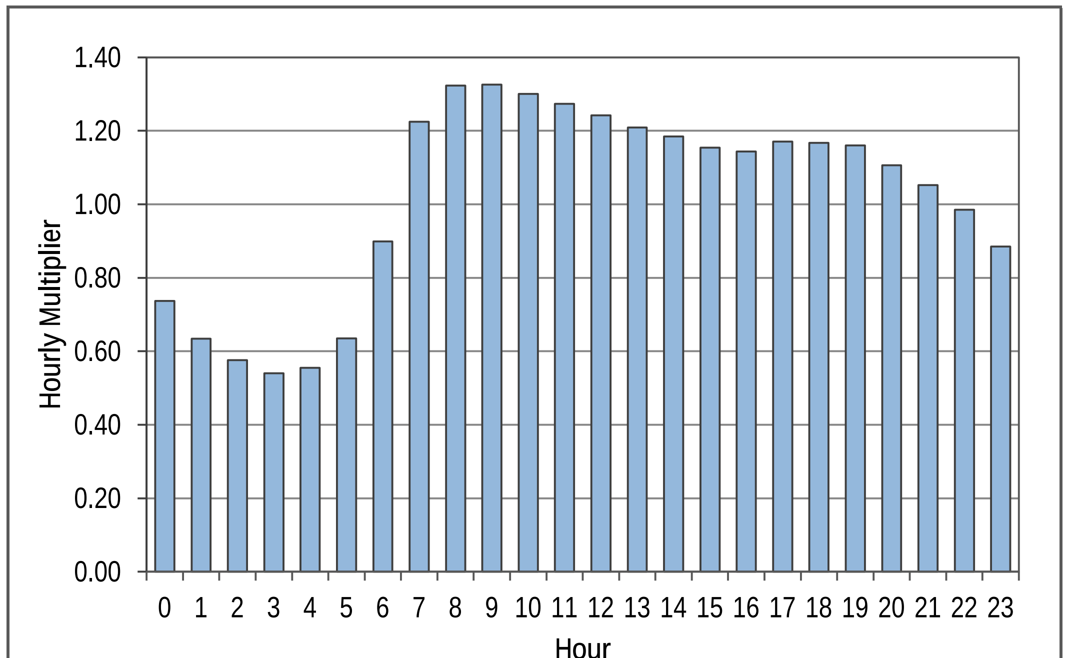
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	4.301	4.477	0.89	0.74	0.74
	1	3.582	4.053	0.74	0.63	0.63
	2	3.079	3.617	0.63	0.58	0.58
	3	2.798	3.211	0.58	0.54	0.54
	4	2.625	2.929	0.54	0.56	0.56
	5	2.698	2.801	0.56	0.64	0.64
	6	3.086	2.896	0.64	0.90	0.90
	7	4.366	3.661	0.90	1.22	1.22
	8	5.949	5.297	1.22	1.32	1.32
	9	6.427	6.463	1.32	1.33	1.33
	10	6.440	6.817	1.33	1.30	1.30
	11	6.318	6.746	1.30	1.27	1.27
	12	6.187	6.514	1.27	1.24	1.24
	13	6.035	6.177	1.24	1.21	1.21
	14	5.875	5.929	1.21	1.18	1.18
	15	5.754	5.744	1.18	1.15	1.15
	16	5.608	5.564	1.15	1.14	1.14
	17	5.557	5.484	1.14	1.17	1.17
	18	5.686	5.537	1.17	1.17	1.17
	19	5.669	5.642	1.17	1.16	1.16
	20	5.638	5.720	1.16	1.11	1.11
	21	5.373	5.693	1.11	1.05	1.05
	22	5.110	5.461	1.05	0.99	0.99
	23	4.786	4.963	0.99	0.89	0.89
Weekend	24	4.185	4.476	0.86	0.77	0.77
	25	3.748	3.977	0.77	0.67	0.67
	26	3.262	3.569	0.67	0.60	0.60
	27	2.892	3.269	0.60	0.55	0.55
	28	2.689	3.010	0.55	0.55	0.55
	29	2.656	2.844	0.55	0.57	0.57
	30	2.758	2.832	0.57	0.64	0.64
	31	3.098	3.092	0.64	0.83	0.83
	32	4.030	3.832	0.83	1.09	1.09
	33	5.315	5.100	1.09	1.23	1.23
	34	5.971	6.096	1.23	1.29	1.29
	35	6.246	6.528	1.29	1.26	1.26
	36	6.144	6.493	1.26	1.23	1.23
	37	5.955	6.243	1.23	1.18	1.18
	38	5.754	5.879	1.18	1.13	1.13
	39	5.494	5.576	1.13	1.08	1.08
	40	5.270	5.332	1.08	1.07	1.07
	41	5.186	5.126	1.07	1.08	1.08
	42	5.224	5.013	1.08	1.09	1.09
	43	5.313	5.096	1.09	1.09	1.09
	44	5.289	5.245	1.09	1.03	1.03
	45	5.011	5.255	1.03	0.98	0.98
	46	4.773	5.150	0.98	0.91	0.91
	47	4.411	4.914	0.91	0.86	0.86
Average						
Weekday		4.956	5.058	1.02	1.02	1.02
Weekend		4.611	4.748	0.95	0.95	0.95
ADWF[(1)]		4.858	4.969	1.00	1.00	1.00
% Error						
Weekday			2.1%			
Weekend			3.0%			

Notes:

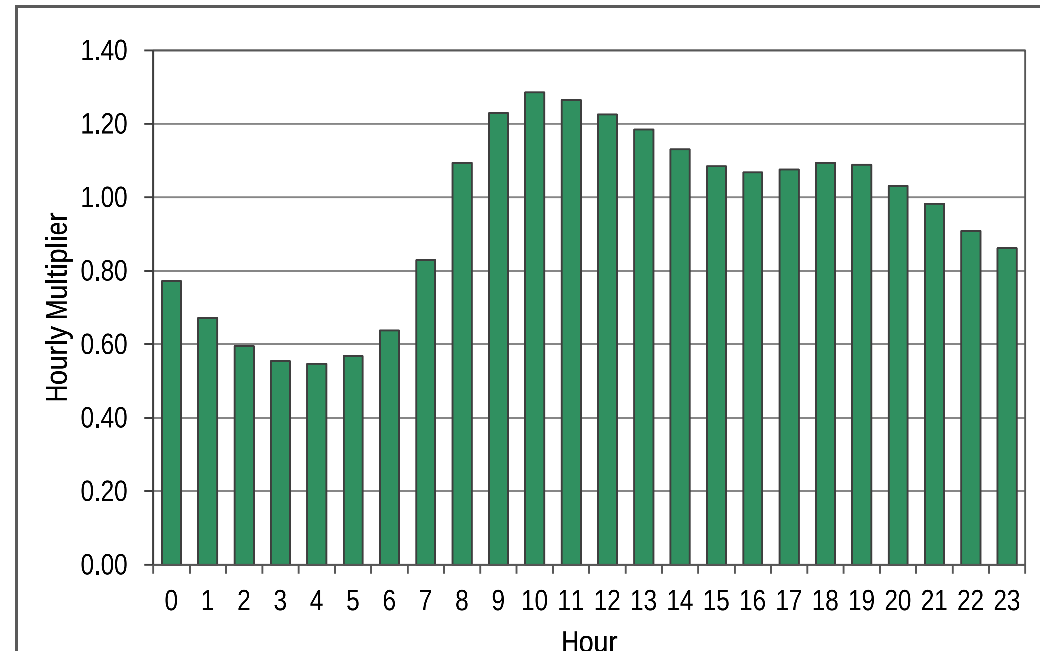
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

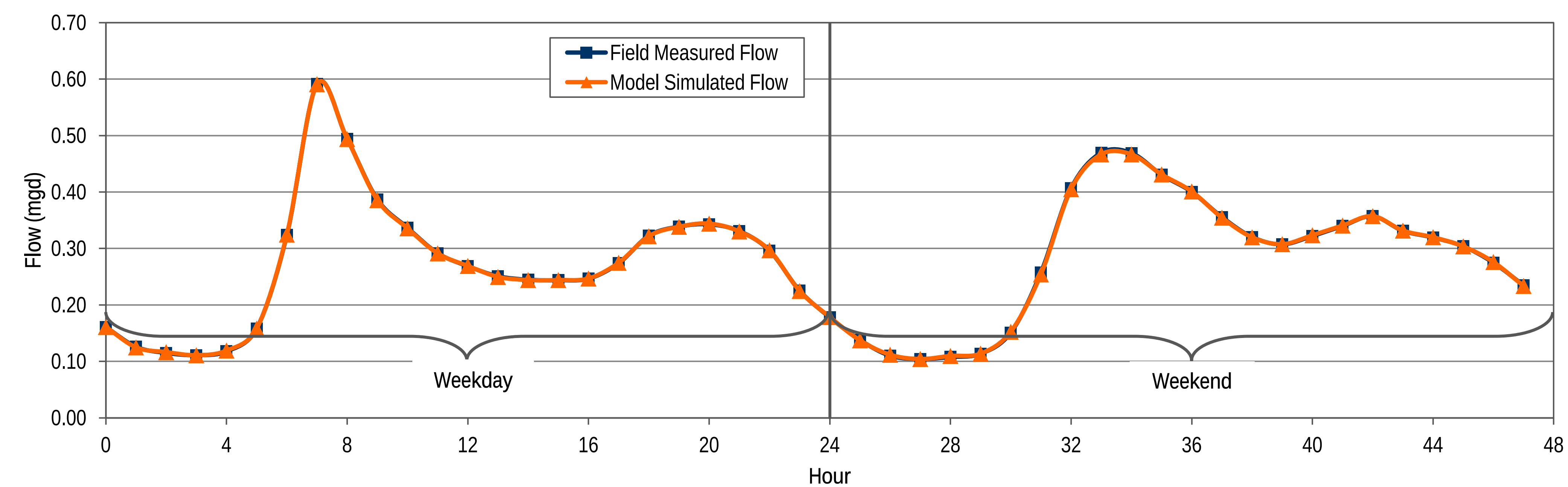
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S1 DRY WEATHER CALIBRATION

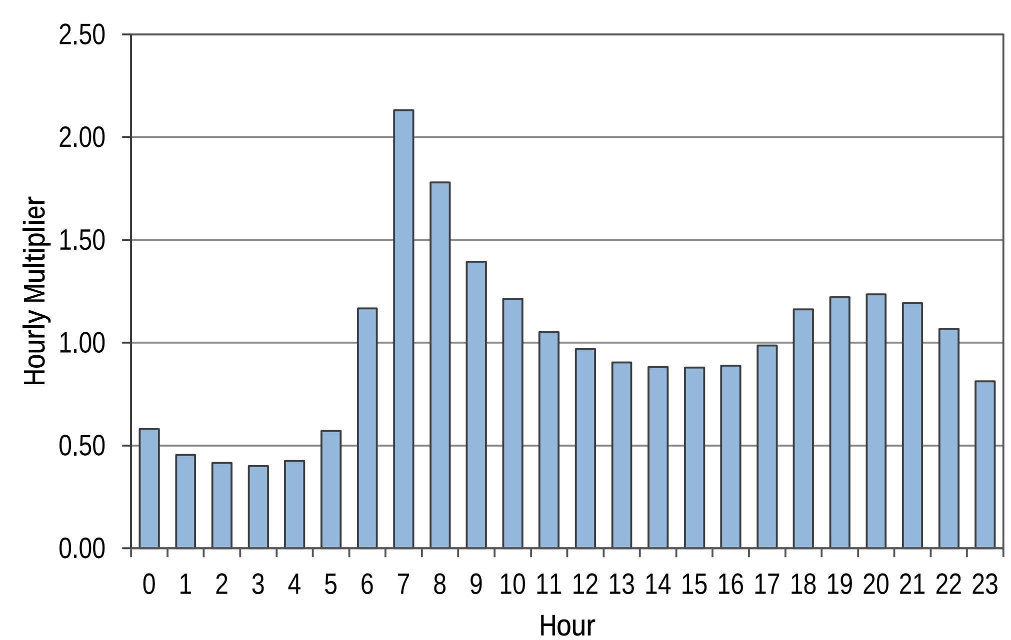
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.161	0.161	0.58	0.58	0.58
	1	0.126	0.125	0.45	0.45	0.45
	2	0.115	0.117	0.42	0.42	0.42
	3	0.111	0.111	0.40	0.40	0.40
	4	0.118	0.119	0.43	0.43	0.43
	5	0.158	0.158	0.57	0.57	0.57
	6	0.324	0.325	1.17	1.17	1.17
	7	0.591	0.591	2.13	2.13	2.13
	8	0.494	0.494	1.78	1.78	1.78
	9	0.387	0.386	1.39	1.39	1.39
	10	0.337	0.336	1.21	1.21	1.21
	11	0.292	0.291	1.05	1.05	1.05
	12	0.269	0.269	0.97	0.97	0.97
	13	0.251	0.250	0.90	0.90	0.90
	14	0.245	0.244	0.88	0.88	0.88
	15	0.244	0.244	0.88	0.88	0.88
	16	0.247	0.247	0.89	0.89	0.89
	17	0.274	0.275	0.99	0.99	0.99
	18	0.323	0.322	1.16	1.16	1.16
	19	0.339	0.338	1.22	1.22	1.22
	20	0.343	0.344	1.24	1.24	1.24
	21	0.331	0.330	1.19	1.19	1.19
	22	0.296	0.297	1.07	1.07	1.07
	23	0.225	0.225	0.81	0.81	0.81
Weekend	24	0.178	0.179	0.64	0.64	0.64
	25	0.138	0.137	0.50	0.50	0.50
	26	0.110	0.112	0.40	0.40	0.40
	27	0.105	0.104	0.38	0.38	0.38
	28	0.108	0.110	0.39	0.39	0.39
	29	0.114	0.114	0.41	0.41	0.41
	30	0.151	0.153	0.54	0.54	0.54
	31	0.257	0.254	0.93	0.93	0.93
	32	0.406	0.405	1.47	1.47	1.47
	33	0.469	0.467	1.69	1.69	1.69
	34	0.469	0.467	1.69	1.69	1.69
	35	0.431	0.431	1.55	1.55	1.55
	36	0.400	0.401	1.44	1.44	1.44
	37	0.356	0.355	1.28	1.28	1.28
	38	0.320	0.320	1.15	1.15	1.15
	39	0.307	0.308	1.11	1.11	1.11
	40	0.322	0.323	1.16	1.16	1.16
	41	0.340	0.341	1.23	1.23	1.23
	42	0.357	0.357	1.29	1.29	1.29
	43	0.331	0.332	1.19	1.19	1.19
	44	0.320	0.320	1.15	1.15	1.15
	45	0.304	0.304	1.10	1.10	1.10
	46	0.275	0.276	0.99	0.99	0.99
	47	0.235	0.234	0.85	0.85	0.85
Average						
	Weekday	0.275	0.275	0.99	0.99	0.99
	Weekend	0.284	0.283	1.02	1.02	1.02
	ADWF[1]	0.277	0.277	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.1%			

Notes:

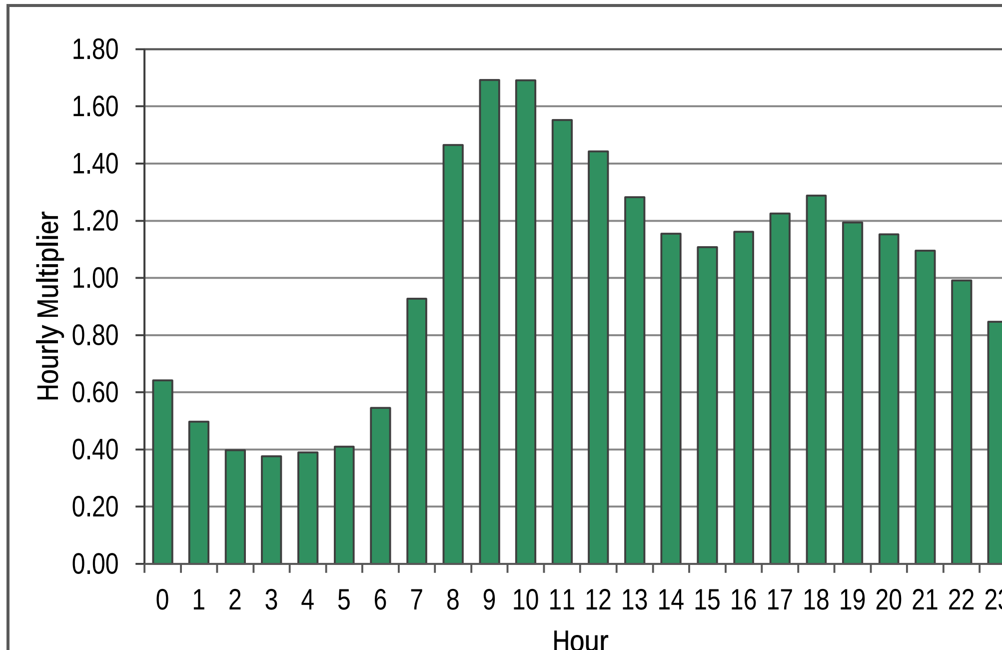
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

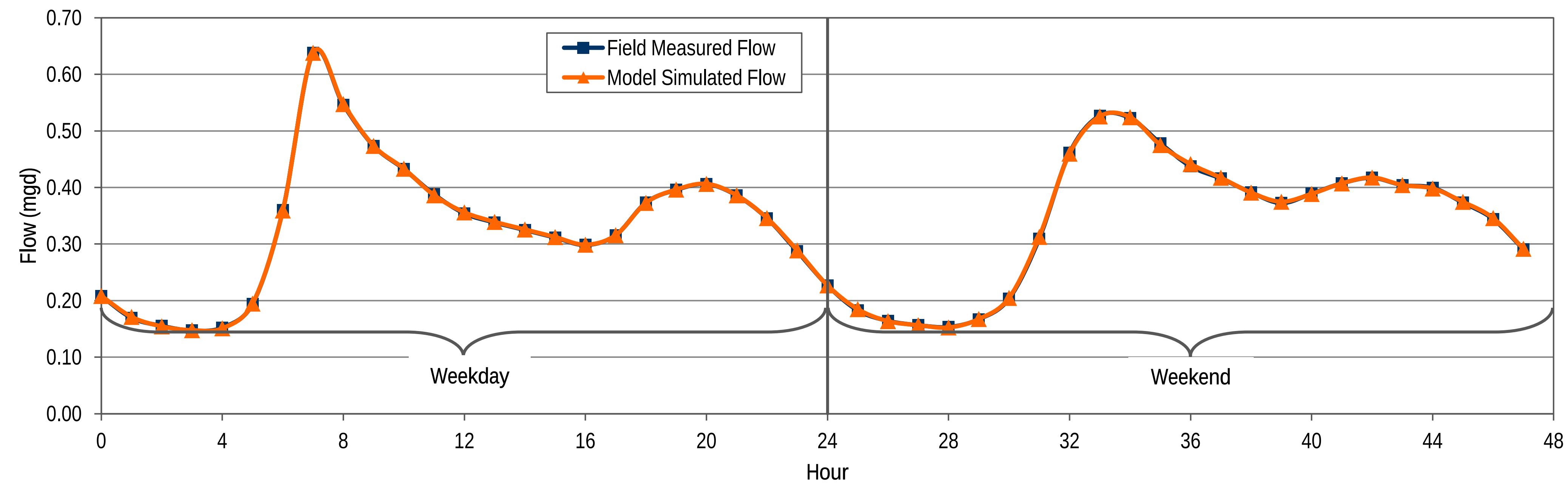
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S2 DRY WEATHER CALIBRATION

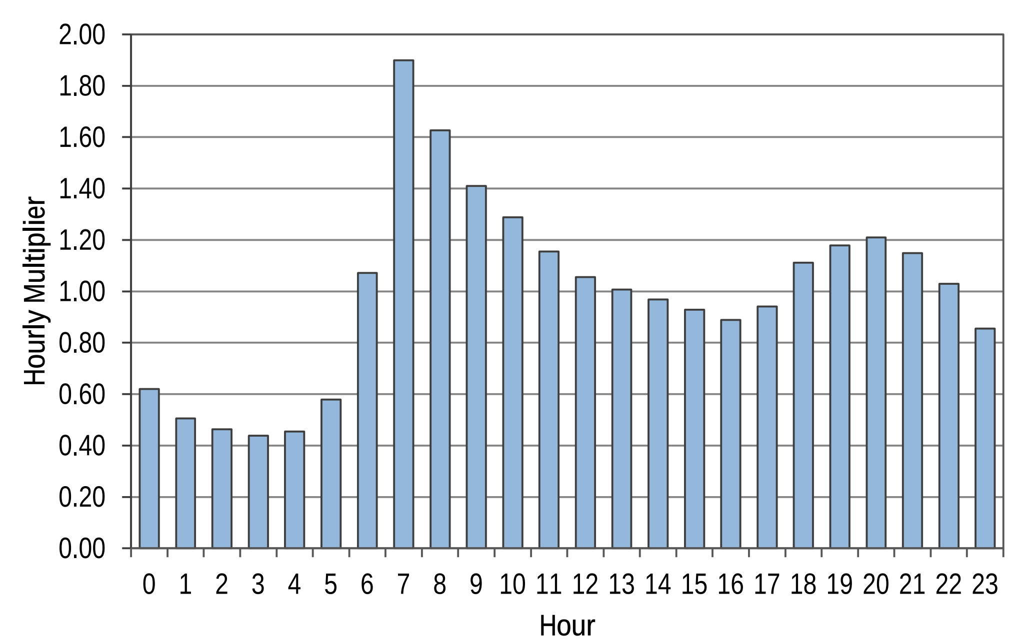
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.208	0.208	0.62	0.62	0.62
	1	0.170	0.171	0.51	0.51	0.51
	2	0.155	0.154	0.46	0.46	0.46
	3	0.147	0.148	0.44	0.44	0.44
	4	0.153	0.151	0.45	0.45	0.45
	5	0.194	0.195	0.58	0.58	0.58
	6	0.360	0.359	1.07	1.07	1.07
	7	0.638	0.638	1.90	1.90	1.90
	8	0.546	0.547	1.63	1.63	1.63
	9	0.473	0.473	1.41	1.41	1.41
	10	0.433	0.433	1.29	1.29	1.29
	11	0.388	0.386	1.15	1.15	1.15
	12	0.354	0.356	1.06	1.06	1.06
	13	0.338	0.339	1.01	1.01	1.01
	14	0.325	0.326	0.97	0.97	0.97
	15	0.312	0.312	0.93	0.93	0.93
	16	0.299	0.299	0.89	0.89	0.89
	17	0.316	0.316	0.94	0.94	0.94
	18	0.373	0.373	1.11	1.11	1.11
	19	0.396	0.396	1.18	1.18	1.18
	20	0.406	0.406	1.21	1.21	1.21
	21	0.386	0.386	1.15	1.15	1.15
	22	0.346	0.346	1.03	1.03	1.03
	23	0.287	0.289	0.86	0.86	0.86
Weekend	24	0.227	0.227	0.68	0.68	0.68
	25	0.183	0.185	0.54	0.54	0.54
	26	0.164	0.164	0.49	0.49	0.49
	27	0.157	0.157	0.47	0.47	0.47
	28	0.154	0.153	0.46	0.46	0.46
	29	0.167	0.168	0.50	0.50	0.50
	30	0.204	0.205	0.61	0.61	0.61
	31	0.310	0.313	0.92	0.92	0.92
	32	0.461	0.460	1.37	1.37	1.37
	33	0.527	0.526	1.57	1.57	1.57
	34	0.523	0.524	1.56	1.56	1.56
	35	0.478	0.475	1.42	1.42	1.42
	36	0.438	0.441	1.30	1.30	1.30
	37	0.416	0.417	1.24	1.24	1.24
	38	0.391	0.391	1.17	1.17	1.17
	39	0.373	0.375	1.11	1.11	1.11
	40	0.389	0.389	1.16	1.16	1.16
	41	0.408	0.407	1.21	1.21	1.21
	42	0.417	0.417	1.24	1.24	1.24
	43	0.404	0.404	1.20	1.20	1.20
	44	0.400	0.398	1.19	1.19	1.19
	45	0.373	0.375	1.11	1.11	1.11
	46	0.344	0.346	1.03	1.03	1.03
	47	0.291	0.292	0.87	0.87	0.87
Average						
	Weekday	0.333	0.334	0.99	0.99	0.99
	Weekend	0.342	0.342	1.02	1.02	1.02
	ADWF[1]	0.336	0.336	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		0.1%			

Notes:

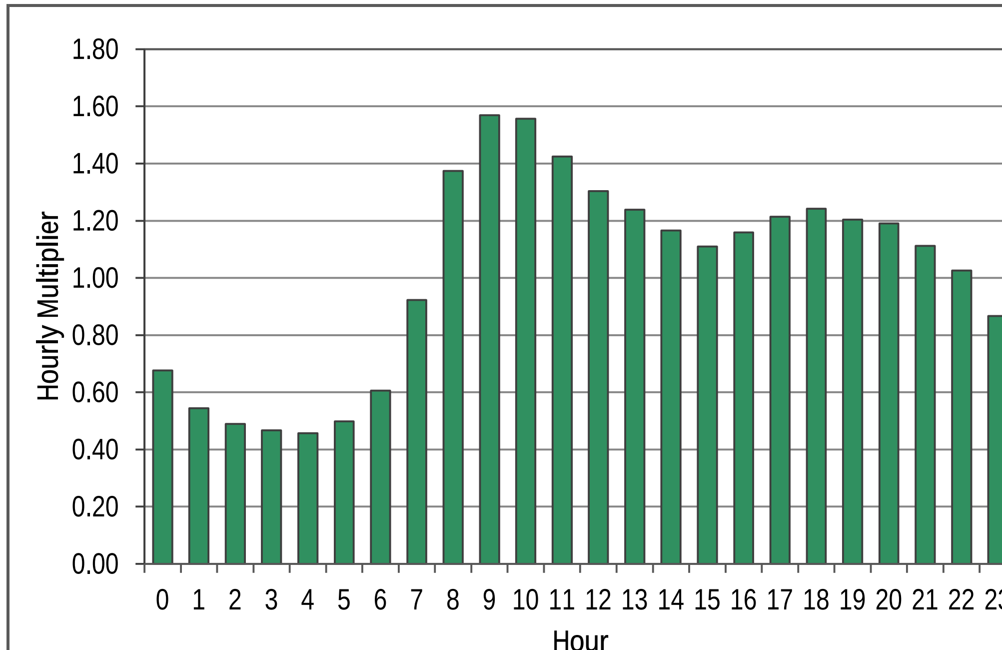
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

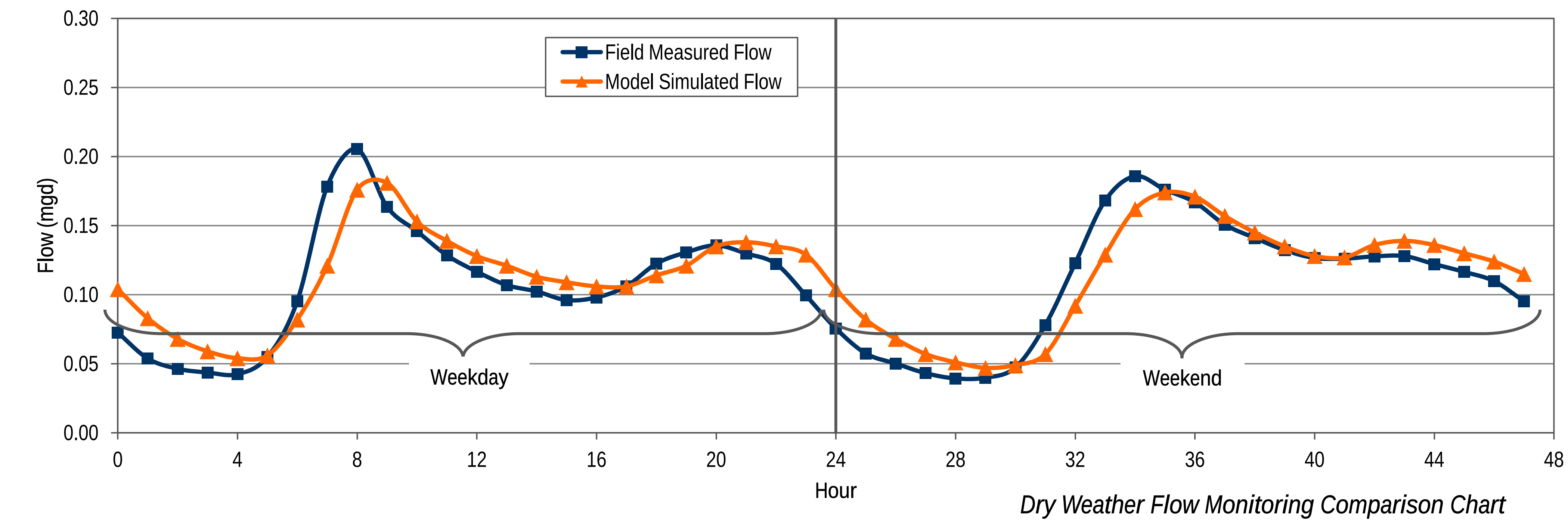
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.1 DRY WEATHER CALIBRATION

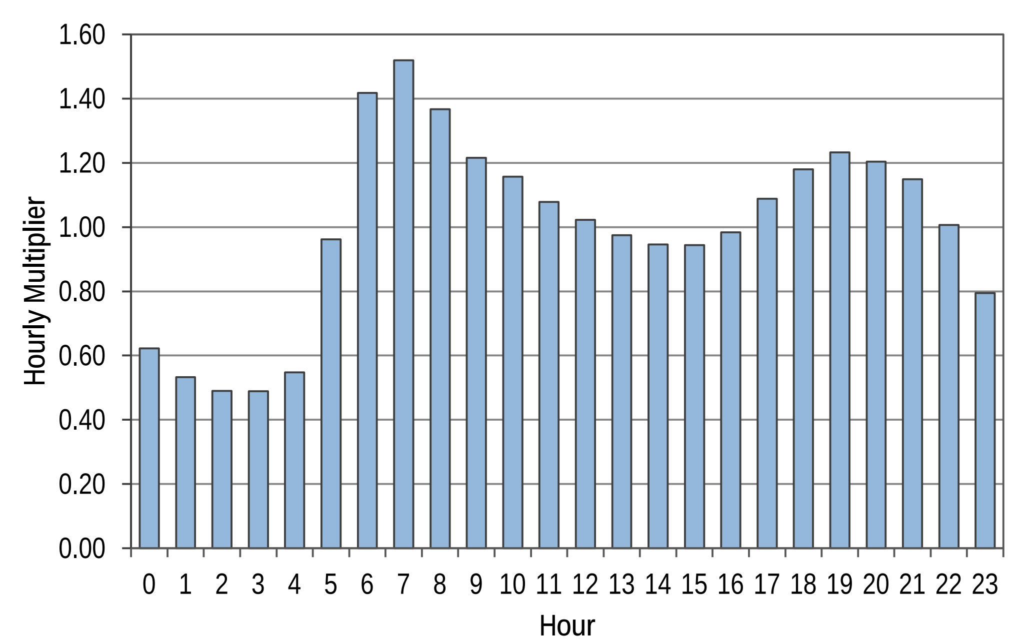
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.073	0.104	0.67	0.50	0.62
	1	0.054	0.083	0.50	0.43	0.53
	2	0.046	0.068	0.43	0.40	0.49
	3	0.044	0.059	0.40	0.39	0.49
	4	0.042	0.054	0.39	0.51	0.55
	5	0.055	0.056	0.51	0.88	0.96
	6	0.095	0.082	0.88	1.64	1.42
	7	0.178	0.121	1.64	1.89	1.52
	8	0.205	0.176	1.89	1.51	1.37
	9	0.164	0.181	1.51	1.34	1.22
	10	0.146	0.153	1.34	1.18	1.16
	11	0.128	0.139	1.18	1.07	1.08
	12	0.117	0.128	1.07	0.98	1.02
	13	0.107	0.121	0.98	0.94	0.97
	14	0.102	0.113	0.94	0.89	0.95
	15	0.096	0.109	0.89	0.90	0.94
	16	0.098	0.106	0.90	0.98	0.98
	17	0.106	0.106	0.98	1.13	1.09
	18	0.122	0.114	1.13	1.20	1.18
	19	0.131	0.121	1.20	1.25	1.23
	20	0.136	0.135	1.25	1.20	1.20
	21	0.130	0.138	1.20	1.13	1.15
	22	0.122	0.135	1.13	0.92	1.01
	23	0.099	0.129	0.92	0.67	0.79
Weekend	24	0.076	0.104	0.70	0.53	0.64
	25	0.057	0.082	0.53	0.46	0.52
	26	0.050	0.068	0.46	0.40	0.46
	27	0.043	0.057	0.40	0.36	0.43
	28	0.039	0.051	0.36	0.37	0.43
	29	0.040	0.047	0.37	0.44	0.49
	30	0.047	0.049	0.44	0.72	0.69
	31	0.078	0.057	0.72	1.13	1.05
	32	0.123	0.092	1.13	1.55	1.40
	33	0.168	0.129	1.55	1.71	1.52
	34	0.186	0.162	1.71	1.62	1.50
	35	0.176	0.174	1.62	1.54	1.43
	36	0.167	0.171	1.54	1.39	1.32
	37	0.151	0.157	1.39	1.30	1.23
	38	0.141	0.145	1.30	1.22	1.17
	39	0.132	0.135	1.22	1.17	1.12
	40	0.127	0.128	1.17	1.16	1.17
	41	0.126	0.127	1.16	1.18	1.24
	42	0.128	0.136	1.18	1.18	1.24
	43	0.128	0.139	1.18	1.12	1.18
	44	0.122	0.136	1.12	1.07	1.12
	45	0.116	0.130	1.07	1.01	1.07
	46	0.110	0.124	1.01	0.88	0.95
	47	0.095	0.115	0.88	0.70	0.82
Average						
Weekday		0.108	0.114	1.00	1.00	1.00
Weekend		0.109	0.113	1.01	1.01	1.01
ADWF[1]		0.109	0.114	1.00	1.00	1.00
% Error						
Weekday			5.2%			
Weekend			3.4%			

Notes:

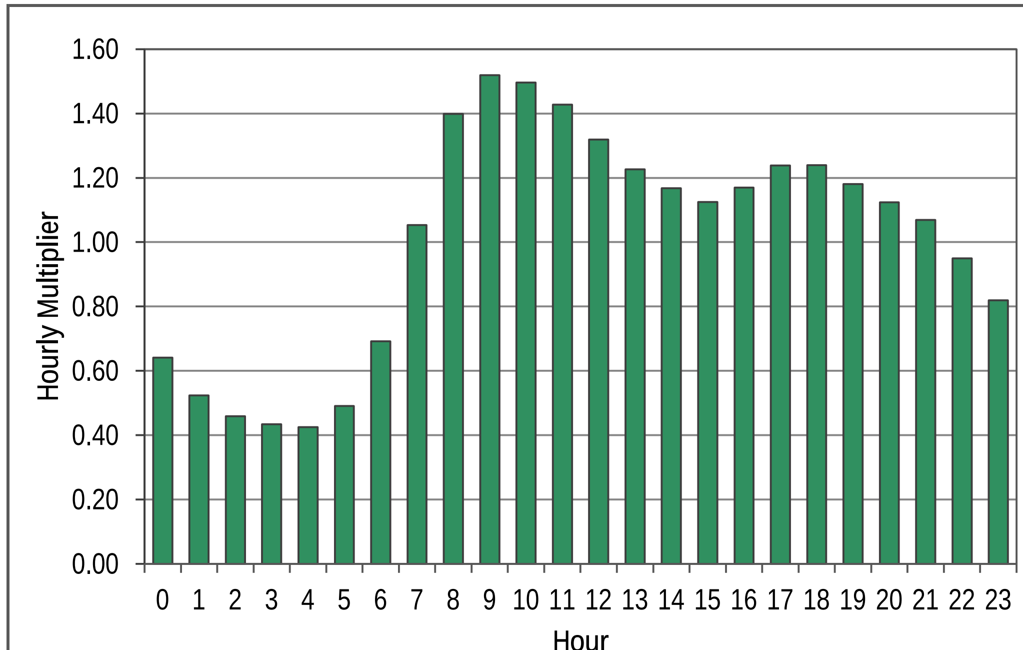
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

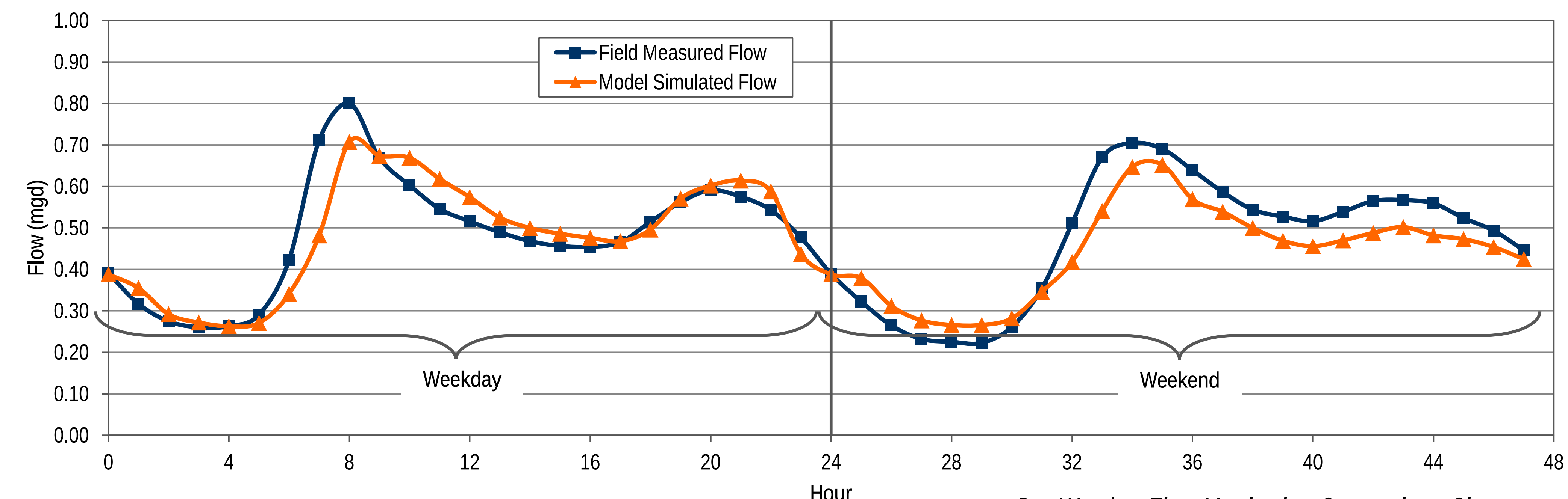
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.2 DRY WEATHER CALIBRATION

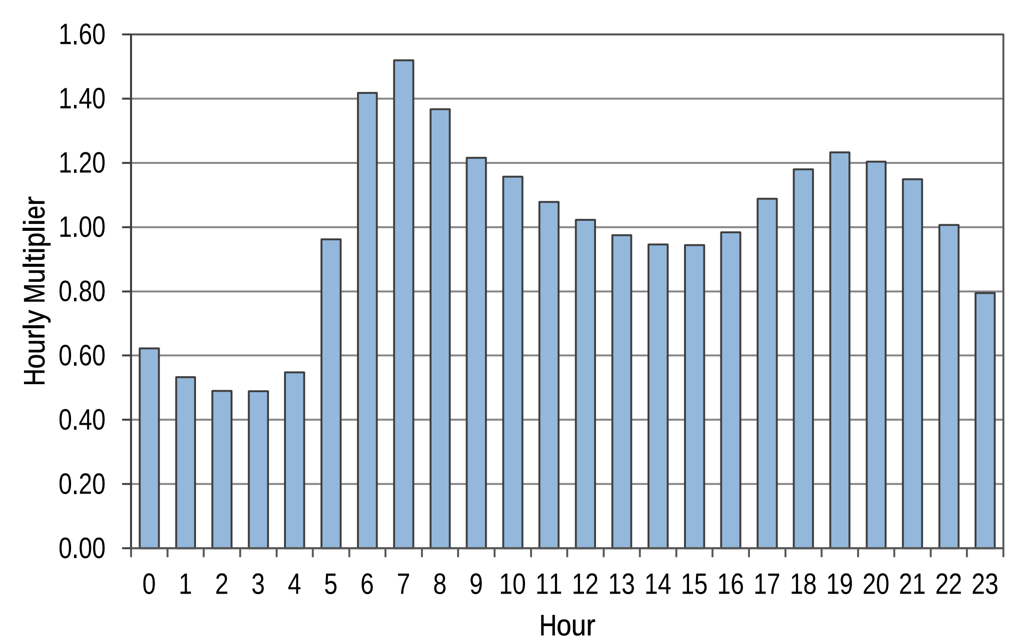
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.390	0.388	0.36	0.33	0.62
	1	0.317	0.355	0.33	0.27	0.53
	2	0.275	0.292	0.27	0.25	0.49
	3	0.261	0.272	0.25	0.24	0.49
	4	0.263	0.263	0.24	0.25	0.55
	5	0.291	0.271	0.25	0.31	0.96
	6	0.422	0.341	0.31	0.44	1.42
	7	0.711	0.482	0.44	0.65	1.52
	8	0.801	0.707	0.65	0.61	1.37
	9	0.669	0.674	0.61	0.59	1.22
	10	0.603	0.669	0.59	0.57	1.16
	11	0.546	0.618	0.57	0.52	1.08
	12	0.516	0.574	0.52	0.48	1.02
	13	0.490	0.525	0.48	0.46	0.97
	14	0.468	0.500	0.46	0.45	0.95
	15	0.457	0.486	0.45	0.44	0.94
	16	0.455	0.476	0.44	0.43	0.98
	17	0.465	0.468	0.43	0.46	1.09
	18	0.515	0.496	0.46	0.52	1.18
	19	0.562	0.571	0.52	0.54	1.23
	20	0.591	0.602	0.54	0.55	1.20
	21	0.575	0.614	0.55	0.53	1.15
	22	0.543	0.588	0.53	0.40	1.01
	23	0.477	0.437	0.40	0.36	0.79
Weekend	24	0.389	0.388	0.36	0.35	0.64
	25	0.323	0.379	0.35	0.29	0.52
	26	0.265	0.312	0.29	0.26	0.46
	27	0.232	0.277	0.26	0.25	0.43
	28	0.225	0.266	0.25	0.25	0.43
	29	0.223	0.266	0.25	0.26	0.49
	30	0.261	0.282	0.26	0.32	0.69
	31	0.355	0.346	0.32	0.38	1.05
	32	0.511	0.418	0.38	0.50	1.40
	33	0.670	0.541	0.50	0.59	1.52
	34	0.704	0.647	0.59	0.59	1.50
	35	0.690	0.652	0.59	0.55	1.43
	36	0.639	0.569	0.55	0.52	1.32
	37	0.587	0.539	0.52	0.49	1.23
	38	0.544	0.500	0.49	0.46	1.17
	39	0.527	0.469	0.46	0.44	1.12
	40	0.516	0.456	0.44	0.46	1.17
	41	0.539	0.470	0.46	0.47	1.24
	42	0.565	0.488	0.47	0.49	1.24
	43	0.567	0.502	0.49	0.47	1.18
	44	0.560	0.482	0.47	0.46	1.12
	45	0.524	0.473	0.46	0.44	1.07
	46	0.494	0.454	0.44	0.41	0.95
	47	0.446	0.425	0.41	0.36	0.82
Average						
Weekday		0.486	0.486	0.44	0.44	1.00
Weekend		0.473	0.442	0.42	0.42	1.01
ADWF[(1)]		0.482	0.473	0.44	0.44	1.00
% Error						
Weekday			0.0%			
Weekend			-6.7%			

Notes:

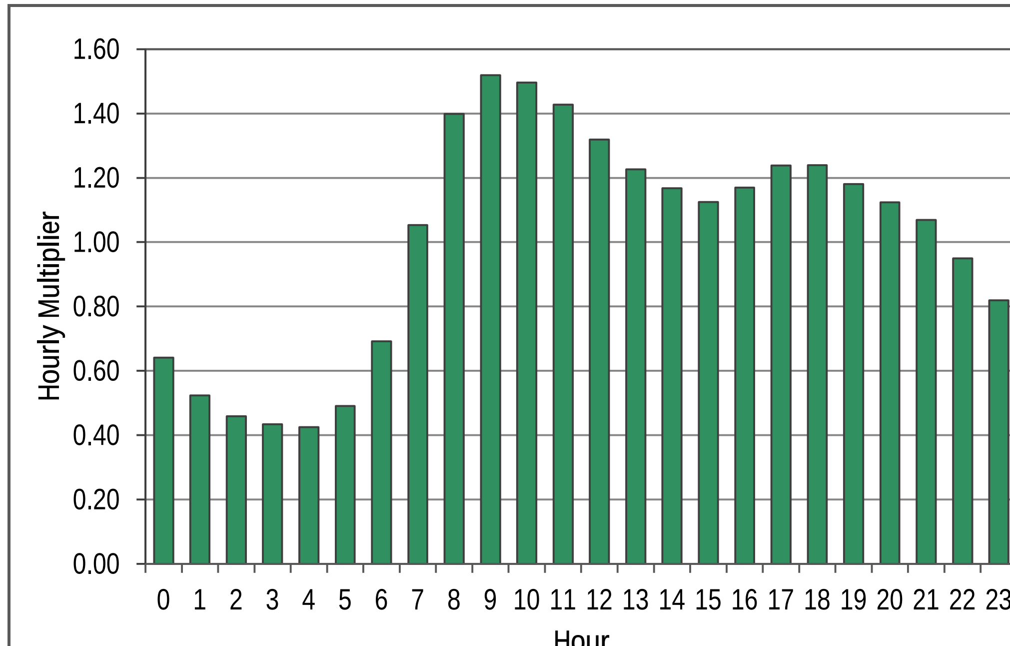
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

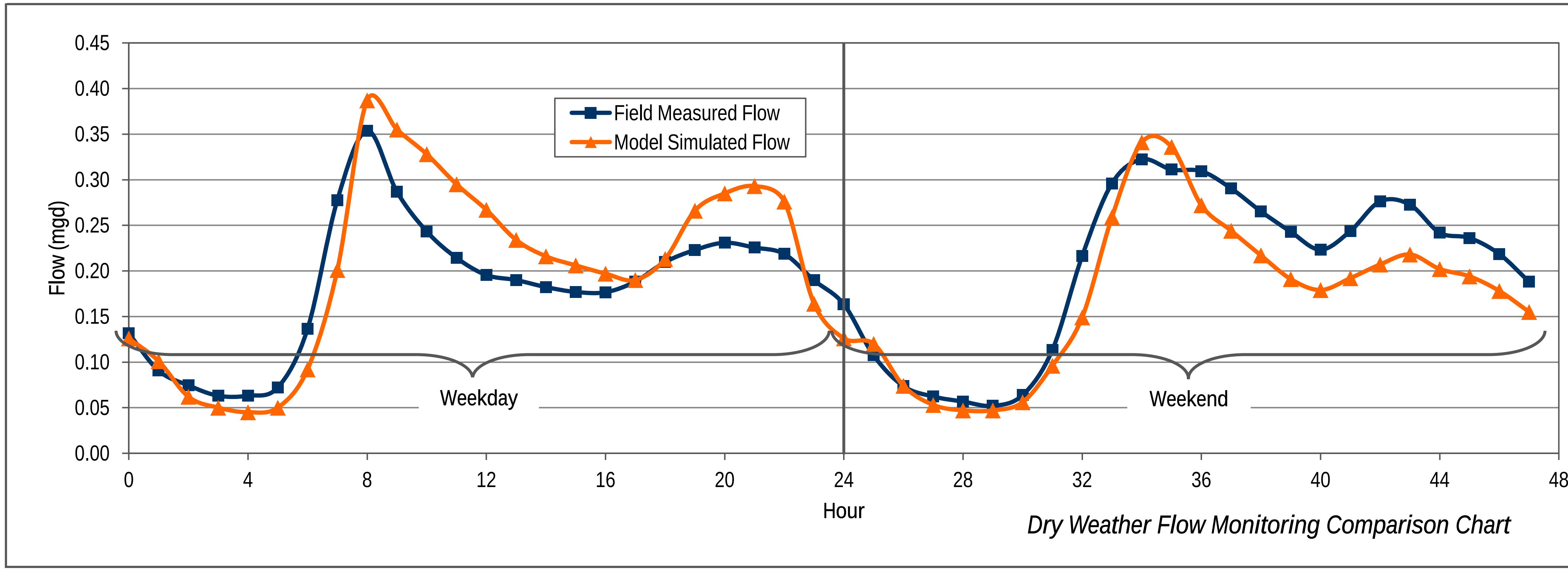
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.3 DRY WEATHER CALIBRATION

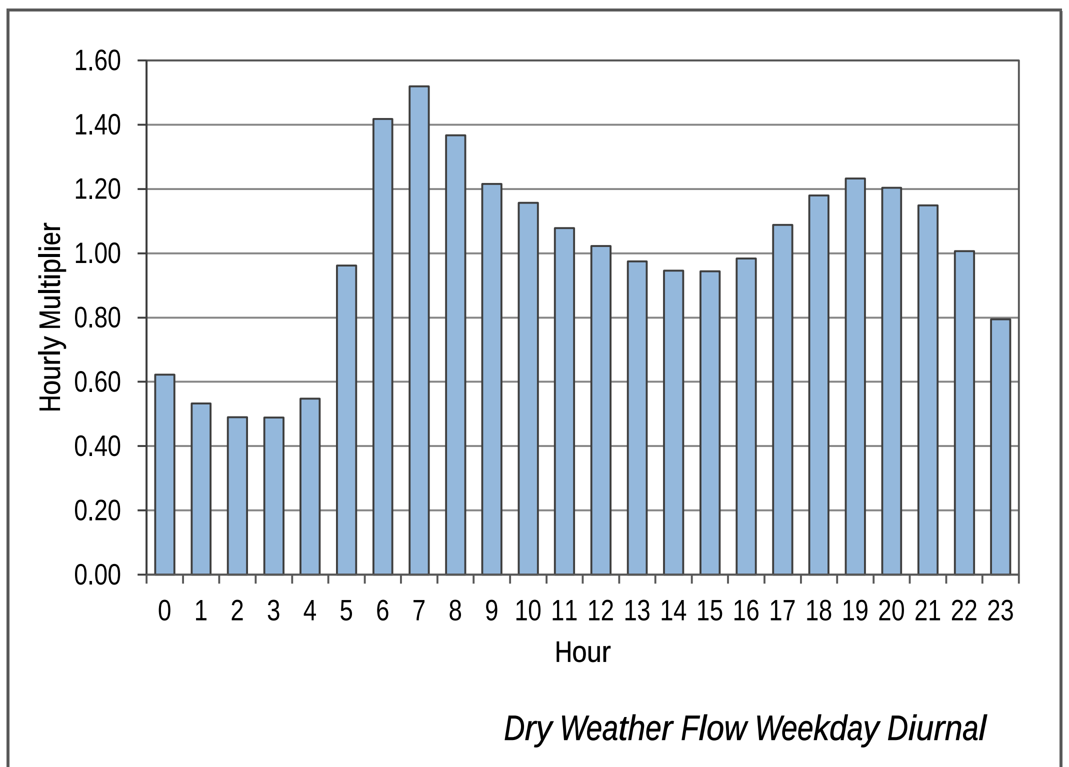
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.132	0.126	0.70	0.48	0.62
	1	0.091	0.101	0.48	0.39	0.53
	2	0.075	0.062	0.39	0.33	0.49
	3	0.063	0.050	0.33	0.33	0.49
	4	0.063	0.045	0.33	0.38	0.55
	5	0.072	0.050	0.38	0.72	0.96
	6	0.136	0.092	0.72	1.47	1.42
	7	0.278	0.201	1.47	1.87	1.52
	8	0.354	0.387	1.87	1.52	1.37
	9	0.287	0.355	1.52	1.29	1.22
	10	0.243	0.328	1.29	1.13	1.16
	11	0.214	0.295	1.13	1.03	1.08
	12	0.196	0.267	1.03	1.00	1.02
	13	0.190	0.234	1.00	0.96	0.97
	14	0.182	0.216	0.96	0.94	0.95
	15	0.177	0.206	0.94	0.93	0.94
	16	0.177	0.197	0.93	1.00	0.98
	17	0.188	0.190	1.00	1.11	1.09
	18	0.210	0.213	1.11	1.18	1.18
	19	0.223	0.266	1.18	1.22	1.23
	20	0.231	0.285	1.22	1.19	1.20
	21	0.226	0.293	1.19	1.16	1.15
	22	0.219	0.276	1.16	1.00	1.01
	23	0.190	0.164	1.00	0.70	0.79
Weekend	24	0.163	0.126	0.86	0.57	0.64
	25	0.107	0.120	0.57	0.39	0.52
	26	0.074	0.074	0.39	0.33	0.46
	27	0.062	0.053	0.33	0.30	0.43
	28	0.057	0.047	0.30	0.28	0.43
	29	0.052	0.047	0.28	0.34	0.49
	30	0.064	0.056	0.34	0.60	0.69
	31	0.113	0.096	0.60	1.14	1.05
	32	0.216	0.149	1.14	1.57	1.40
	33	0.296	0.259	1.57	1.70	1.52
	34	0.322	0.341	1.70	1.65	1.50
	35	0.311	0.336	1.65	1.64	1.43
	36	0.309	0.272	1.64	1.54	1.32
	37	0.290	0.244	1.54	1.40	1.23
	38	0.265	0.217	1.40	1.28	1.17
	39	0.243	0.191	1.28	1.18	1.12
	40	0.223	0.179	1.18	1.29	1.17
	41	0.244	0.192	1.29	1.46	1.24
	42	0.276	0.207	1.46	1.44	1.24
	43	0.273	0.218	1.44	1.28	1.18
	44	0.242	0.202	1.28	1.25	1.12
	45	0.236	0.194	1.25	1.16	1.07
	46	0.219	0.178	1.16	1.00	0.95
	47	0.188	0.155	1.00	0.86	0.82
Average						
	Weekday	0.184	0.204	0.97	0.97	1.00
	Weekend	0.202	0.173	1.07	1.07	1.01
	ADWF[(1)]	0.189	0.195	1.00	1.00	1.00
% Error						
	Weekday		10.9%			
	Weekend		-14.3%			

Notes:

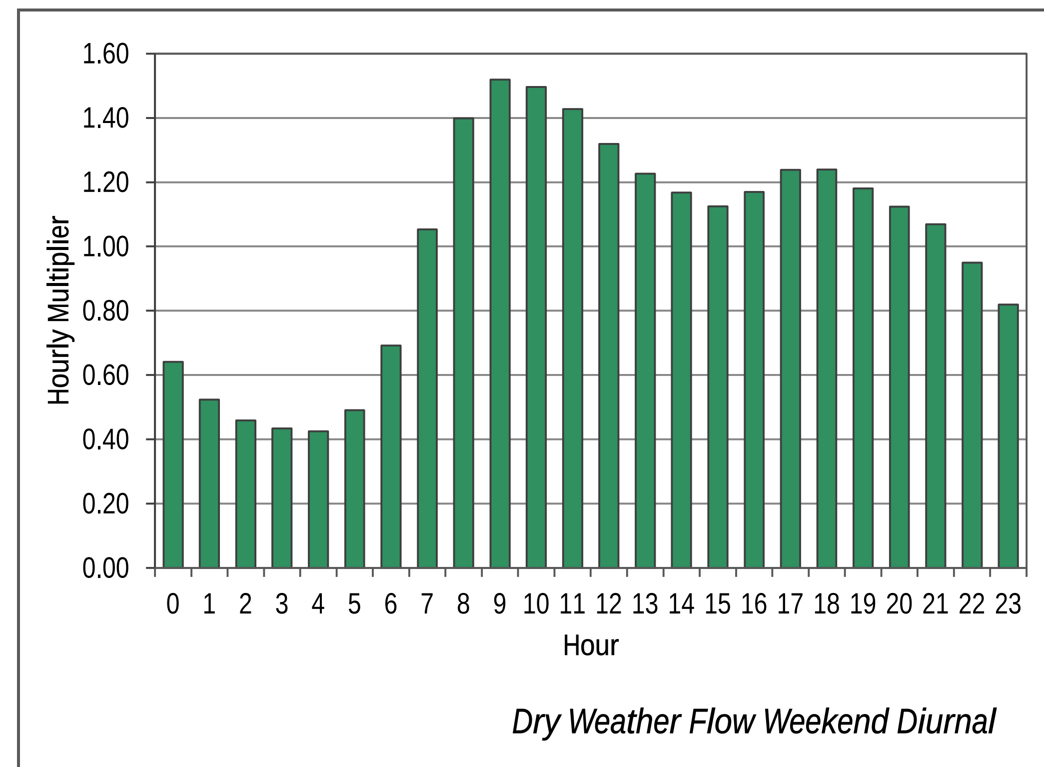
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

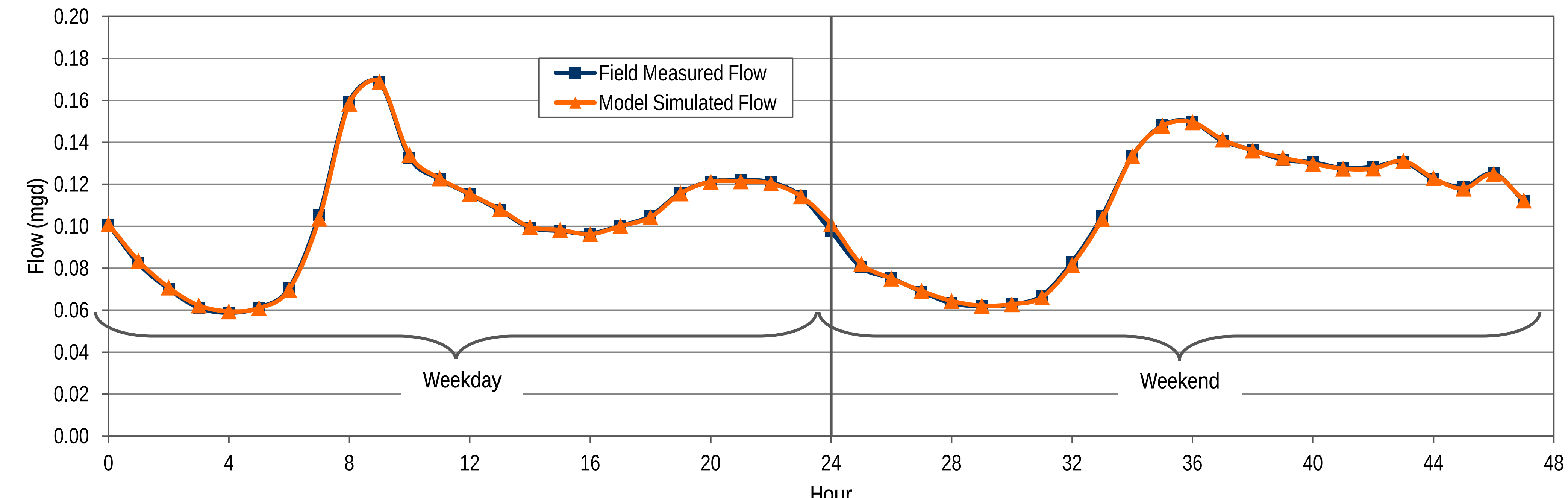
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.4 DRY WEATHER CALIBRATION

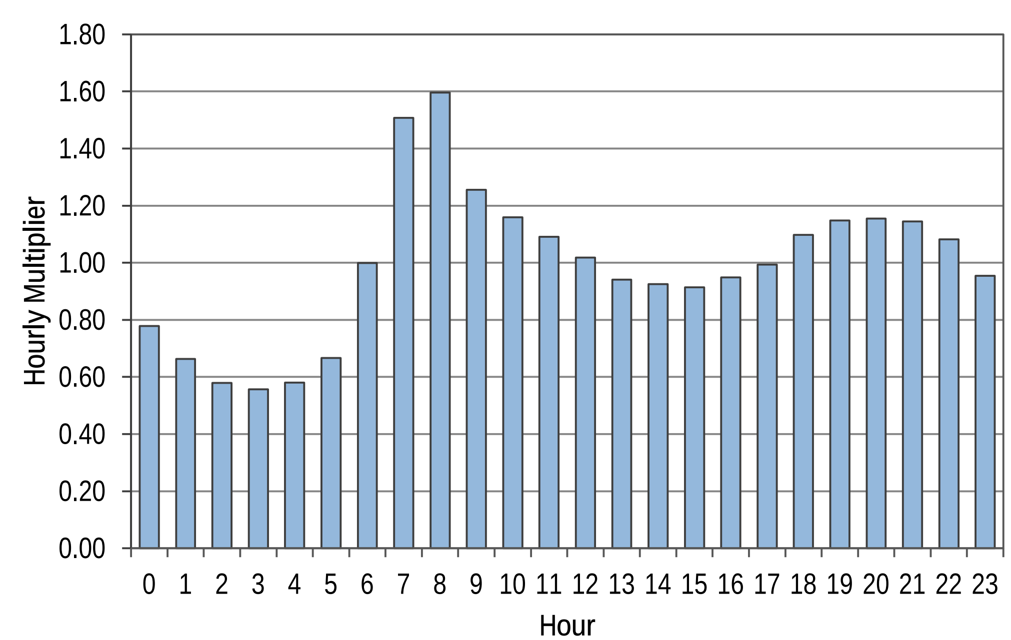
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.101	0.101	0.95	0.78	0.78
	1	0.082	0.084	0.78	0.66	0.66
	2	0.070	0.071	0.66	0.58	0.58
	3	0.061	0.062	0.58	0.56	0.56
	4	0.059	0.059	0.56	0.58	0.58
	5	0.061	0.061	0.58	0.67	0.67
	6	0.070	0.070	0.67	1.00	1.00
	7	0.106	0.104	1.00	1.51	1.51
	8	0.159	0.158	1.51	1.60	1.60
	9	0.169	0.169	1.60	1.26	1.26
	10	0.133	0.134	1.26	1.16	1.16
	11	0.122	0.123	1.16	1.09	1.09
	12	0.115	0.115	1.09	1.02	1.02
	13	0.108	0.108	1.02	0.94	0.94
	14	0.099	0.100	0.94	0.93	0.93
	15	0.098	0.098	0.93	0.91	0.91
	16	0.097	0.096	0.91	0.95	0.95
	17	0.100	0.100	0.95	0.99	0.99
	18	0.105	0.104	0.99	1.10	1.10
	19	0.116	0.116	1.10	1.15	1.15
	20	0.121	0.121	1.15	1.15	1.15
	21	0.122	0.121	1.15	1.14	1.14
	22	0.121	0.120	1.14	1.08	1.08
	23	0.114	0.114	1.08	0.95	0.95
Weekend	24	0.098	0.101	0.92	0.76	0.76
	25	0.080	0.082	0.76	0.71	0.71
	26	0.075	0.075	0.71	0.65	0.65
	27	0.069	0.069	0.65	0.60	0.60
	28	0.063	0.064	0.60	0.59	0.59
	29	0.062	0.062	0.59	0.59	0.59
	30	0.063	0.063	0.59	0.63	0.63
	31	0.067	0.066	0.63	0.78	0.78
	32	0.083	0.082	0.78	0.99	0.99
	33	0.105	0.104	0.99	1.26	1.26
	34	0.133	0.133	1.26	1.40	1.40
	35	0.148	0.148	1.40	1.42	1.42
	36	0.150	0.150	1.42	1.33	1.33
	37	0.141	0.141	1.33	1.29	1.29
	38	0.136	0.136	1.29	1.25	1.25
	39	0.132	0.133	1.25	1.23	1.23
	40	0.130	0.130	1.23	1.21	1.21
	41	0.128	0.127	1.21	1.21	1.21
	42	0.128	0.128	1.21	1.24	1.24
	43	0.131	0.131	1.24	1.16	1.16
	44	0.122	0.123	1.16	1.13	1.13
	45	0.119	0.118	1.13	1.19	1.19
	46	0.125	0.125	1.19	1.06	1.06
	47	0.112	0.112	1.06	0.92	0.92
Average						
	Weekday	0.105	0.105	0.99	0.99	0.99
	Weekend	0.108	0.108	1.03	1.03	1.03
	ADWF[1]	0.106	0.106	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.1%			

Notes:

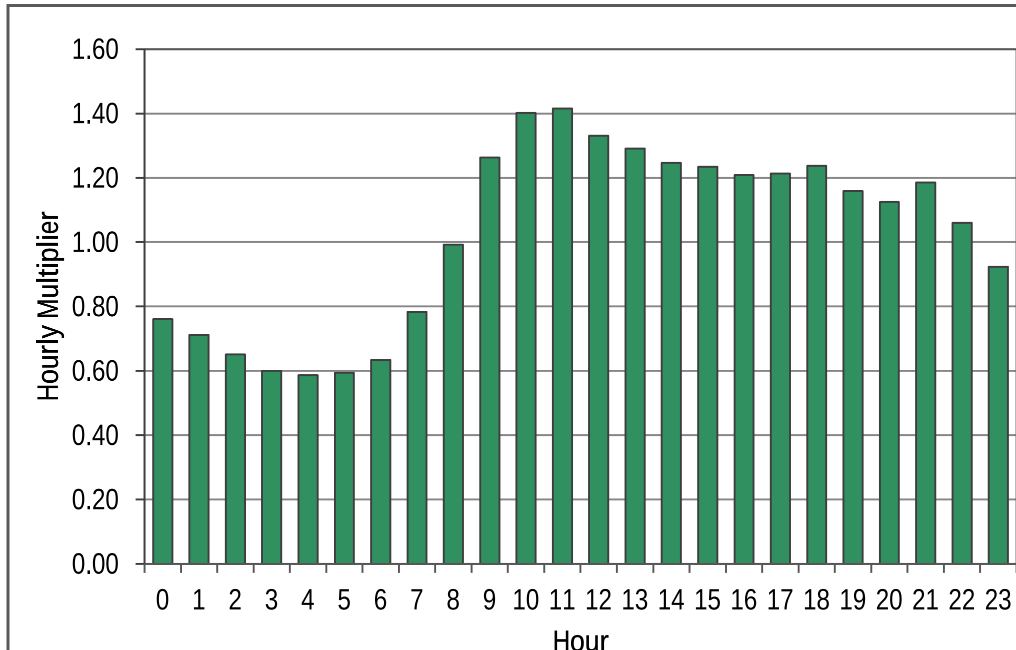
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

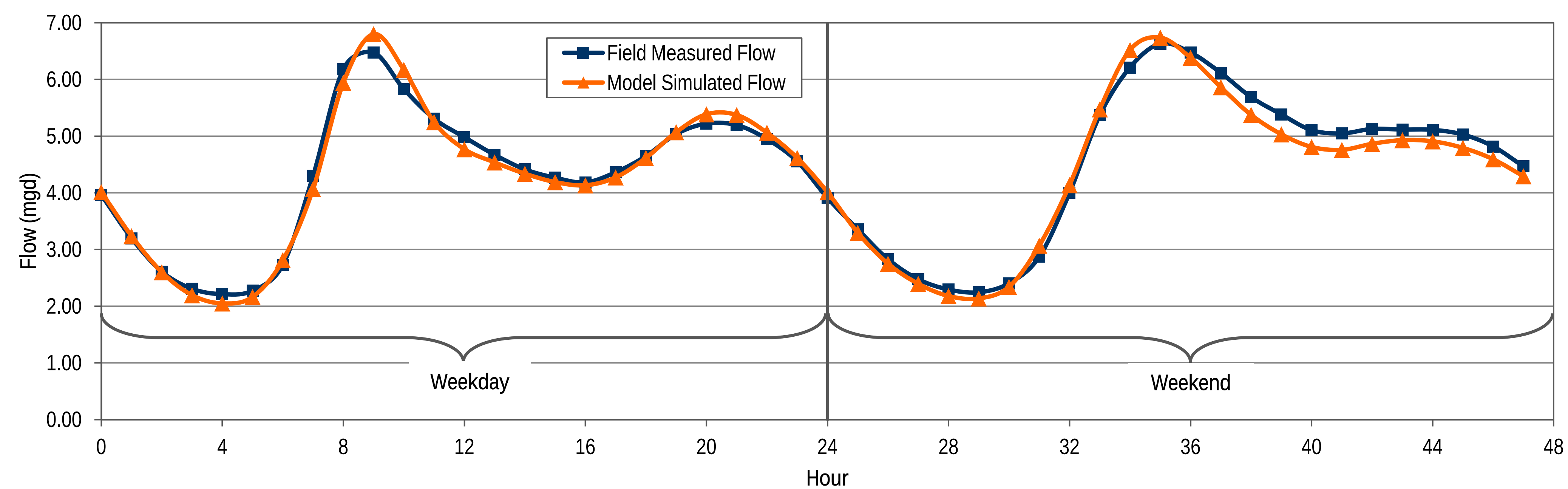
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-1 DRY WEATHER CALIBRATION

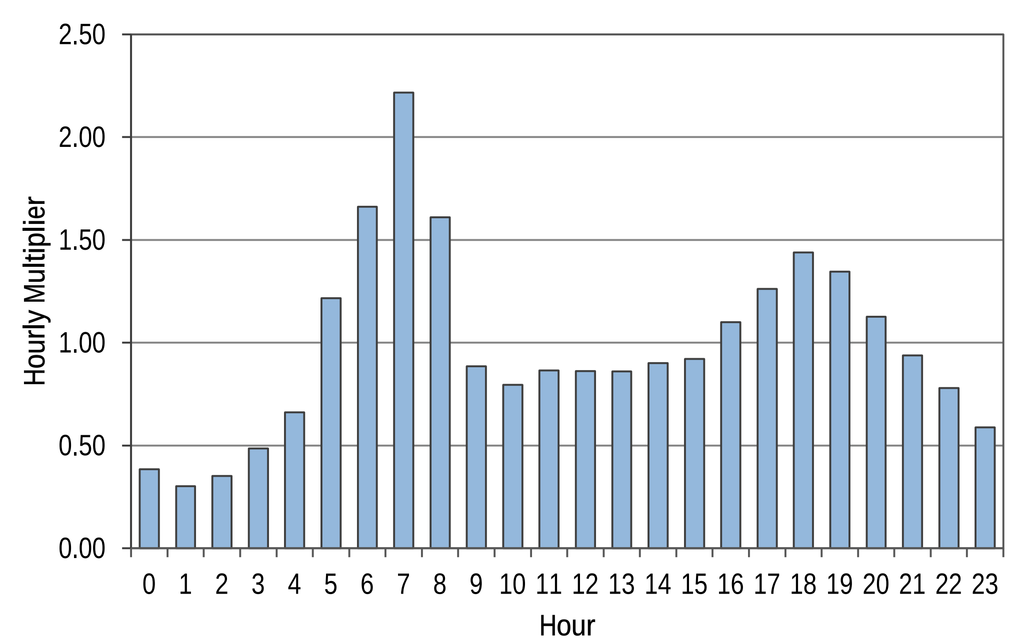
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	3.961	4.010	0.90	0.73	0.39
	1	3.198	3.235	0.73	0.60	0.30
	2	2.610	2.598	0.60	0.53	0.35
	3	2.308	2.194	0.53	0.51	0.49
	4	2.213	2.048	0.51	0.52	0.66
	5	2.274	2.163	0.52	0.62	1.22
	6	2.729	2.811	0.62	0.98	1.66
	7	4.301	4.066	0.98	1.41	2.22
	8	6.184	5.941	1.41	1.48	1.61
	9	6.471	6.797	1.48	1.33	0.89
	10	5.827	6.168	1.33	1.21	0.80
	11	5.305	5.246	1.21	1.14	0.86
	12	4.980	4.768	1.14	1.07	0.86
	13	4.669	4.535	1.07	1.01	0.86
	14	4.413	4.336	1.01	0.97	0.90
	15	4.266	4.188	0.97	0.96	0.92
	16	4.184	4.132	0.96	1.00	1.10
	17	4.362	4.272	1.00	1.06	1.26
	18	4.647	4.614	1.06	1.15	1.44
	19	5.035	5.068	1.15	1.19	1.35
	20	5.219	5.383	1.19	1.19	1.13
	21	5.194	5.371	1.19	1.13	0.94
	22	4.947	5.059	1.13	1.04	0.78
	23	4.553	4.613	1.04	0.90	0.59
Weekend	24	3.910	4.010	0.89	0.77	0.46
	25	3.356	3.294	0.77	0.65	0.39
	26	2.829	2.750	0.65	0.57	0.39
	27	2.476	2.394	0.57	0.52	0.45
	28	2.295	2.179	0.52	0.51	0.55
	29	2.247	2.136	0.51	0.55	0.79
	30	2.405	2.340	0.55	0.66	1.39
	31	2.873	3.067	0.66	0.91	1.65
	32	3.998	4.135	0.91	1.23	2.01
	33	5.366	5.472	1.23	1.42	1.94
	34	6.209	6.518	1.42	1.51	1.54
	35	6.629	6.736	1.51	1.48	1.29
	36	6.473	6.380	1.48	1.40	1.15
	37	6.114	5.861	1.40	1.30	1.07
	38	5.687	5.374	1.30	1.23	1.07
	39	5.382	5.031	1.23	1.17	1.05
	40	5.105	4.808	1.17	1.15	1.10
	41	5.047	4.756	1.15	1.17	1.18
	42	5.126	4.863	1.17	1.17	1.12
	43	5.115	4.927	1.17	1.17	1.08
	44	5.109	4.907	1.17	1.15	1.04
	45	5.028	4.791	1.15	1.10	0.98
	46	4.818	4.591	1.10	1.02	0.86
	47	4.467	4.291	1.02	0.89	0.55
Average						
	Weekday	4.327	4.317	0.99	0.99	0.98
	Weekend	4.503	4.400	1.03	1.03	1.05
	ADWF[1]	4.377	4.341	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		-2.3%			

Notes:

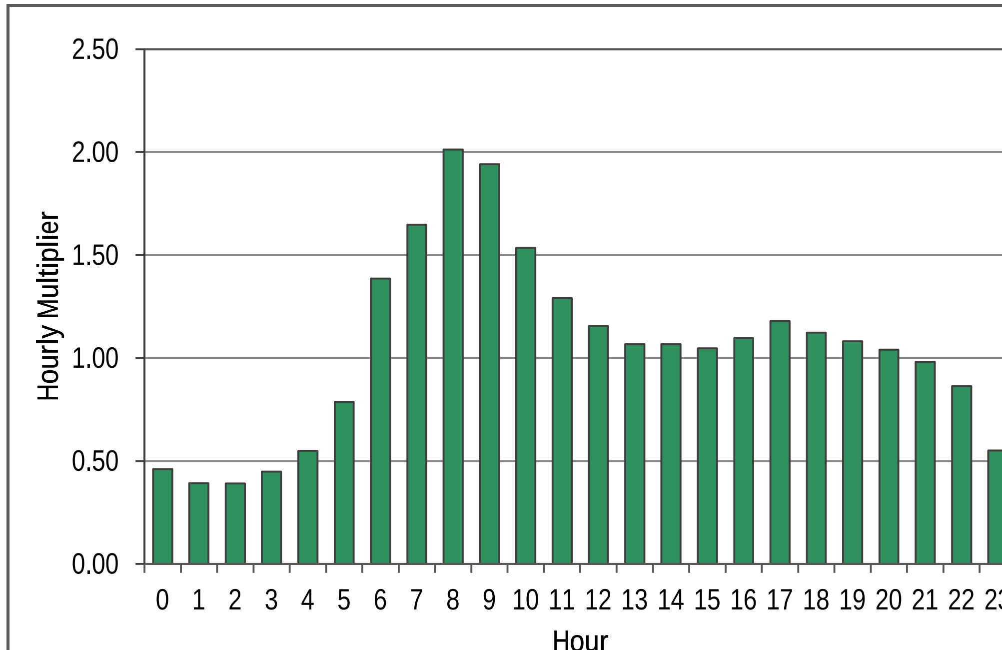
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

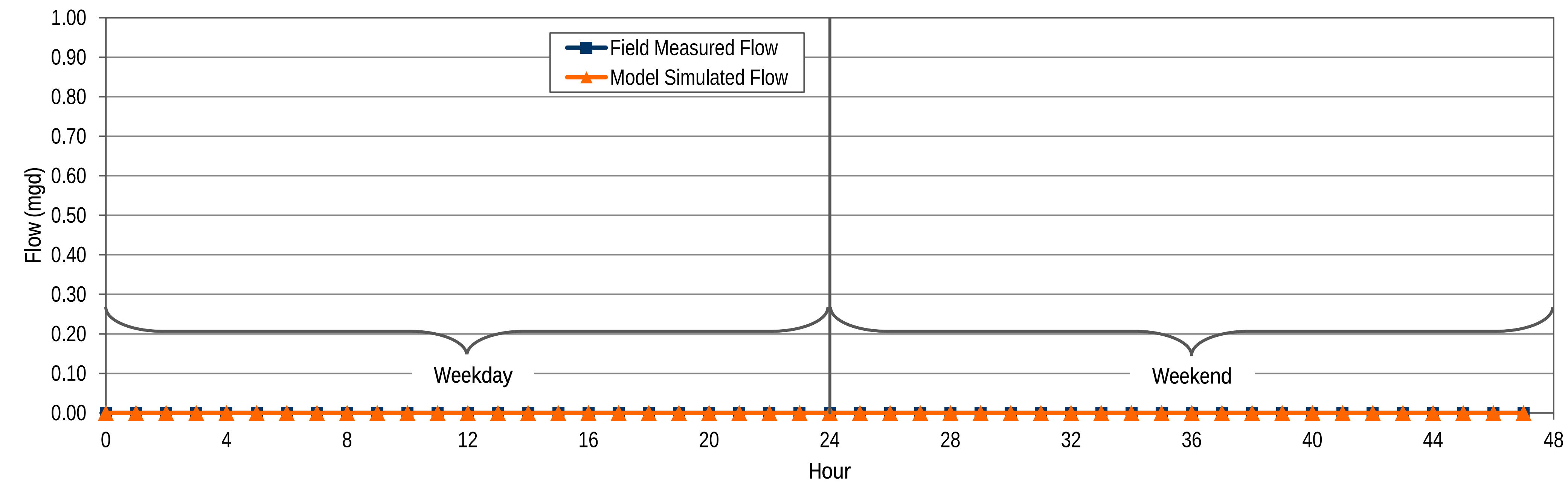
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-2 DRY WEATHER CALIBRATION

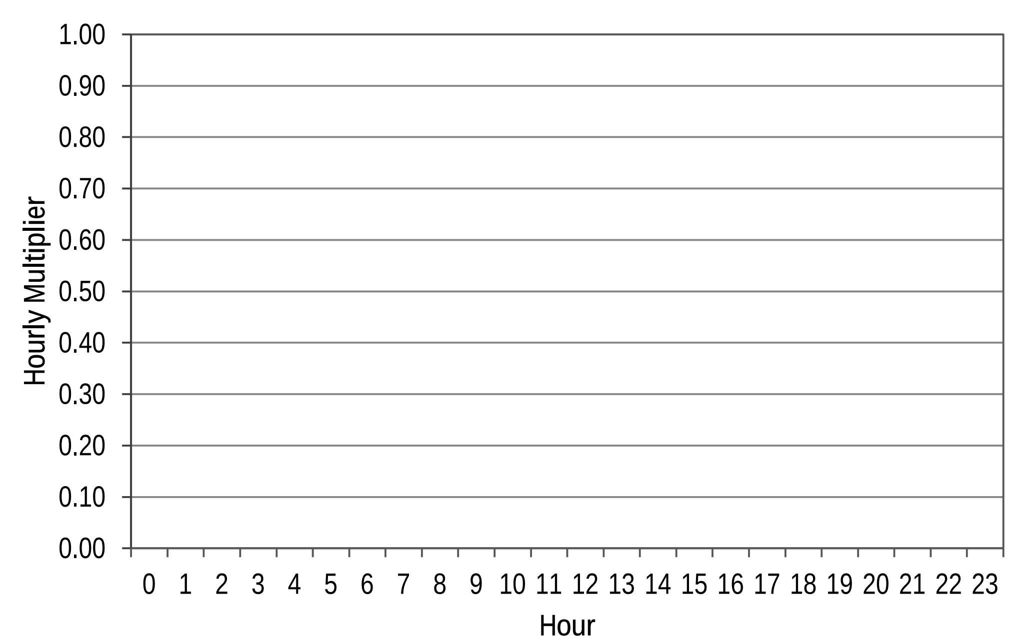
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.000	0.000	0.00	0.00	0.00
	1	0.000	0.000	0.00	0.00	0.00
	2	0.000	0.000	0.00	0.00	0.00
	3	0.000	0.000	0.00	0.00	0.00
	4	0.000	0.000	0.00	0.00	0.00
	5	0.000	0.000	0.00	0.00	0.00
	6	0.000	0.000	0.00	0.00	0.00
	7	0.000	0.000	0.00	0.00	0.00
	8	0.000	0.000	0.00	0.00	0.00
	9	0.000	0.000	0.00	0.00	0.00
	10	0.000	0.000	0.00	0.00	0.00
	11	0.000	0.000	0.00	0.00	0.00
	12	0.000	0.000	0.00	0.00	0.00
	13	0.000	0.000	0.00	0.00	0.00
	14	0.000	0.000	0.00	0.00	0.00
	15	0.000	0.000	0.00	0.00	0.00
	16	0.000	0.000	0.00	0.00	0.00
	17	0.000	0.000	0.00	0.00	0.00
	18	0.000	0.000	0.00	0.00	0.00
	19	0.000	0.000	0.00	0.00	0.00
	20	0.000	0.000	0.00	0.00	0.00
	21	0.000	0.000	0.00	0.00	0.00
	22	0.000	0.000	0.00	0.00	0.00
	23	0.000	0.000	0.00	0.00	0.00
Weekend	24	0.000	0.000	0.00	0.00	0.00
	25	0.000	0.000	0.00	0.00	0.00
	26	0.000	0.000	0.00	0.00	0.00
	27	0.000	0.000	0.00	0.00	0.00
	28	0.000	0.000	0.00	0.00	0.00
	29	0.000	0.000	0.00	0.00	0.00
	30	0.000	0.000	0.00	0.00	0.00
	31	0.000	0.000	0.00	0.00	0.00
	32	0.000	0.000	0.00	0.00	0.00
	33	0.000	0.000	0.00	0.00	0.00
	34	0.000	0.000	0.00	0.00	0.00
	35	0.000	0.000	0.00	0.00	0.00
	36	0.000	0.000	0.00	0.00	0.00
	37	0.000	0.000	0.00	0.00	0.00
	38	0.000	0.000	0.00	0.00	0.00
	39	0.000	0.000	0.00	0.00	0.00
	40	0.000	0.000	0.00	0.00	0.00
	41	0.000	0.000	0.00	0.00	0.00
	42	0.000	0.000	0.00	0.00	0.00
	43	0.000	0.000	0.00	0.00	0.00
	44	0.000	0.000	0.00	0.00	0.00
	45	0.000	0.000	0.00	0.00	0.00
	46	0.000	0.000	0.00	0.00	0.00
	47	0.000	0.000	0.00	0.00	0.00
Average						
	Weekday	0.000	0.000	0.00	0.00	0.00
	Weekend	0.000	0.000	0.00	0.00	0.00
	ADWF[(1)]	0.000	0.000	0.00	0.00	0.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

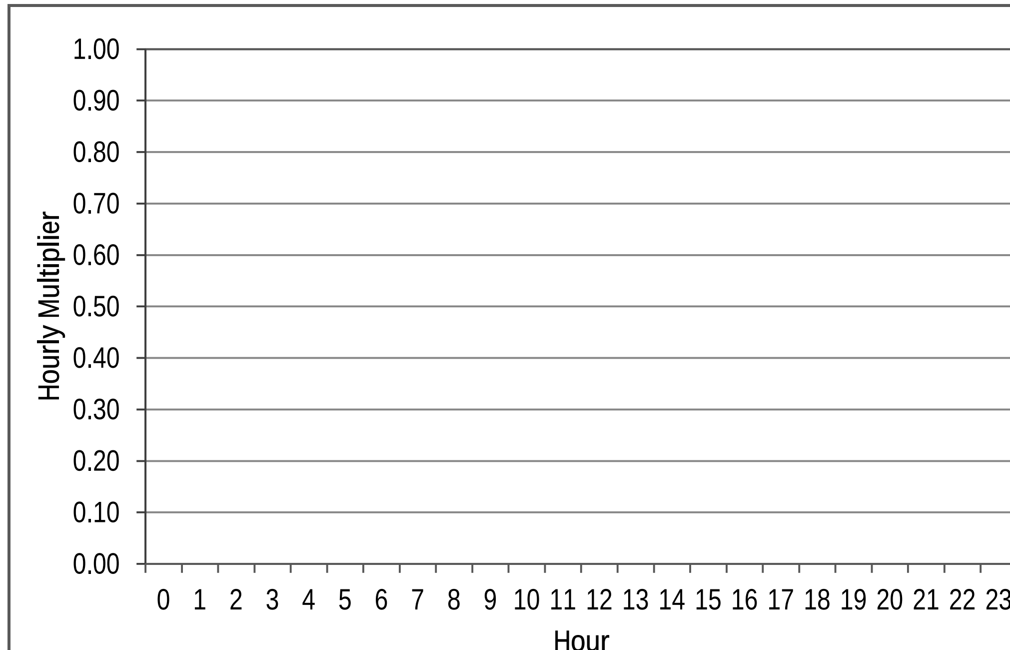
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

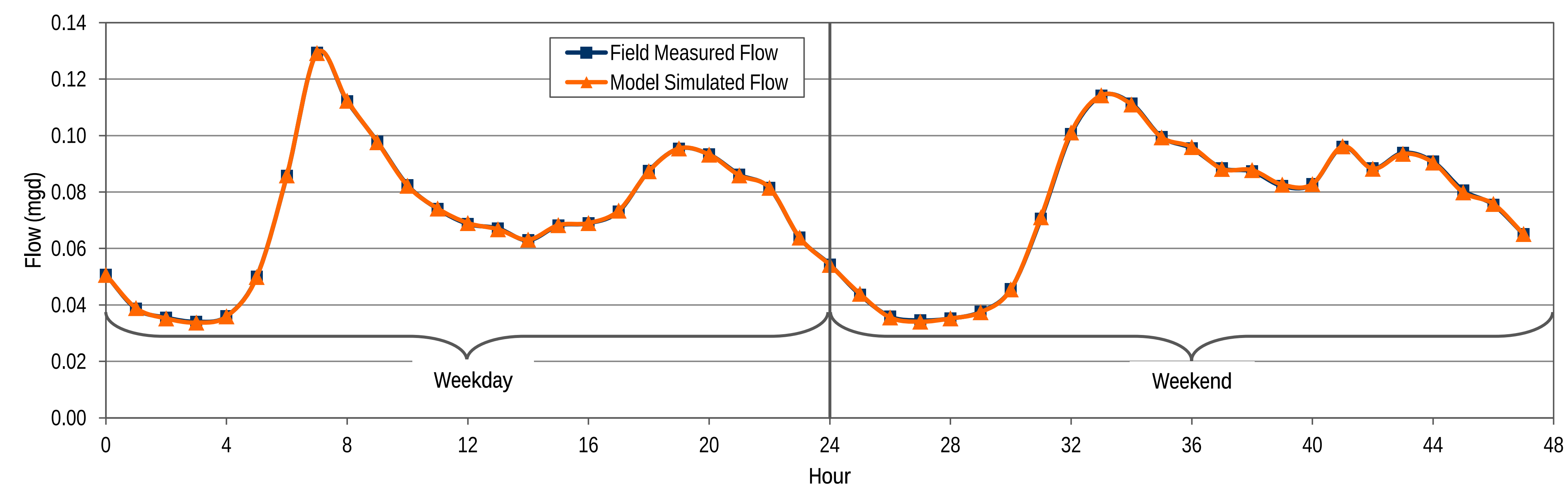
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S3 DRY WEATHER CALIBRATION

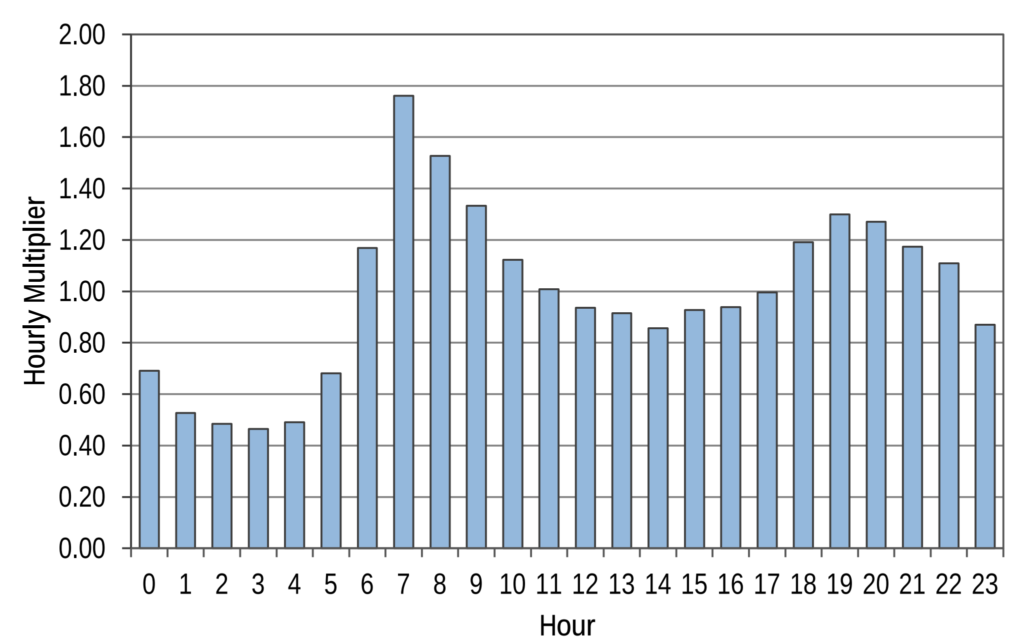
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.051	0.051	0.69	0.69	0.69
	1	0.039	0.039	0.53	0.53	0.53
	2	0.036	0.035	0.48	0.48	0.48
	3	0.034	0.034	0.46	0.46	0.46
	4	0.036	0.036	0.49	0.49	0.49
	5	0.050	0.050	0.68	0.68	0.68
	6	0.086	0.086	1.17	1.17	1.17
	7	0.129	0.129	1.76	1.76	1.76
	8	0.112	0.112	1.53	1.53	1.53
	9	0.098	0.098	1.33	1.33	1.33
	10	0.082	0.082	1.12	1.12	1.12
	11	0.074	0.074	1.01	1.01	1.01
	12	0.069	0.069	0.94	0.94	0.94
	13	0.067	0.067	0.91	0.91	0.91
	14	0.063	0.063	0.86	0.86	0.86
	15	0.068	0.068	0.93	0.93	0.93
	16	0.069	0.069	0.94	0.94	0.94
	17	0.073	0.073	1.00	1.00	1.00
	18	0.087	0.087	1.19	1.19	1.19
	19	0.095	0.095	1.30	1.30	1.30
	20	0.093	0.093	1.27	1.27	1.27
	21	0.086	0.086	1.17	1.17	1.17
	22	0.081	0.082	1.11	1.11	1.11
	23	0.064	0.064	0.87	0.87	0.87
Weekend	24	0.054	0.054	0.74	0.74	0.74
	25	0.044	0.044	0.59	0.59	0.59
	26	0.036	0.036	0.49	0.49	0.49
	27	0.035	0.034	0.47	0.47	0.47
	28	0.035	0.035	0.48	0.48	0.48
	29	0.038	0.037	0.51	0.51	0.51
	30	0.046	0.046	0.62	0.62	0.62
	31	0.071	0.071	0.96	0.96	0.96
	32	0.101	0.101	1.37	1.37	1.37
	33	0.114	0.114	1.55	1.55	1.55
	34	0.111	0.111	1.52	1.52	1.52
	35	0.100	0.099	1.36	1.36	1.36
	36	0.096	0.096	1.30	1.30	1.30
	37	0.088	0.088	1.20	1.20	1.20
	38	0.087	0.088	1.19	1.19	1.19
	39	0.082	0.083	1.12	1.12	1.12
	40	0.083	0.083	1.13	1.13	1.13
	41	0.096	0.096	1.31	1.31	1.31
	42	0.088	0.088	1.20	1.20	1.20
	43	0.094	0.094	1.28	1.28	1.28
	44	0.091	0.090	1.24	1.24	1.24
	45	0.081	0.080	1.10	1.10	1.10
	46	0.076	0.076	1.03	1.03	1.03
	47	0.065	0.065	0.89	0.89	0.89
Average						
	Weekday	0.073	0.073	0.99	0.99	0.99
	Weekend	0.075	0.075	1.03	1.03	1.03
	ADWF(1)	0.073	0.073	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

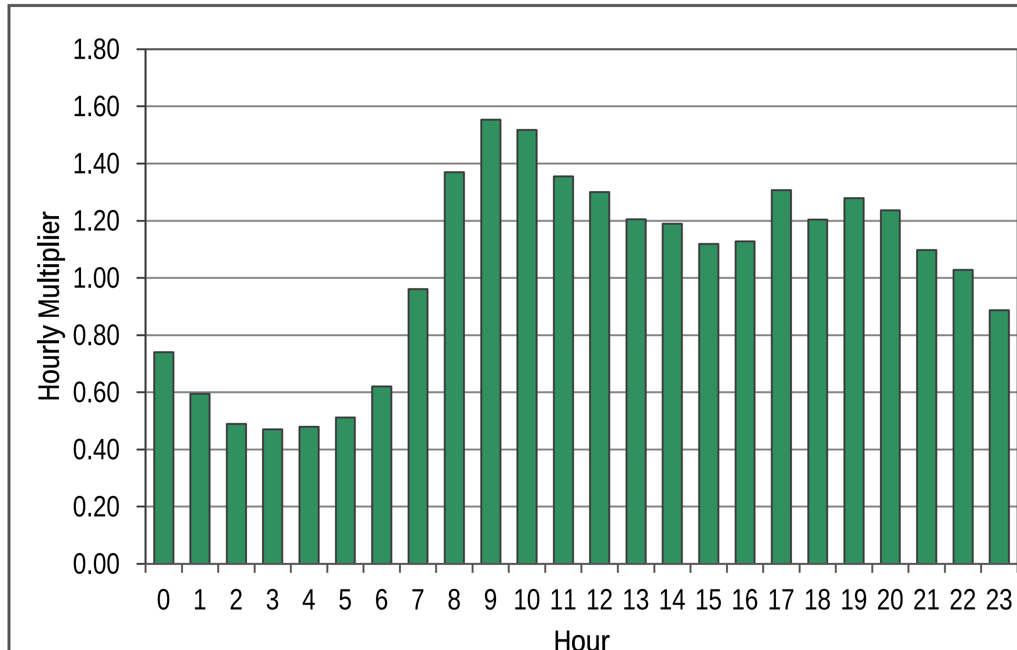
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

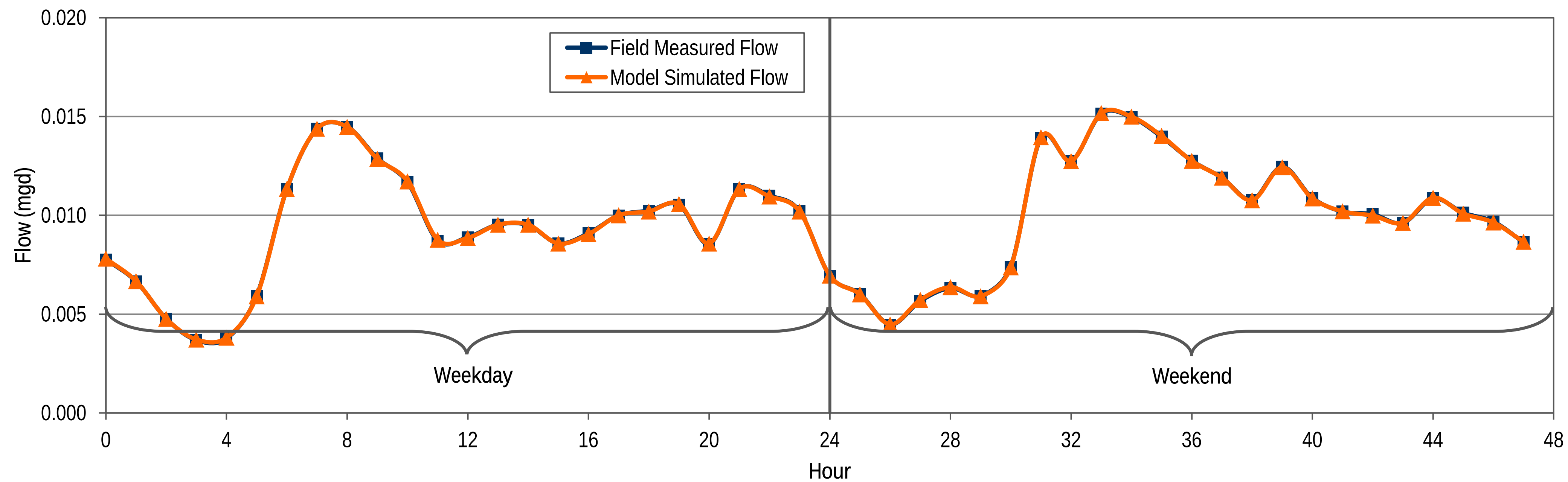
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S4 DRY WEATHER CALIBRATION

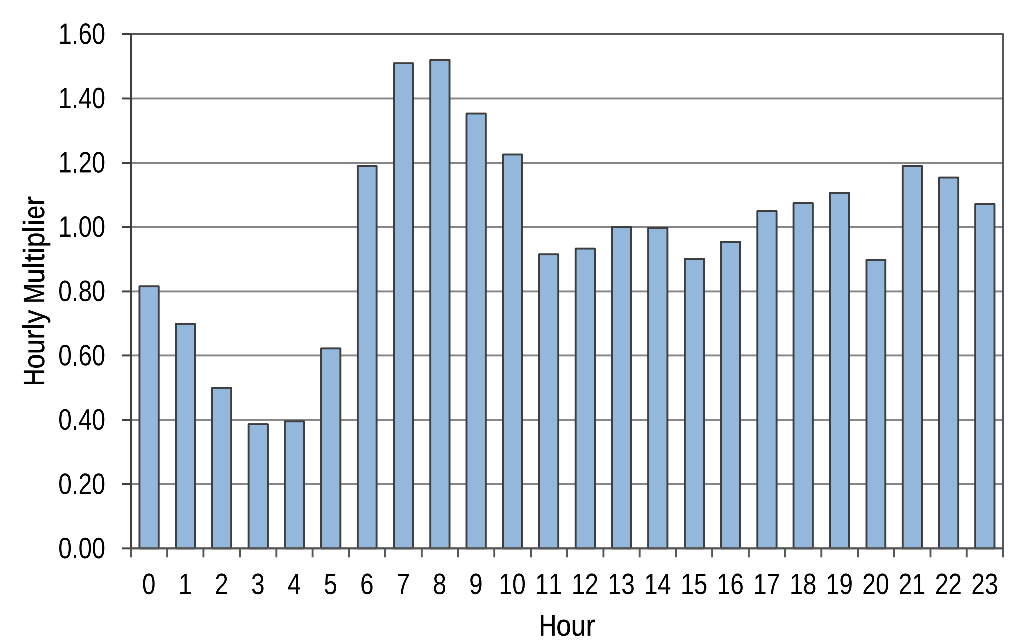
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.008	0.008	0.82	0.82	0.82
	1	0.007	0.007	0.70	0.70	0.70
	2	0.005	0.005	0.50	0.50	0.50
	3	0.004	0.004	0.39	0.39	0.39
	4	0.004	0.004	0.40	0.40	0.40
	5	0.006	0.006	0.62	0.62	0.62
	6	0.011	0.011	1.19	1.19	1.19
	7	0.014	0.014	1.51	1.51	1.51
	8	0.014	0.014	1.52	1.52	1.52
	9	0.013	0.013	1.35	1.35	1.35
	10	0.012	0.012	1.23	1.23	1.23
	11	0.009	0.009	0.92	0.92	0.92
	12	0.009	0.009	0.93	0.93	0.93
	13	0.010	0.010	1.00	1.00	1.00
	14	0.010	0.010	1.00	1.00	1.00
	15	0.009	0.009	0.90	0.90	0.90
	16	0.009	0.009	0.95	0.95	0.95
	17	0.010	0.010	1.05	1.05	1.05
	18	0.010	0.010	1.07	1.07	1.07
	19	0.011	0.011	1.11	1.11	1.11
	20	0.009	0.009	0.90	0.90	0.90
	21	0.011	0.011	1.19	1.19	1.19
	22	0.011	0.011	1.15	1.15	1.15
	23	0.010	0.010	1.07	1.07	1.07
Weekend	24	0.007	0.007	0.73	0.73	0.73
	25	0.006	0.006	0.63	0.63	0.63
	26	0.004	0.004	0.47	0.47	0.47
	27	0.006	0.006	0.59	0.59	0.59
	28	0.006	0.006	0.66	0.66	0.66
	29	0.006	0.006	0.62	0.62	0.62
	30	0.007	0.007	0.78	0.78	0.78
	31	0.014	0.014	1.46	1.46	1.46
	32	0.013	0.013	1.34	1.34	1.34
	33	0.015	0.015	1.59	1.59	1.59
	34	0.015	0.015	1.57	1.57	1.57
	35	0.014	0.014	1.47	1.47	1.47
	36	0.013	0.013	1.34	1.34	1.34
	37	0.012	0.012	1.25	1.25	1.25
	38	0.011	0.011	1.13	1.13	1.13
	39	0.012	0.012	1.31	1.31	1.31
	40	0.011	0.011	1.14	1.14	1.14
	41	0.010	0.010	1.07	1.07	1.07
	42	0.010	0.010	1.06	1.06	1.06
	43	0.010	0.010	1.01	1.01	1.01
	44	0.011	0.011	1.14	1.14	1.14
	45	0.010	0.010	1.06	1.06	1.06
	46	0.010	0.010	1.02	1.02	1.02
	47	0.009	0.009	0.91	0.91	0.91
Average						
	Weekday	0.009	0.009	0.98	0.98	0.98
	Weekend	0.010	0.010	1.06	1.06	1.06
	ADWF[(1)]	0.010	0.010	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

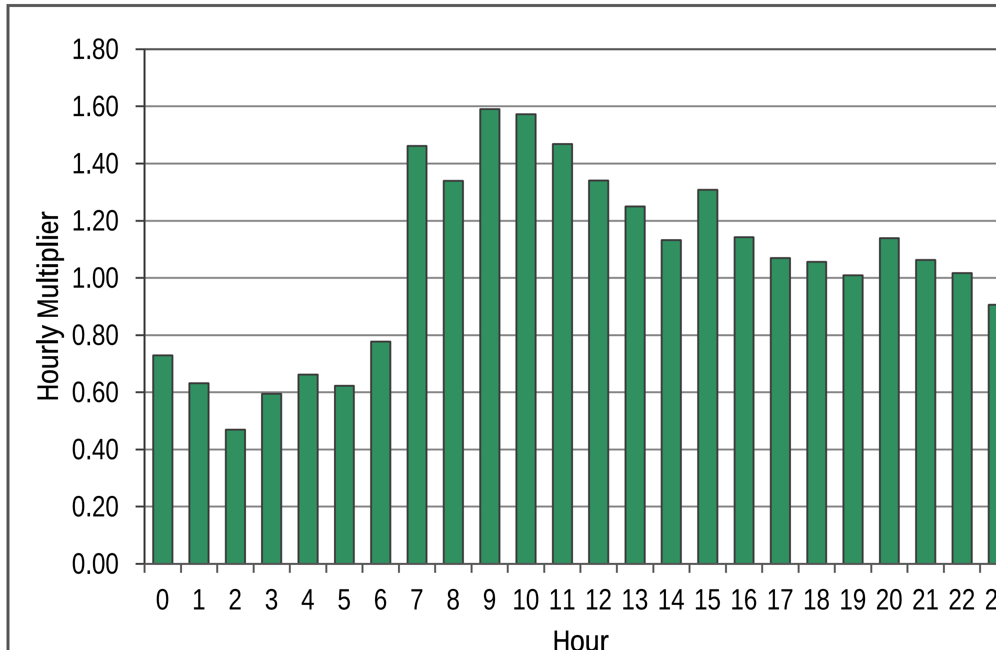
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

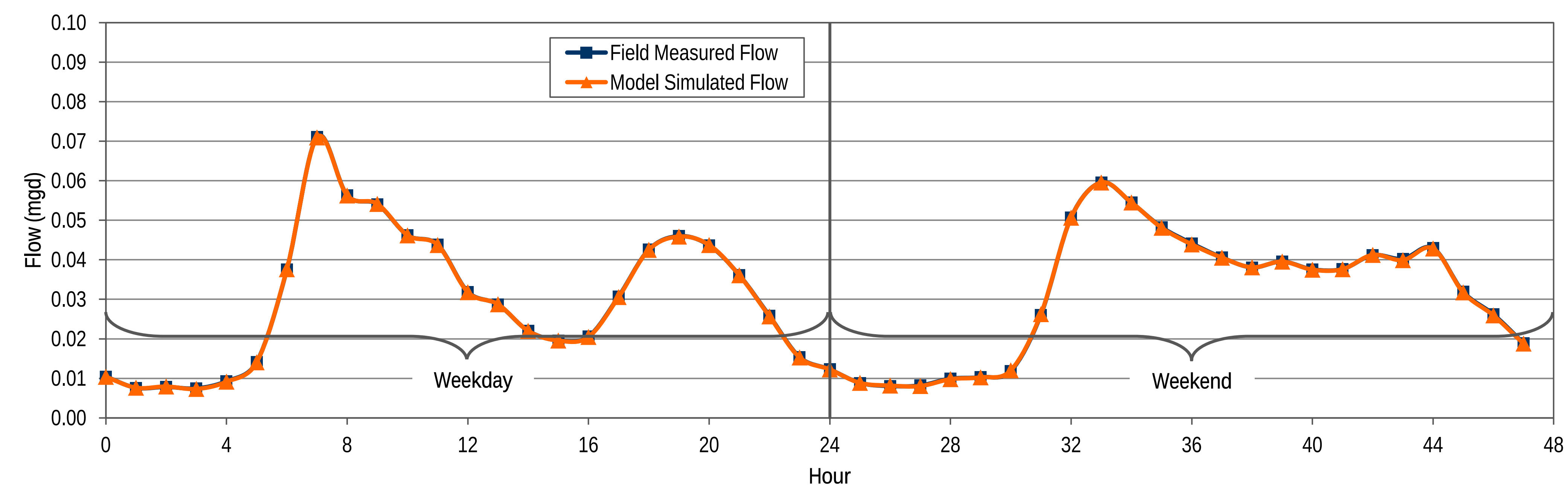
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S4A DRY WEATHER CALIBRATION

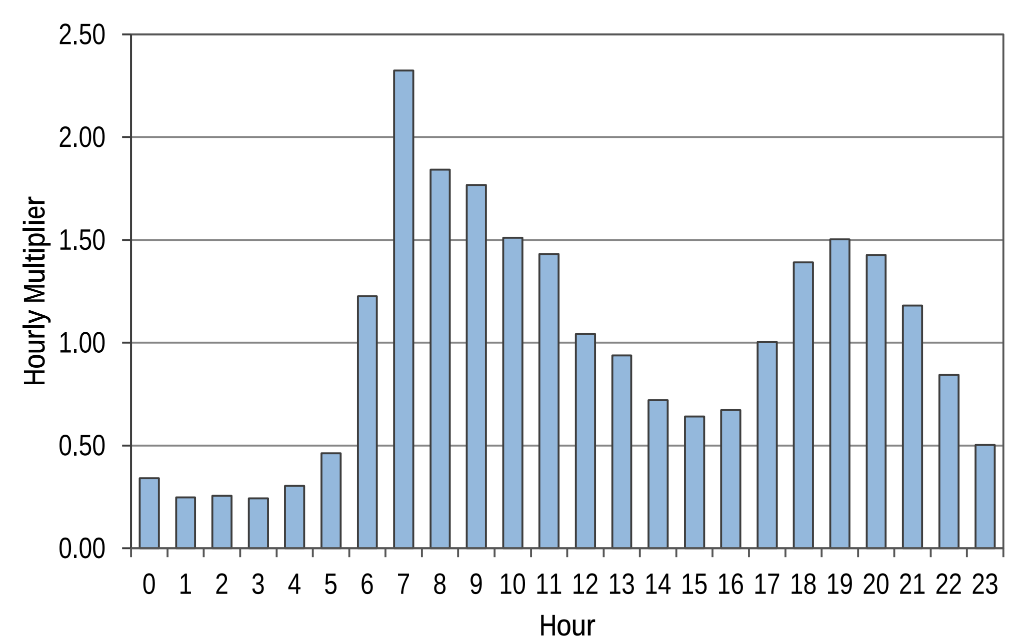
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.010	0.010	0.34	0.34	0.34
	1	0.008	0.008	0.25	0.25	0.25
	2	0.008	0.008	0.26	0.26	0.26
	3	0.007	0.007	0.24	0.24	0.24
	4	0.009	0.009	0.30	0.30	0.30
	5	0.014	0.014	0.46	0.46	0.46
	6	0.038	0.038	1.23	1.23	1.23
	7	0.071	0.071	2.32	2.32	2.32
	8	0.056	0.056	1.84	1.84	1.84
	9	0.054	0.054	1.77	1.77	1.77
	10	0.046	0.046	1.51	1.51	1.51
	11	0.044	0.044	1.43	1.43	1.43
	12	0.032	0.032	1.04	1.04	1.04
	13	0.029	0.029	0.94	0.94	0.94
	14	0.022	0.022	0.72	0.72	0.72
	15	0.020	0.020	0.64	0.64	0.64
	16	0.021	0.020	0.67	0.67	0.67
	17	0.031	0.031	1.00	1.00	1.00
	18	0.043	0.043	1.39	1.39	1.39
	19	0.046	0.046	1.50	1.50	1.50
	20	0.044	0.044	1.43	1.43	1.43
	21	0.036	0.036	1.18	1.18	1.18
	22	0.026	0.026	0.84	0.84	0.84
	23	0.015	0.015	0.50	0.50	0.50
Weekend	24	0.012	0.012	0.40	0.40	0.40
	25	0.009	0.009	0.29	0.29	0.29
	26	0.008	0.008	0.26	0.26	0.26
	27	0.008	0.008	0.27	0.27	0.27
	28	0.010	0.010	0.32	0.32	0.32
	29	0.010	0.010	0.34	0.34	0.34
	30	0.012	0.012	0.39	0.39	0.39
	31	0.026	0.026	0.85	0.85	0.85
	32	0.051	0.051	1.66	1.66	1.66
	33	0.060	0.060	1.95	1.95	1.95
	34	0.054	0.054	1.78	1.78	1.78
	35	0.048	0.048	1.58	1.58	1.58
	36	0.044	0.044	1.44	1.44	1.44
	37	0.041	0.041	1.33	1.33	1.33
	38	0.038	0.038	1.24	1.24	1.24
	39	0.040	0.040	1.29	1.29	1.29
	40	0.038	0.037	1.23	1.23	1.23
	41	0.038	0.038	1.23	1.23	1.23
	42	0.041	0.041	1.35	1.35	1.35
	43	0.040	0.040	1.32	1.32	1.32
	44	0.043	0.043	1.40	1.40	1.40
	45	0.032	0.032	1.04	1.04	1.04
	46	0.026	0.026	0.86	0.86	0.86
	47	0.019	0.019	0.62	0.62	0.62
Average						
	Weekday	0.030	0.030	0.99	0.99	0.99
	Weekend	0.031	0.031	1.02	1.02	1.02
	ADWF(1)	0.031	0.031	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.1%			

Notes:

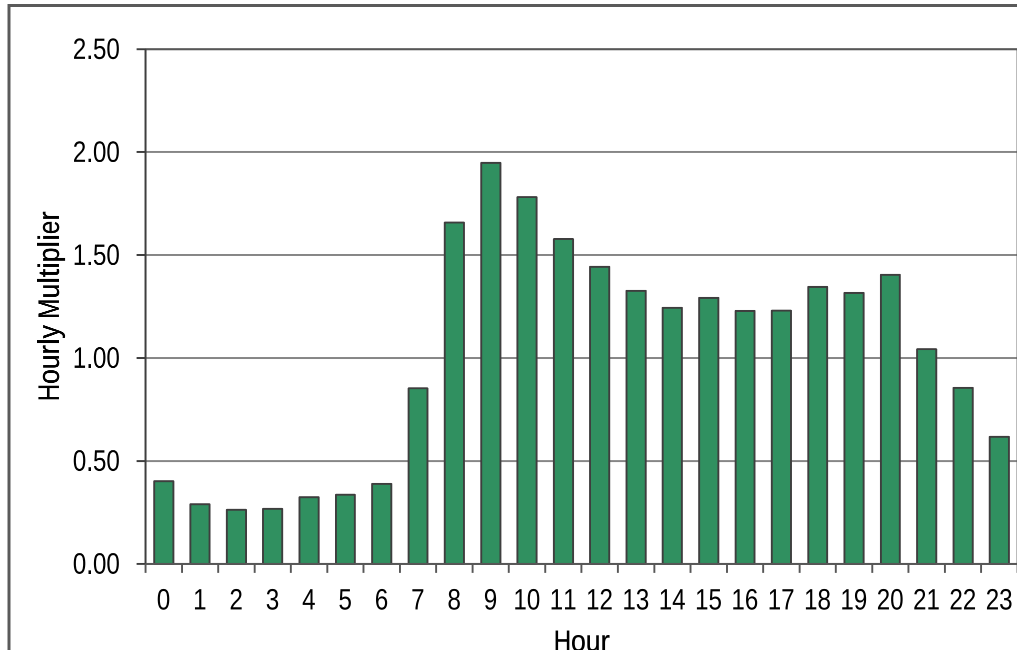
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

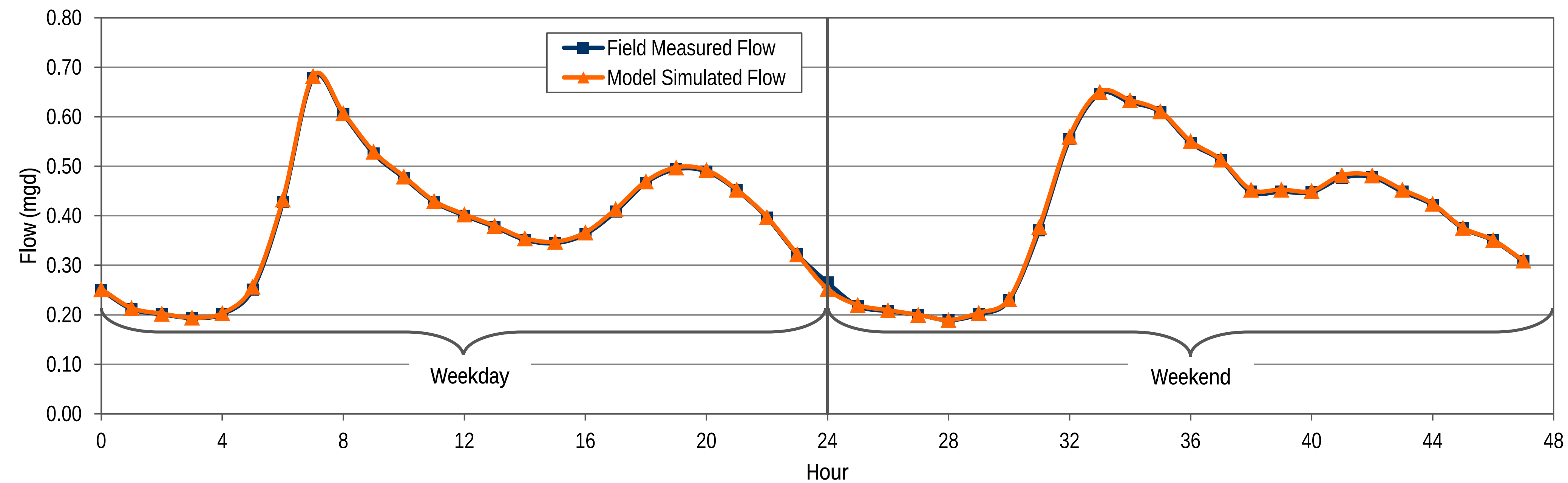
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54D DRY WEATHER CALIBRATION

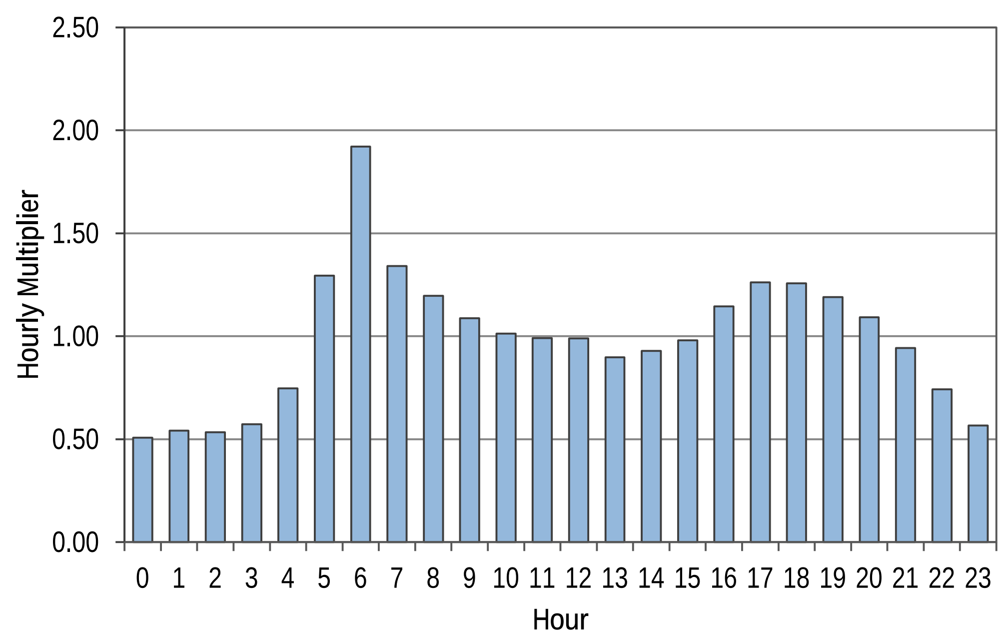
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.250	0.252	0.64	0.54	0.51
	1	0.212	0.214	0.54	0.51	0.54
	2	0.201	0.202	0.51	0.50	0.53
	3	0.194	0.194	0.50	0.51	0.57
	4	0.202	0.203	0.51	0.64	0.75
	5	0.251	0.257	0.64	1.09	1.30
	6	0.428	0.433	1.09	1.73	1.92
	7	0.679	0.682	1.73	1.54	1.34
	8	0.605	0.607	1.54	1.34	1.20
	9	0.526	0.530	1.34	1.22	1.09
	10	0.477	0.479	1.22	1.09	1.01
	11	0.428	0.430	1.09	1.02	0.99
	12	0.401	0.403	1.02	0.96	0.99
	13	0.378	0.380	0.96	0.90	0.90
	14	0.352	0.354	0.90	0.88	0.93
	15	0.345	0.348	0.88	0.93	0.98
	16	0.363	0.366	0.93	1.04	1.15
	17	0.409	0.413	1.04	1.19	1.26
	18	0.467	0.470	1.19	1.26	1.26
	19	0.494	0.498	1.26	1.25	1.19
	20	0.490	0.492	1.25	1.15	1.09
	21	0.452	0.453	1.15	1.01	0.94
	22	0.397	0.398	1.01	0.82	0.74
	23	0.322	0.322	0.82	0.64	0.57
Weekend	24	0.265	0.252	0.68	0.56	0.51
	25	0.218	0.220	0.56	0.53	0.52
	26	0.208	0.209	0.53	0.51	0.54
	27	0.200	0.200	0.51	0.48	0.50
	28	0.189	0.190	0.48	0.51	0.54
	29	0.201	0.204	0.51	0.59	0.64
	30	0.230	0.232	0.59	0.95	1.15
	31	0.371	0.378	0.95	1.42	1.66
	32	0.555	0.560	1.42	1.65	1.72
	33	0.646	0.650	1.65	1.61	1.56
	34	0.629	0.634	1.61	1.56	1.57
	35	0.610	0.611	1.56	1.40	1.41
	36	0.547	0.551	1.40	1.31	1.33
	37	0.512	0.514	1.31	1.15	1.12
	38	0.449	0.453	1.15	1.15	1.16
	39	0.449	0.453	1.15	1.14	1.16
	40	0.448	0.450	1.14	1.22	1.25
	41	0.476	0.482	1.22	1.22	1.20
	42	0.478	0.482	1.22	1.15	1.12
	43	0.449	0.453	1.15	1.08	1.01
	44	0.422	0.424	1.08	0.96	0.81
	45	0.375	0.376	0.96	0.89	0.83
	46	0.350	0.351	0.89	0.79	0.70
	47	0.309	0.310	0.79	0.68	0.63
Average						
	Weekday	0.388	0.391	0.99	0.99	0.99
	Weekend	0.399	0.402	1.02	1.02	1.03
	ADWF[(1)]	0.391	0.394	1.00	1.00	1.00
% Error						
	Weekday		0.7%			
	Weekend		0.5%			

Notes:

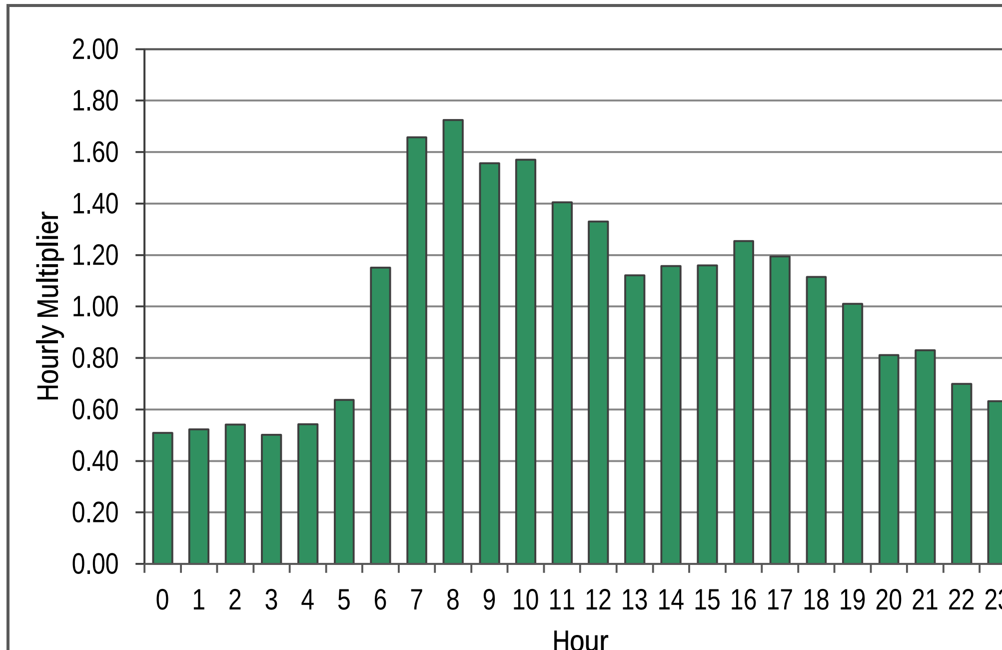
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

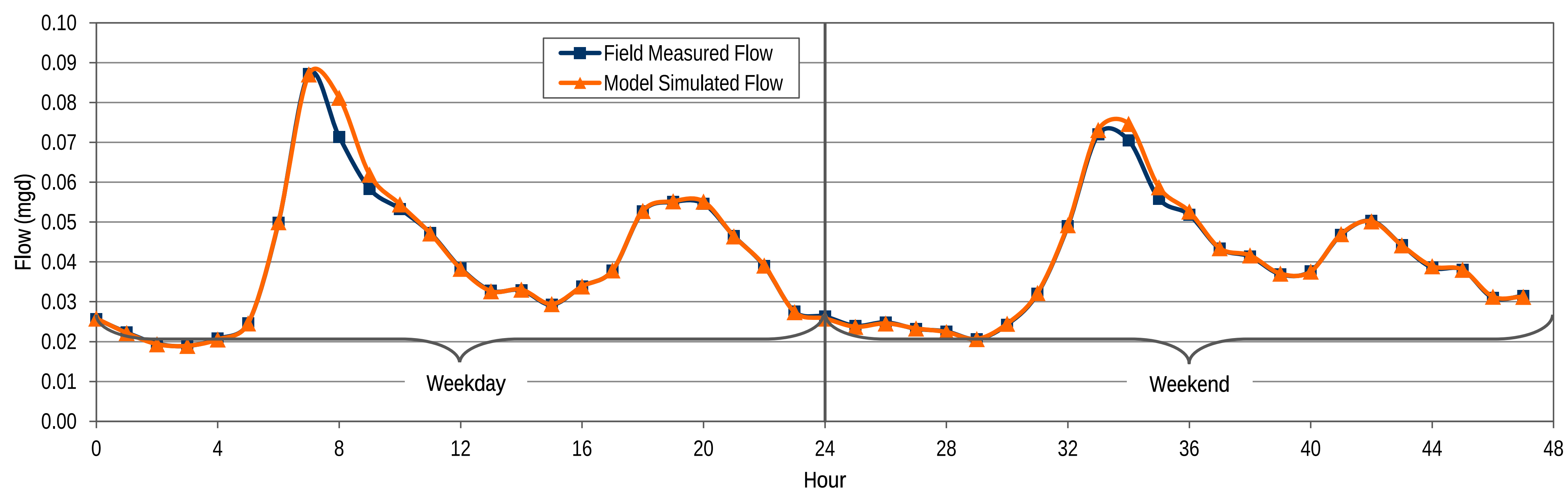
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54D.1 DRY WEATHER CALIBRATION

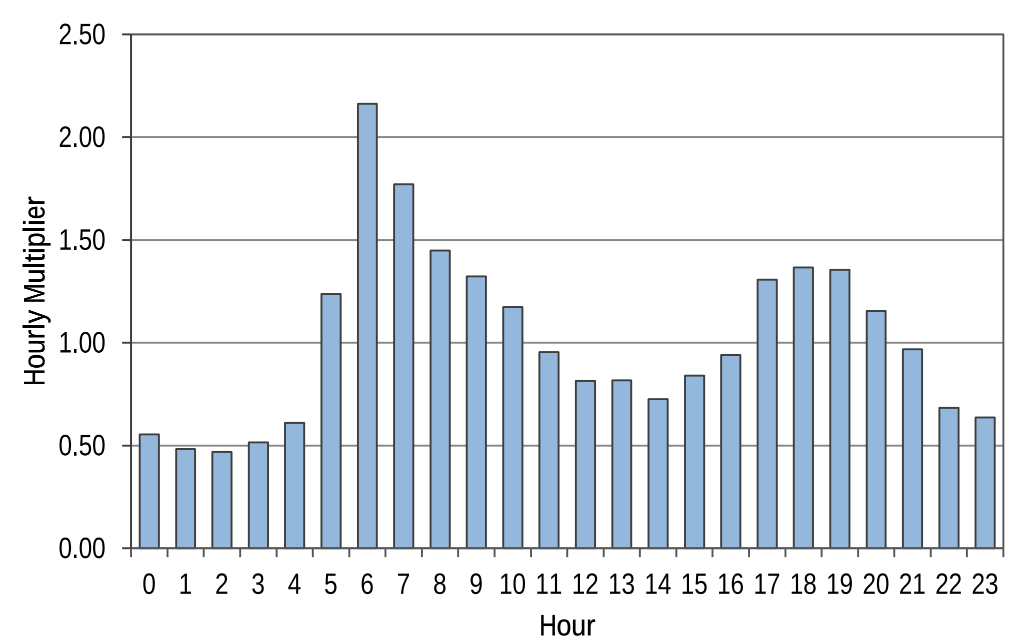
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.026	0.026	0.64	0.55	0.55
	1	0.022	0.022	0.55	0.48	0.48
	2	0.019	0.019	0.48	0.47	0.47
	3	0.019	0.019	0.47	0.51	0.51
	4	0.021	0.021	0.51	0.61	0.61
	5	0.025	0.025	0.61	1.24	1.24
	6	0.050	0.050	1.24	2.16	2.16
	7	0.087	0.087	2.16	1.77	1.77
	8	0.071	0.081	1.77	1.45	1.45
	9	0.058	0.062	1.45	1.32	1.32
	10	0.053	0.054	1.32	1.17	1.17
	11	0.047	0.047	1.17	0.95	0.95
	12	0.038	0.038	0.95	0.81	0.81
	13	0.033	0.033	0.81	0.82	0.82
	14	0.033	0.033	0.82	0.73	0.73
	15	0.029	0.029	0.73	0.84	0.84
	16	0.034	0.034	0.84	0.94	0.94
	17	0.038	0.038	0.94	1.31	1.31
	18	0.053	0.053	1.31	1.37	1.37
	19	0.055	0.055	1.37	1.36	1.36
	20	0.055	0.055	1.36	1.15	1.15
	21	0.046	0.046	1.15	0.97	0.97
	22	0.039	0.039	0.97	0.68	0.68
	23	0.028	0.027	0.68	0.64	0.64
Weekend	24	0.026	0.026	0.65	0.59	0.59
	25	0.024	0.024	0.59	0.62	0.62
	26	0.025	0.025	0.62	0.58	0.58
	27	0.023	0.023	0.58	0.56	0.56
	28	0.023	0.022	0.56	0.51	0.51
	29	0.021	0.021	0.51	0.60	0.60
	30	0.024	0.024	0.60	0.79	0.79
	31	0.032	0.032	0.79	1.22	1.22
	32	0.049	0.049	1.22	1.79	1.79
	33	0.072	0.073	1.79	1.75	1.75
	34	0.071	0.075	1.75	1.39	1.39
	35	0.056	0.059	1.39	1.29	1.29
	36	0.052	0.053	1.29	1.08	1.08
	37	0.043	0.043	1.08	1.03	1.03
	38	0.041	0.042	1.03	0.92	0.92
	39	0.037	0.037	0.92	0.93	0.93
	40	0.038	0.038	0.93	1.16	1.16
	41	0.047	0.047	1.16	1.25	1.25
	42	0.050	0.050	1.25	1.10	1.10
	43	0.044	0.044	1.10	0.96	0.96
	44	0.039	0.039	0.96	0.94	0.94
	45	0.038	0.038	0.94	0.77	0.77
	46	0.031	0.031	0.77	0.78	0.78
	47	0.031	0.031	0.78	0.65	0.65
Average						
	Weekday	0.041	0.041	1.01	1.01	1.01
	Weekend	0.039	0.039	0.97	0.97	0.97
	ADWF[(1)]	0.040	0.041	1.00	1.00	1.00
% Error						
	Weekday		1.5%			
	Weekend		1.0%			

Notes:

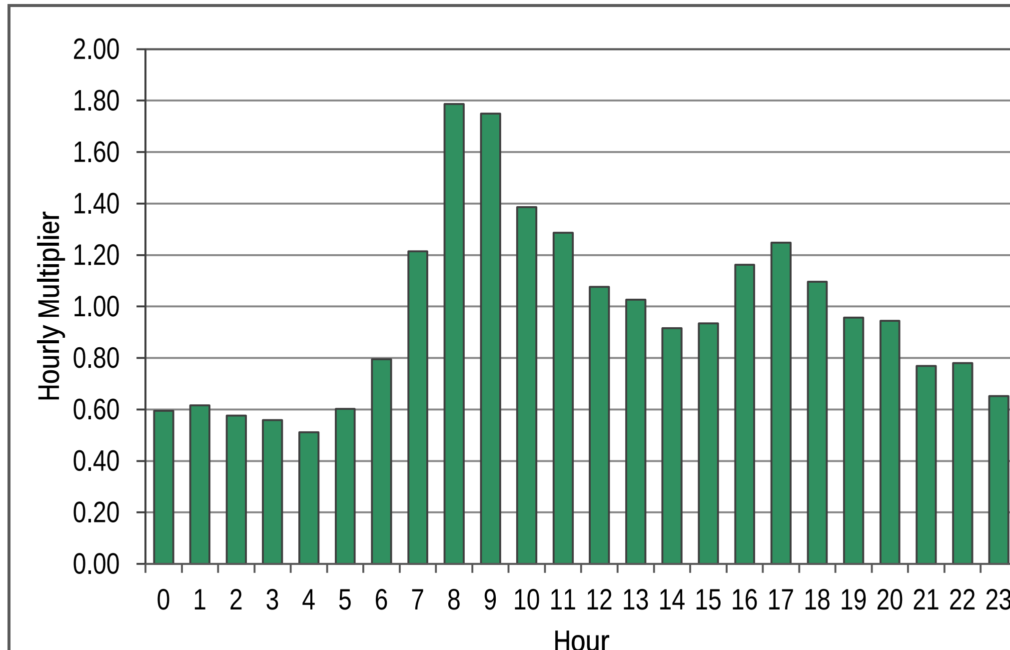
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

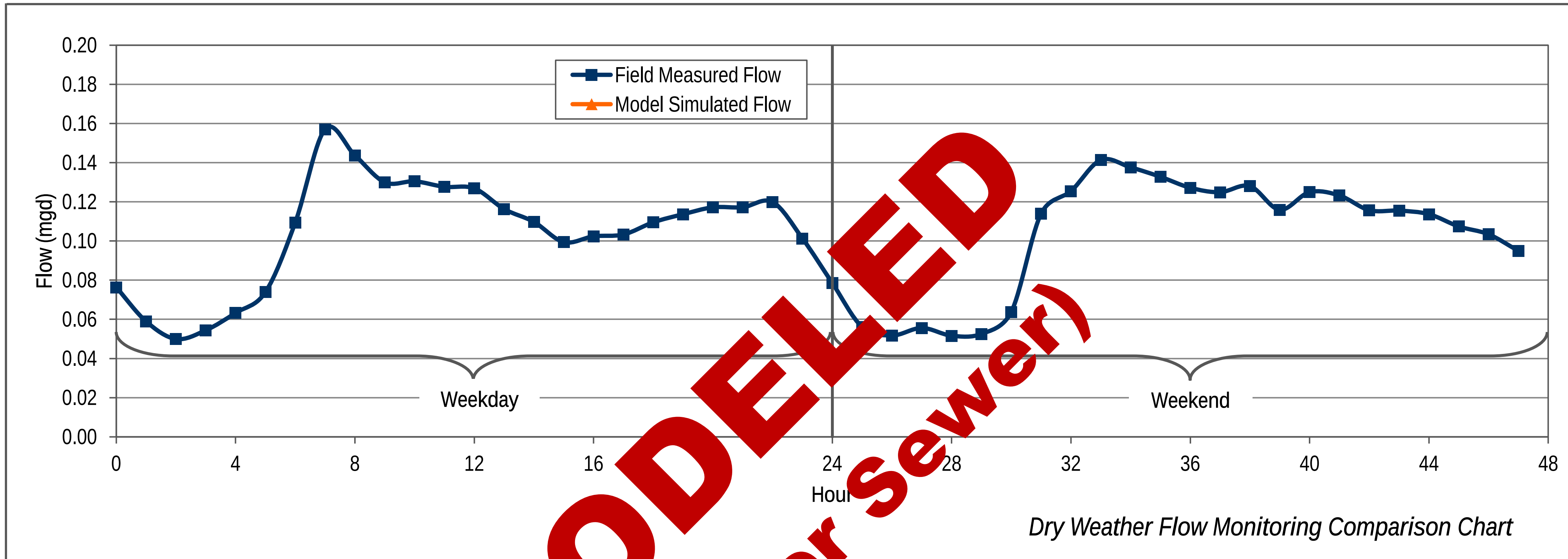
FLOW MONITORING SITE 54-S5 DRY WEATHER CALIBRATION

NOT MODELED (Small Diameter Sewer)

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.076		0.73		
	1	0.059		0.57		
	2	0.050		0.48		
	3	0.054		0.52		
	4	0.063		0.61		
	5	0.074		0.71		
	6	0.109		1.05		
	7	0.157		1.51		
	8	0.144		1.38		
	9	0.130		1.25		
	10	0.130		1.25		
	11	0.128		1.23		
	12	0.127		1.22		
	13	0.116		1.12		
	14	0.110		1.06		
	15	0.099		0.96		
	16	0.102		0.98		
	17	0.103		0.99		
	18	0.110		1.05		
	19	0.114		1.09		
	20	0.117		1.13		
	21	0.117		1.13		
	22	0.120		1.15		
	23	0.101		0.97		
Weekend	24	0.079		0.76		
	25	0.056		0.54		
	26	0.052		0.50		
	27	0.056		0.53		
	28	0.052		0.50		
	29	0.052		0.50		
	30	0.064		0.61		
	31	0.114		1.10		
	32	0.125		1.21		
	33	0.141		1.36		
	34	0.138		1.32		
	35	0.133		1.28		
	36	0.127		1.22		
	37	0.125		1.20		
	38	0.128		1.23		
	39	0.116		1.11		
	40	0.125		1.20		
	41	0.123		1.19		
	42	0.116		1.11		
	43	0.115		1.11		
	44	0.114		1.09		
	45	0.107		1.03		
	46	0.103		0.99		
	47	0.095		0.91		
Average						
	Weekday	0.105	#DIV/0!	1.01	#DIV/0!	#DIV/0!
	Weekend	0.102	#DIV/0!	0.98	#DIV/0!	#DIV/0!
	ADWF(1)	0.104	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

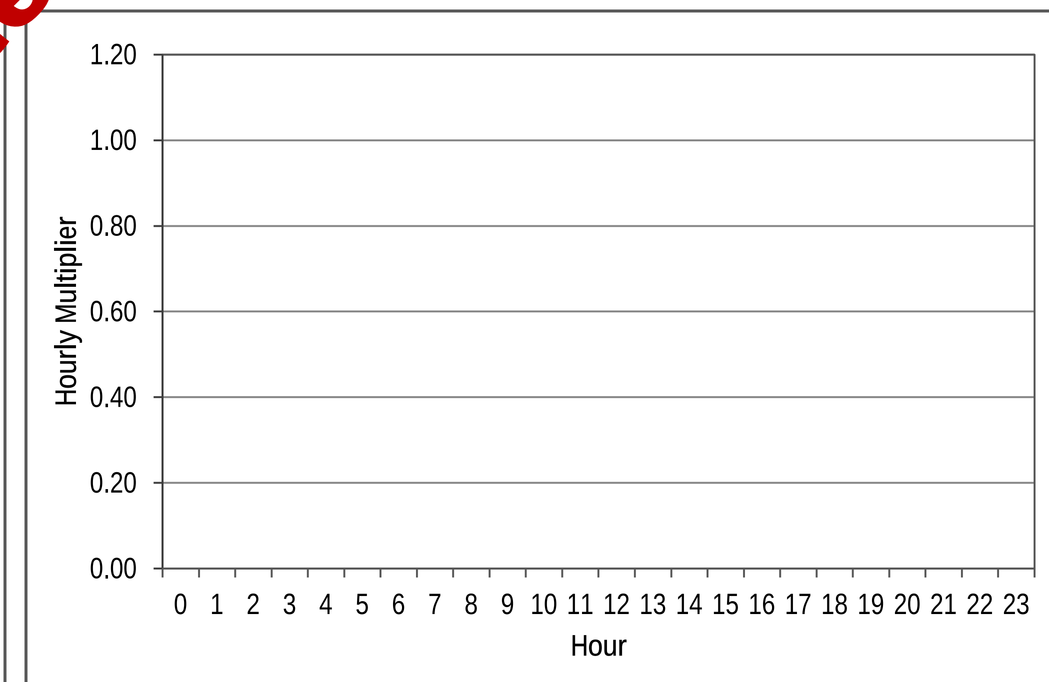
Notes:

1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

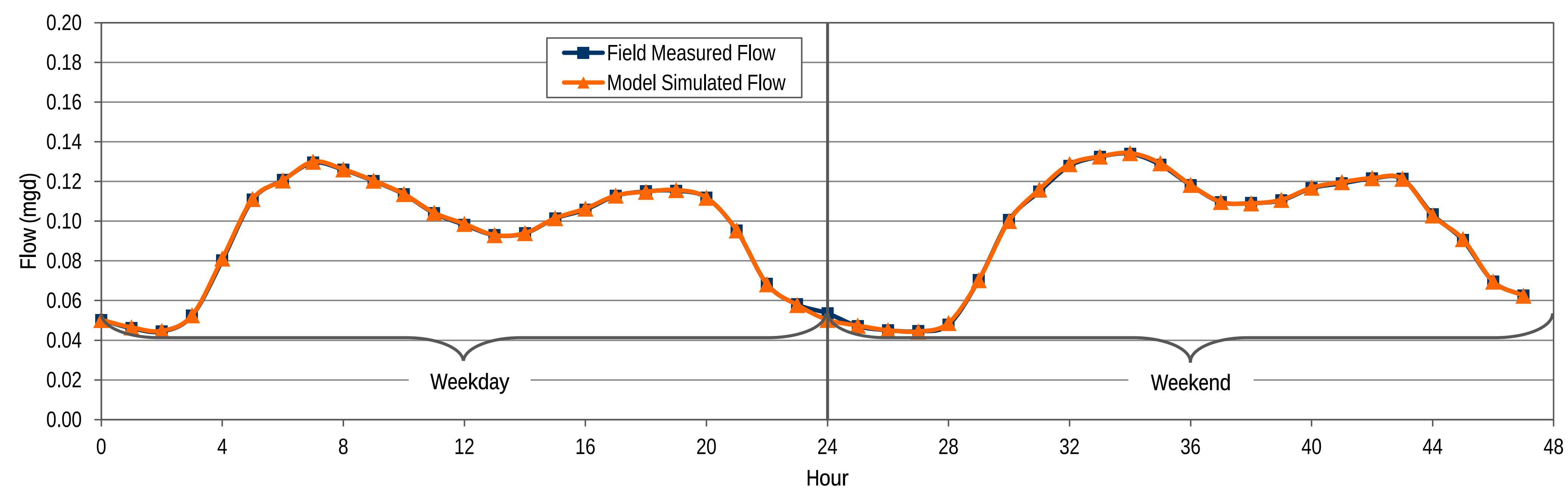
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S6 DRY WEATHER CALIBRATION

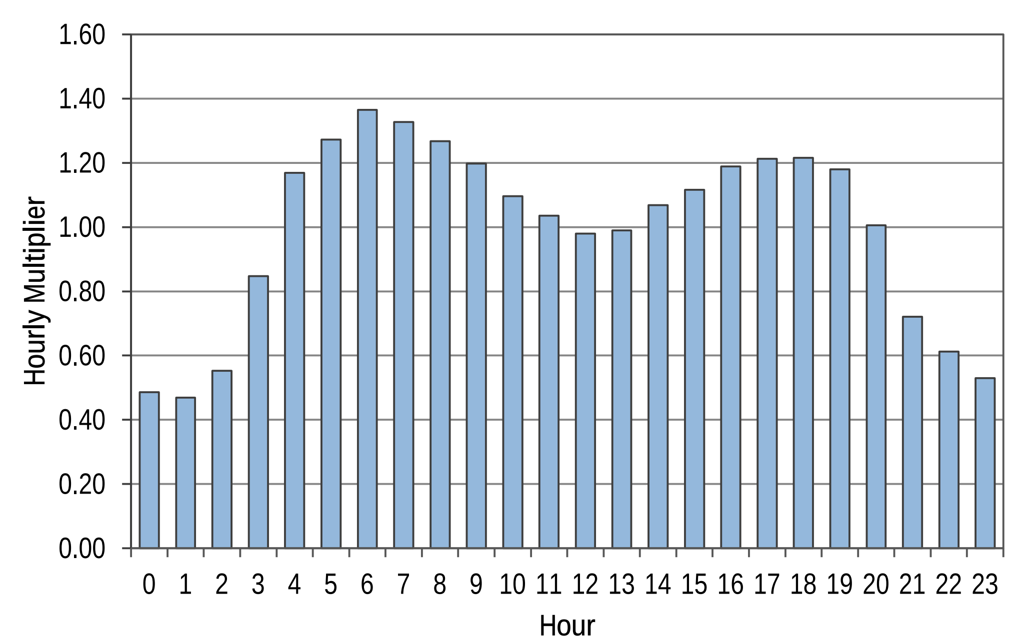
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.050	0.050	0.53	0.49	0.49
	1	0.046	0.046	0.49	0.47	0.47
	2	0.044	0.045	0.47	0.55	0.55
	3	0.052	0.053	0.55	0.85	0.85
	4	0.080	0.081	0.85	1.17	1.17
	5	0.111	0.111	1.17	1.27	1.27
	6	0.121	0.121	1.27	1.37	1.37
	7	0.130	0.130	1.37	1.33	1.33
	8	0.126	0.126	1.33	1.27	1.27
	9	0.120	0.120	1.27	1.20	1.20
	10	0.114	0.114	1.20	1.10	1.10
	11	0.104	0.104	1.10	1.04	1.04
	12	0.098	0.099	1.04	0.98	0.98
	13	0.093	0.093	0.98	0.99	0.99
	14	0.094	0.094	0.99	1.07	1.07
	15	0.101	0.102	1.07	1.12	1.12
	16	0.106	0.106	1.12	1.19	1.19
	17	0.113	0.113	1.19	1.21	1.21
	18	0.115	0.115	1.21	1.22	1.22
	19	0.115	0.116	1.22	1.18	1.18
	20	0.112	0.112	1.18	1.01	1.01
	21	0.095	0.095	1.01	0.72	0.72
	22	0.068	0.068	0.72	0.61	0.61
	23	0.058	0.058	0.61	0.53	0.53
Weekend	24	0.054	0.050	0.57	0.50	0.50
	25	0.047	0.047	0.50	0.48	0.48
	26	0.045	0.045	0.48	0.47	0.47
	27	0.045	0.044	0.47	0.50	0.50
	28	0.048	0.049	0.50	0.74	0.74
	29	0.070	0.070	0.74	1.06	1.06
	30	0.101	0.100	1.06	1.21	1.21
	31	0.115	0.116	1.21	1.35	1.35
	32	0.128	0.129	1.35	1.40	1.40
	33	0.132	0.133	1.40	1.41	1.41
	34	0.134	0.134	1.41	1.35	1.35
	35	0.128	0.129	1.35	1.25	1.25
	36	0.118	0.118	1.25	1.16	1.16
	37	0.110	0.110	1.16	1.15	1.15
	38	0.109	0.109	1.15	1.17	1.17
	39	0.111	0.111	1.17	1.23	1.23
	40	0.117	0.117	1.23	1.26	1.26
	41	0.119	0.120	1.26	1.28	1.28
	42	0.121	0.122	1.28	1.28	1.28
	43	0.121	0.121	1.28	1.09	1.09
	44	0.103	0.103	1.09	0.95	0.95
	45	0.090	0.091	0.95	0.73	0.73
	46	0.070	0.070	0.73	0.66	0.66
	47	0.063	0.062	0.66	0.57	0.57
Average						
	Weekday	0.094	0.095	1.00	1.00	1.00
	Weekend	0.096	0.096	1.01	1.01	1.01
	ADWF[1]	0.095	0.095	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		0.0%			

Notes:

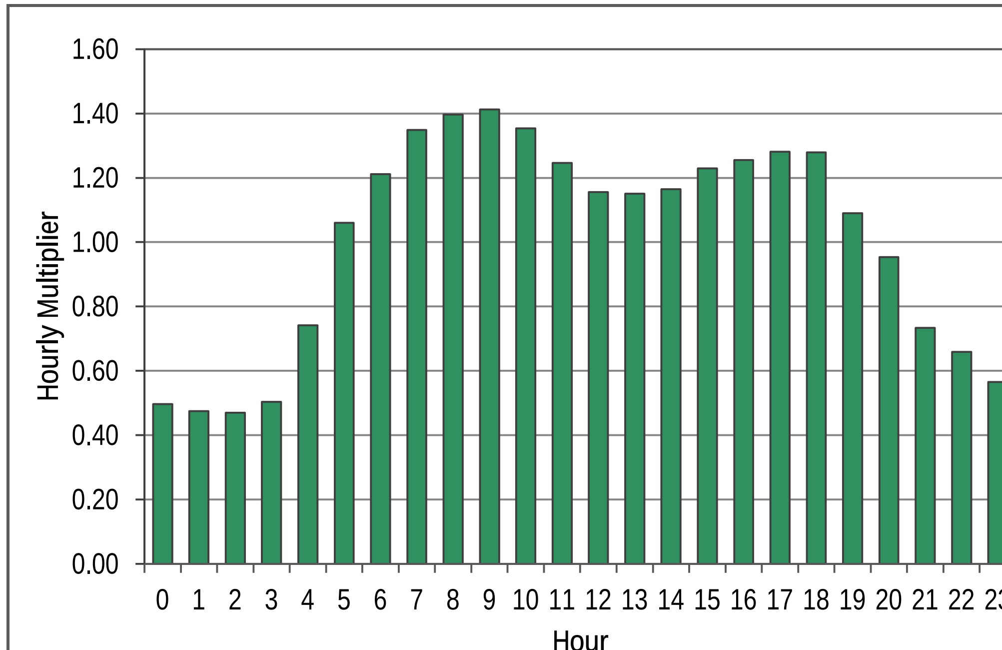
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



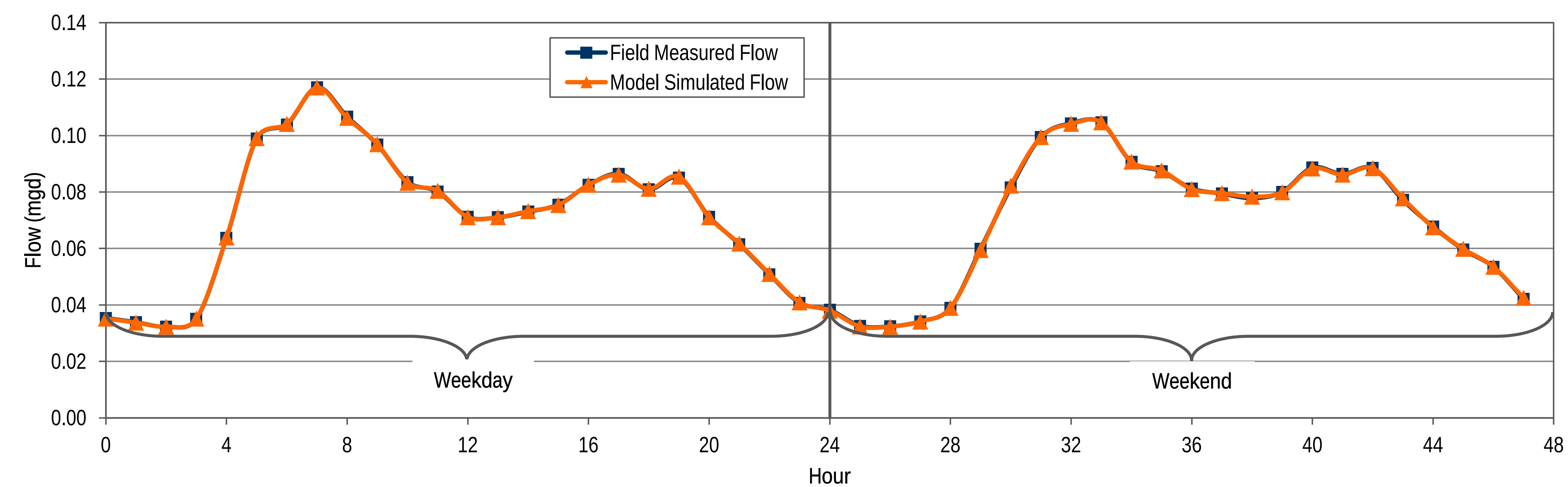
Dry Weather Flow Weekend Diurnal

FLOW MONITORING SITE 54-S7 DRY WEATHER CALIBRATION

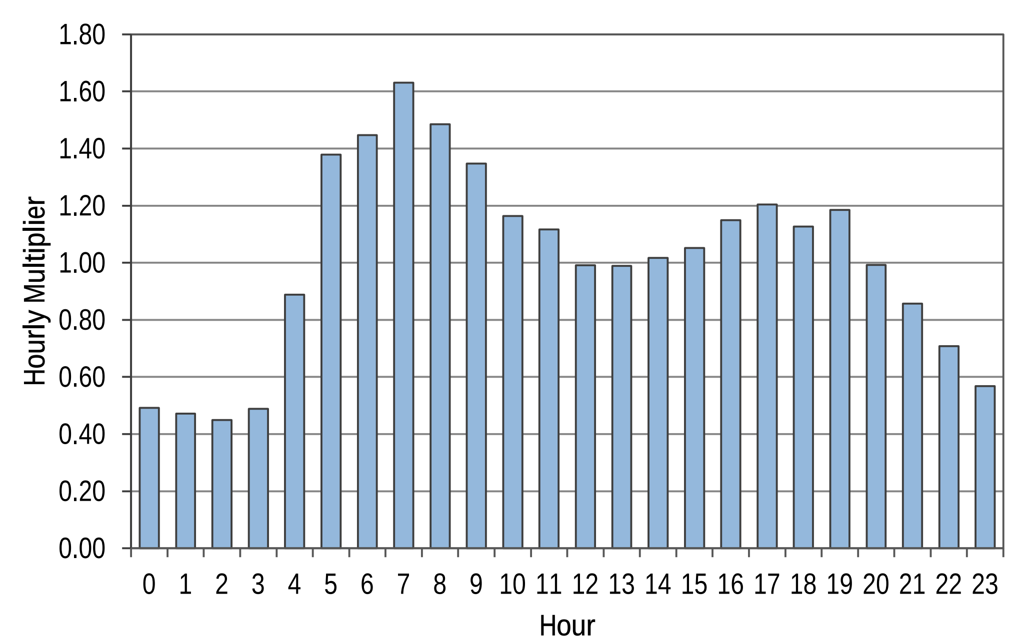
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.035	0.035	0.49	0.49	0.49
	1	0.034	0.034	0.47	0.47	0.47
	2	0.032	0.032	0.45	0.45	0.45
	3	0.035	0.035	0.49	0.49	0.49
	4	0.064	0.064	0.89	0.89	0.89
	5	0.099	0.099	1.38	1.38	1.38
	6	0.104	0.104	1.45	1.45	1.45
	7	0.117	0.117	1.63	1.63	1.63
	8	0.107	0.106	1.48	1.48	1.48
	9	0.097	0.097	1.35	1.35	1.35
	10	0.084	0.083	1.16	1.16	1.16
	11	0.080	0.080	1.12	1.12	1.12
	12	0.071	0.071	0.99	0.99	0.99
	13	0.071	0.071	0.99	0.99	0.99
	14	0.073	0.073	1.02	1.02	1.02
	15	0.076	0.075	1.05	1.05	1.05
	16	0.083	0.083	1.15	1.15	1.15
	17	0.086	0.086	1.20	1.20	1.20
	18	0.081	0.081	1.13	1.13	1.13
	19	0.085	0.085	1.19	1.19	1.19
	20	0.071	0.071	0.99	0.99	0.99
	21	0.062	0.062	0.86	0.86	0.86
	22	0.051	0.051	0.71	0.71	0.71
	23	0.041	0.041	0.57	0.57	0.57
Weekend	24	0.038	0.038	0.53	0.53	0.53
	25	0.033	0.032	0.45	0.45	0.45
	26	0.032	0.032	0.45	0.45	0.45
	27	0.034	0.034	0.48	0.48	0.48
	28	0.039	0.039	0.54	0.54	0.54
	29	0.060	0.059	0.83	0.83	0.83
	30	0.082	0.082	1.14	1.14	1.14
	31	0.099	0.099	1.38	1.38	1.38
	32	0.104	0.104	1.45	1.45	1.45
	33	0.105	0.105	1.46	1.46	1.46
	34	0.091	0.091	1.26	1.26	1.26
	35	0.087	0.088	1.22	1.22	1.22
	36	0.081	0.081	1.13	1.13	1.13
	37	0.079	0.080	1.11	1.11	1.11
	38	0.078	0.078	1.08	1.08	1.08
	39	0.080	0.080	1.11	1.11	1.11
	40	0.089	0.088	1.23	1.23	1.23
	41	0.086	0.086	1.20	1.20	1.20
	42	0.089	0.088	1.23	1.23	1.23
	43	0.077	0.078	1.08	1.08	1.08
	44	0.068	0.068	0.94	0.94	0.94
	45	0.060	0.060	0.83	0.83	0.83
	46	0.053	0.054	0.74	0.74	0.74
	47	0.042	0.043	0.59	0.59	0.59
Average						
	Weekday	0.072	0.072	1.01	1.01	1.01
	Weekend	0.070	0.070	0.98	0.98	0.98
	ADWF[(1)]	0.072	0.072	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

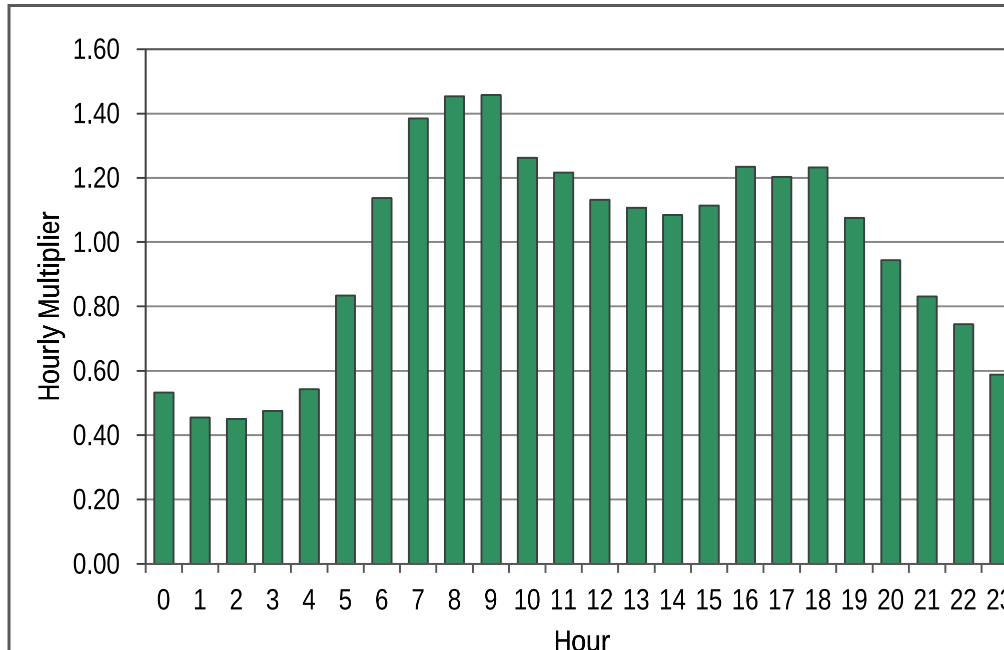
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

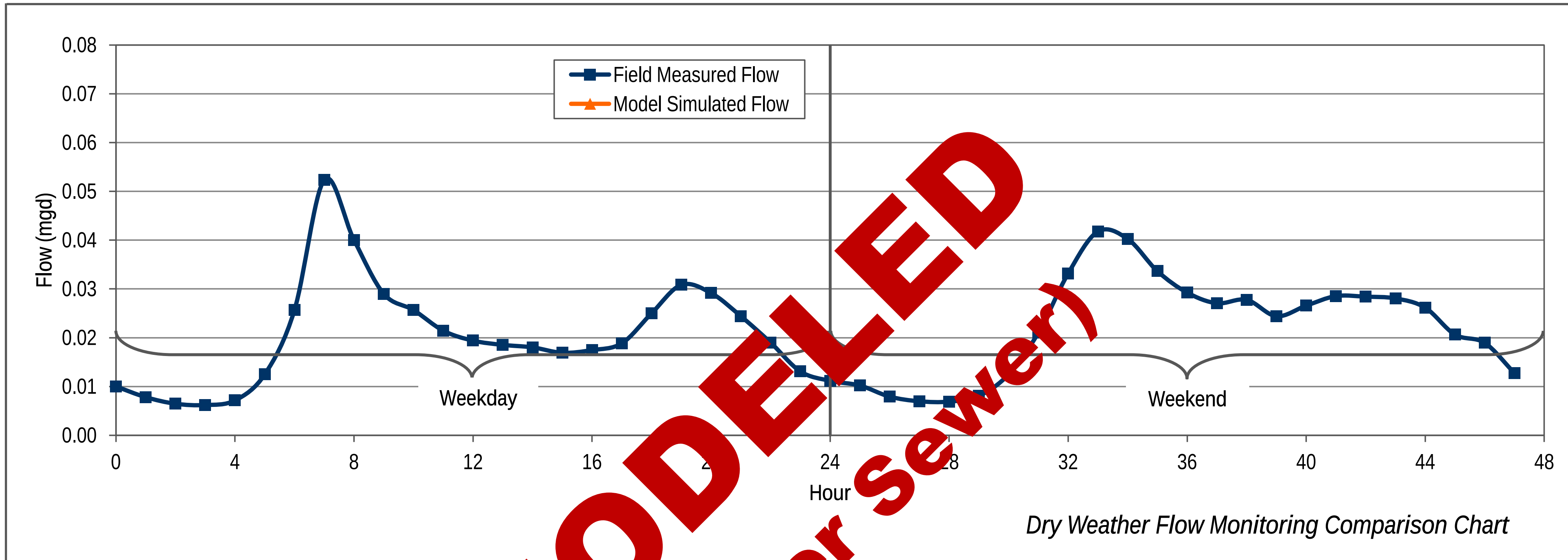
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S8 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.010		0.48		
	1	0.008		0.37		
	2	0.006		0.31		
	3	0.006		0.30		
	4	0.007		0.34		
	5	0.013		0.59		
	6	0.026		1.22		
	7	0.052		2.48		
	8	0.040		1.90		
	9	0.029		1.38		
	10	0.026		1.22		
	11	0.021		1.02		
	12	0.019		0.92		
	13	0.019		0.88		
	14	0.018		0.86		
	15	0.017		0.80		
	16	0.017		0.83		
	17	0.019		0.89		
	18	0.025		1.19		
	19	0.031		1.46		
	20	0.029		1.38		
	21	0.024		1.16		
	22	0.019		0.90		
	23	0.013		0.62		
Weekend	24	0.011		0.53		
	25	0.010		0.48		
	26	0.008		0.38		
	27	0.007		0.33		
	28	0.007		0.33		
	29	0.008		0.38		
	30	0.013		0.59		
	31	0.021		1.00		
	32	0.033		1.57		
	33	0.042		1.98		
	34	0.040		1.91		
	35	0.034		1.60		
	36	0.029		1.39		
	37	0.027		1.28		
	38	0.028		1.32		
	39	0.024		1.16		
	40	0.027		1.26		
	41	0.029		1.35		
	42	0.028		1.35		
	43	0.028		1.33		
	44	0.026		1.24		
	45	0.021		0.98		
	46	0.019		0.90		
	47	0.013		0.61		
Average						
	Weekday	0.021	#DIV/0!	0.98	#DIV/0!	#DIV/0!
	Weekend	0.022	#DIV/0!	1.05	#DIV/0!	#DIV/0!
	ADWF[(1)]	0.021	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

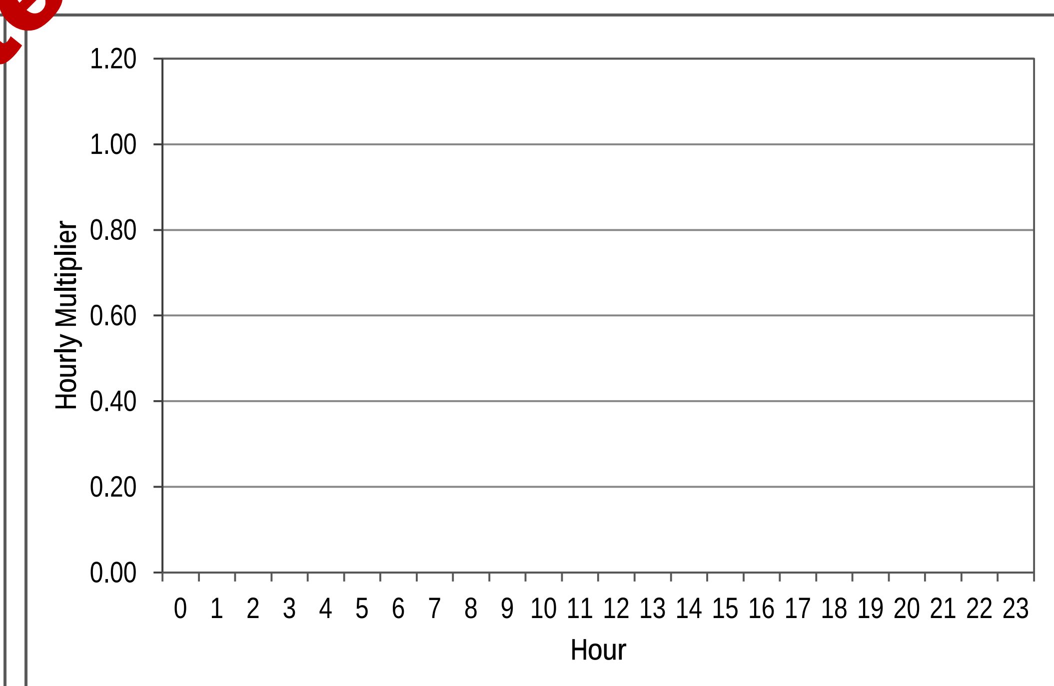
Notes:

1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

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pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

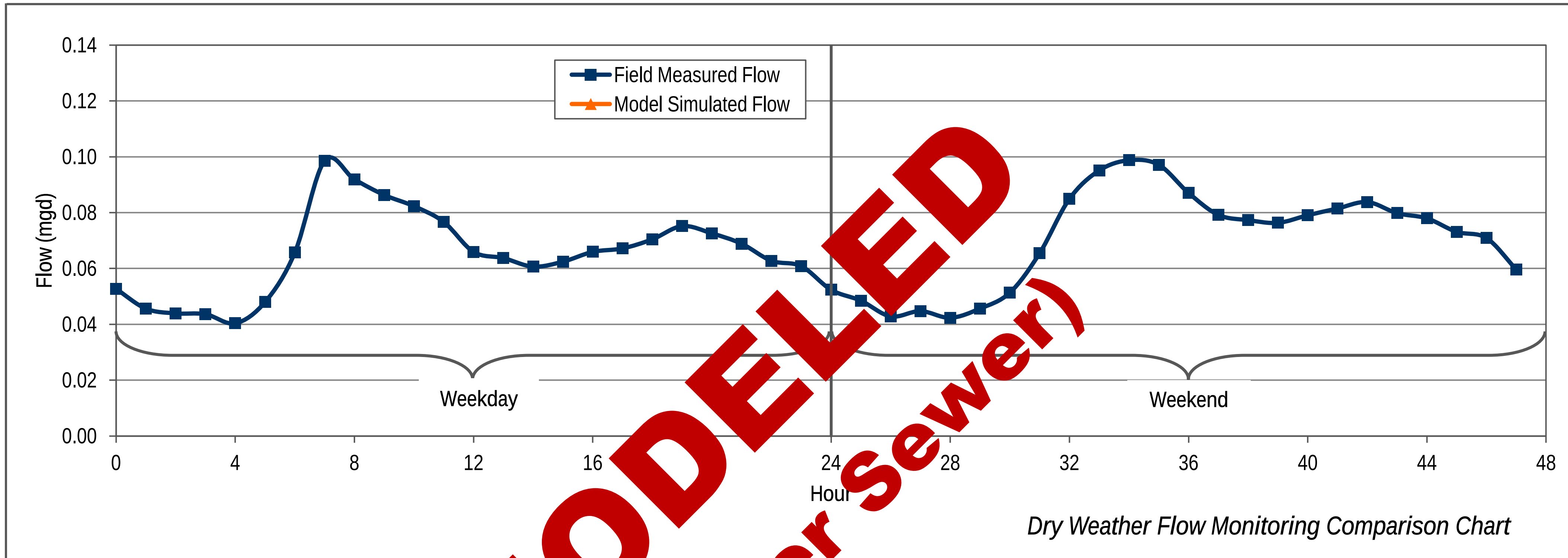
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S9 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.053		0.79		
	1	0.046		0.68		
	2	0.044		0.66		
	3	0.044		0.65		
	4	0.040		0.60		
	5	0.048		0.72		
	6	0.066		0.98		
	7	0.099		1.47		
	8	0.092		1.37		
	9	0.086		1.29		
	10	0.082		1.23		
	11	0.077		1.14		
	12	0.066		0.98		
	13	0.064		0.95		
	14	0.061		0.91		
	15	0.062		0.93		
	16	0.066		0.98		
	17	0.067		1.00		
	18	0.070		1.05		
	19	0.075		1.12		
	20	0.073		1.08		
	21	0.069		1.03		
	22	0.063		0.94		
	23	0.061		0.91		
Weekend	24	0.052		0.78		
	25	0.048		0.72		
	26	0.043		0.64		
	27	0.045		0.67		
	28	0.042		0.63		
	29	0.046		0.68		
	30	0.051		0.77		
	31	0.065		0.98		
	32	0.085		1.27		
	33	0.095		1.42		
	34	0.099		1.47		
	35	0.097		1.45		
	36	0.087		1.30		
	37	0.079		1.18		
	38	0.077		1.15		
	39	0.076		1.14		
	40	0.079		1.18		
	41	0.082		1.22		
	42	0.084		1.25		
	43	0.080		1.19		
	44	0.078		1.16		
	45	0.073		1.09		
	46	0.071		1.06		
	47	0.060		0.89		
Average						
	Weekday	0.066	#DIV/0!	0.98	#DIV/0!	#DIV/0!
	Weekend	0.071	#DIV/0!	1.05	#DIV/0!	#DIV/0!
	ADWF[(1)]	0.067	#DIV/0!	1.00	#DIV/0!	#DIV/0!
% Error						
	Weekday		#DIV/0!			
	Weekend		#DIV/0!			

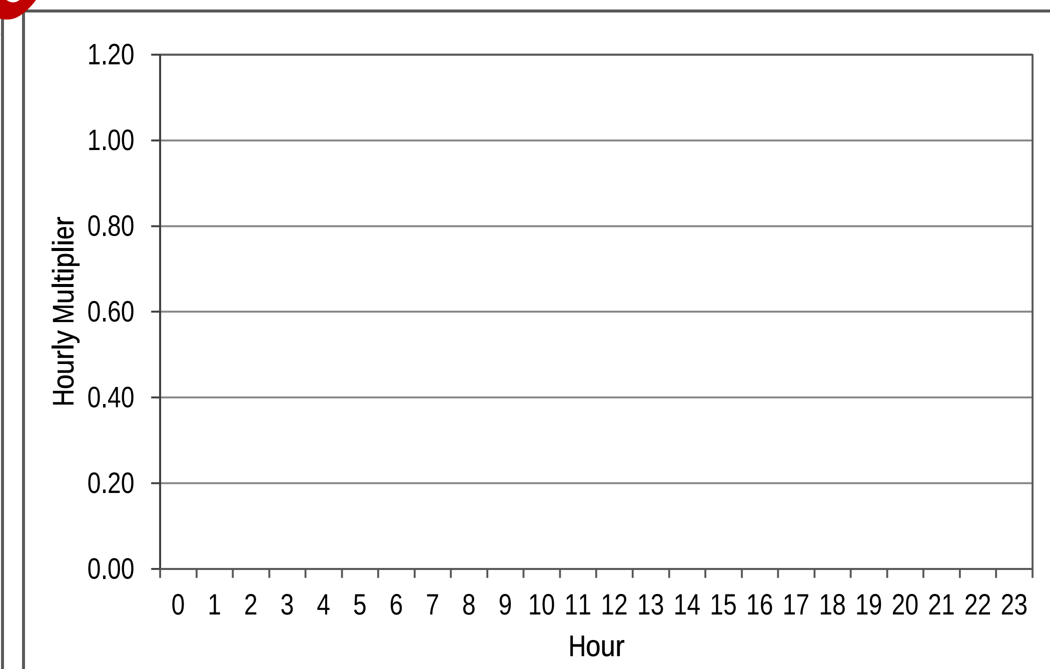
Notes:

1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart

Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

NOT MODELED (Small Diameter Sewer)

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City of Oakland

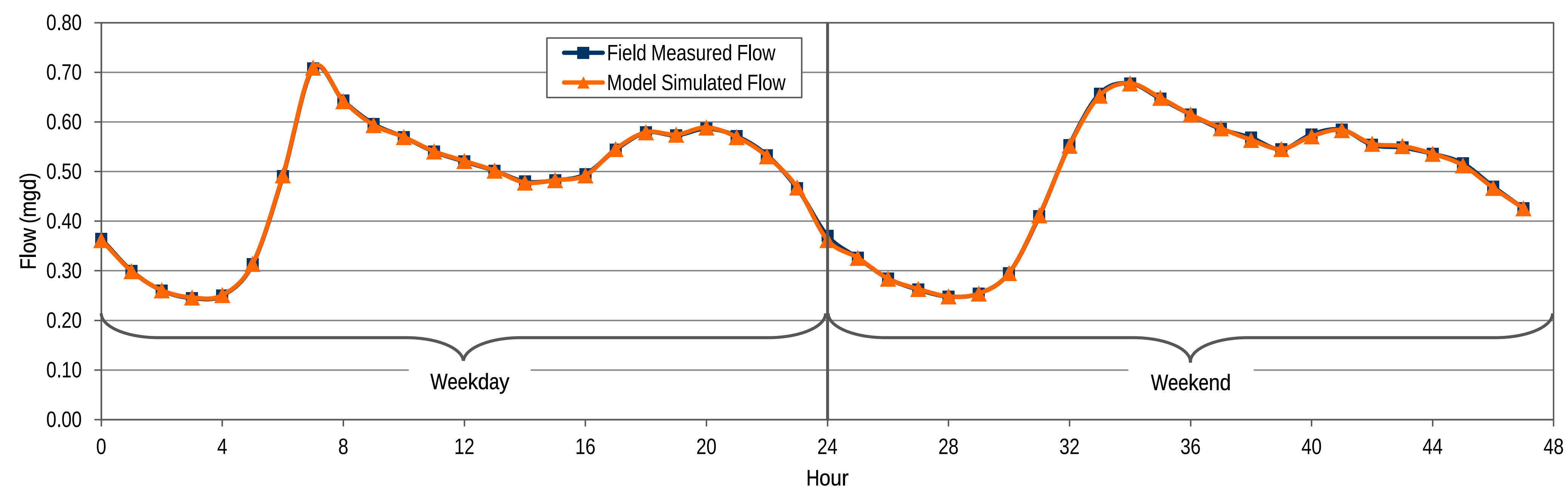
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54A DRY WEATHER CALIBRATION

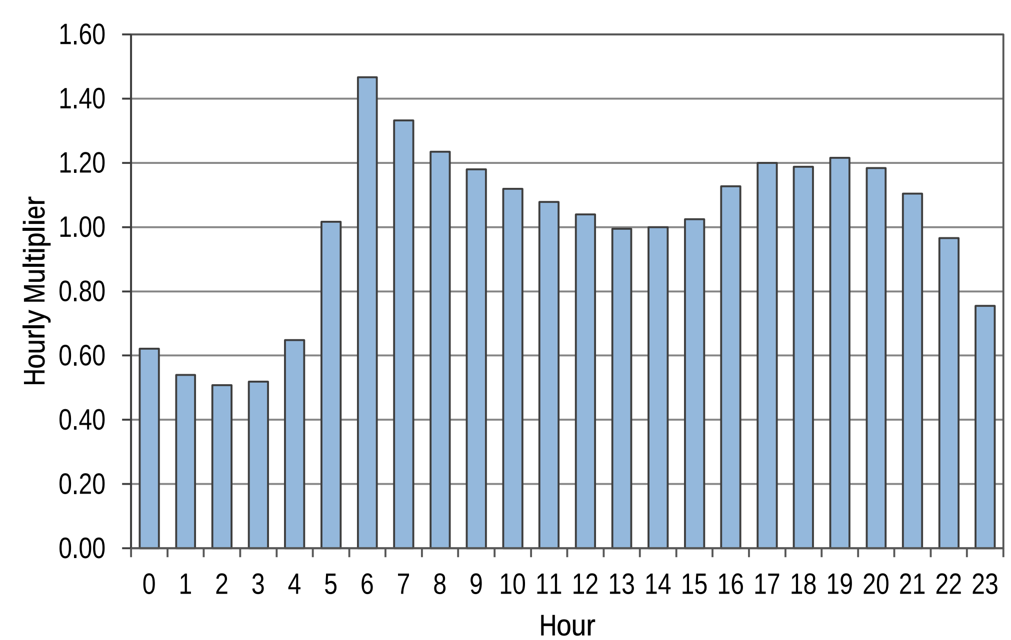
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.364	0.362	0.75	0.62	0.62
	1	0.300	0.299	0.62	0.54	0.54
	2	0.260	0.261	0.54	0.51	0.51
	3	0.245	0.246	0.51	0.52	0.52
	4	0.250	0.251	0.52	0.65	0.65
	5	0.313	0.314	0.65	1.02	1.02
	6	0.491	0.492	1.02	1.47	1.47
	7	0.708	0.709	1.47	1.33	1.33
	8	0.643	0.642	1.33	1.23	1.23
	9	0.596	0.594	1.23	1.18	1.18
	10	0.569	0.569	1.18	1.12	1.12
	11	0.540	0.540	1.12	1.08	1.08
	12	0.520	0.521	1.08	1.04	1.04
	13	0.502	0.502	1.04	0.99	0.99
	14	0.480	0.478	0.99	1.00	1.00
	15	0.482	0.483	1.00	1.02	1.02
	16	0.495	0.492	1.02	1.13	1.13
	17	0.544	0.545	1.13	1.20	1.20
	18	0.579	0.579	1.20	1.19	1.19
	19	0.573	0.574	1.19	1.22	1.22
	20	0.587	0.589	1.22	1.18	1.18
	21	0.571	0.569	1.18	1.10	1.10
	22	0.533	0.531	1.10	0.97	0.97
	23	0.466	0.468	0.97	0.75	0.75
Weekend	24	0.371	0.362	0.77	0.68	0.68
	25	0.326	0.326	0.68	0.59	0.59
	26	0.284	0.284	0.59	0.54	0.54
	27	0.262	0.263	0.54	0.51	0.51
	28	0.248	0.248	0.51	0.53	0.53
	29	0.254	0.254	0.53	0.61	0.61
	30	0.295	0.295	0.61	0.85	0.85
	31	0.410	0.412	0.85	1.15	1.15
	32	0.554	0.552	1.15	1.36	1.36
	33	0.657	0.653	1.36	1.40	1.40
	34	0.678	0.678	1.40	1.34	1.34
	35	0.647	0.649	1.34	1.27	1.27
	36	0.615	0.615	1.27	1.21	1.21
	37	0.586	0.587	1.21	1.18	1.18
	38	0.568	0.564	1.18	1.13	1.13
	39	0.545	0.545	1.13	1.19	1.19
	40	0.575	0.571	1.19	1.21	1.21
	41	0.585	0.584	1.21	1.15	1.15
	42	0.554	0.556	1.15	1.14	1.14
	43	0.548	0.551	1.14	1.11	1.11
	44	0.536	0.536	1.11	1.07	1.07
	45	0.516	0.513	1.07	0.97	0.97
	46	0.470	0.467	0.97	0.88	0.88
	47	0.426	0.426	0.88	0.77	0.77
Average						
Weekday		0.484	0.484	1.00	1.00	1.00
Weekend		0.480	0.479	0.99	0.99	0.99
ADWF[(1)]		0.483	0.482	1.00	1.00	1.00
% Error						
Weekday			0.0%			
Weekend			-0.2%			

Notes:

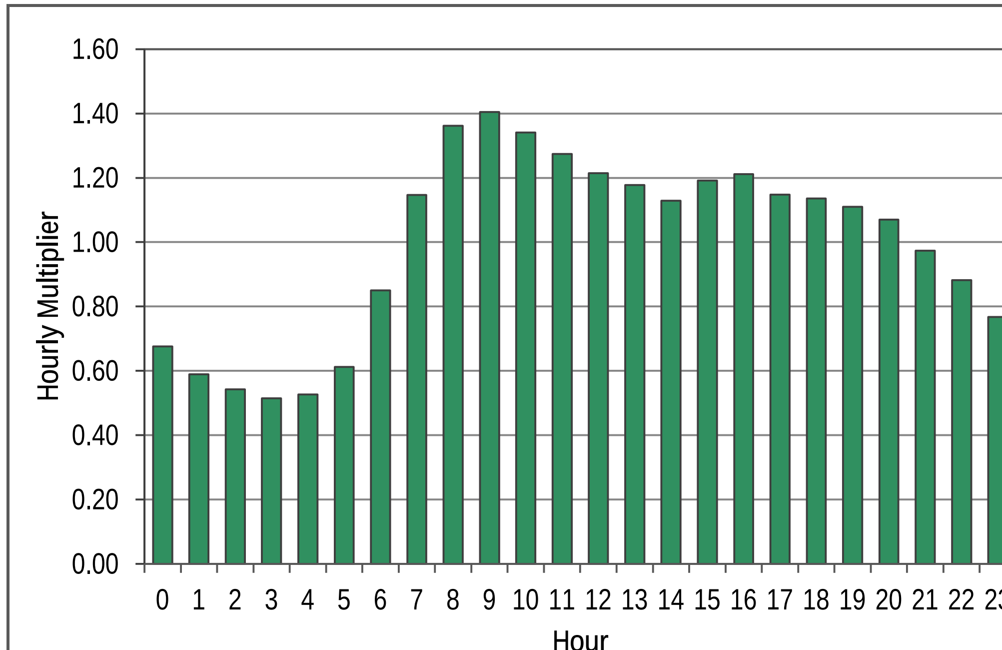
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

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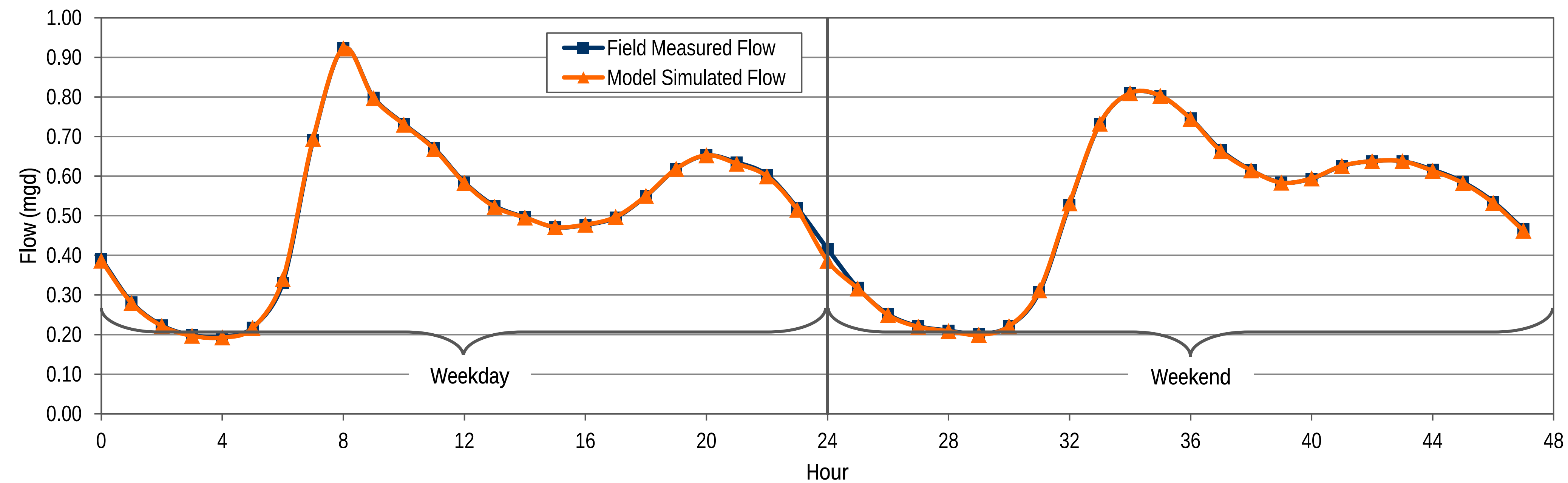
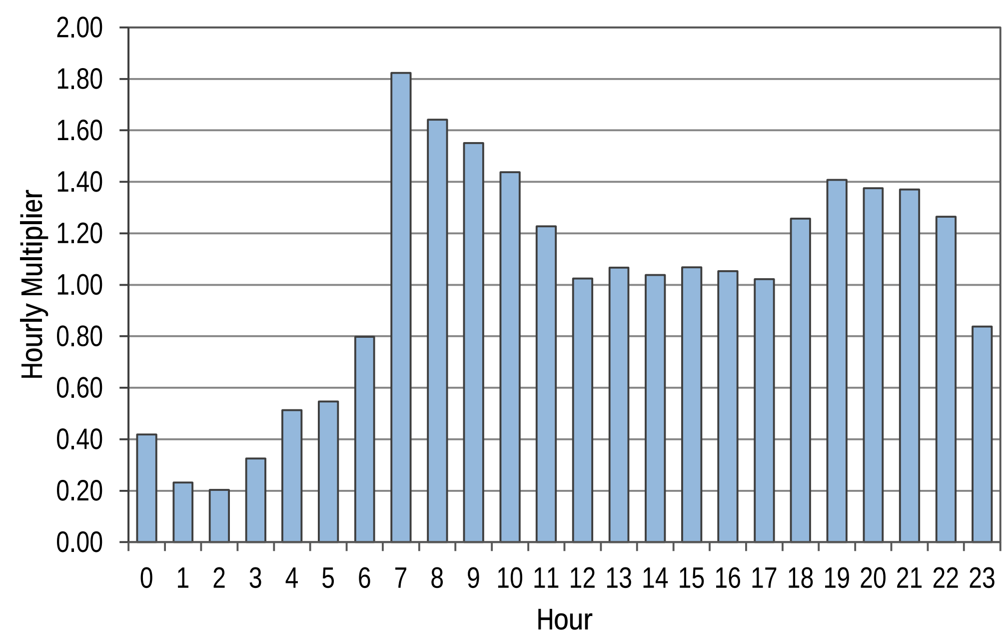
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54C DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.391	0.387	0.76	0.55	0.42
	1	0.282	0.280	0.55	0.44	0.23
	2	0.223	0.222	0.44	0.39	0.20
	3	0.198	0.197	0.39	0.38	0.32
	4	0.195	0.193	0.38	0.42	0.51
	5	0.218	0.217	0.42	0.65	0.55
	6	0.331	0.340	0.65	1.35	0.80
	7	0.691	0.695	1.35	1.80	1.82
	8	0.923	0.923	1.80	1.56	1.64
	9	0.799	0.797	1.56	1.43	1.55
	10	0.732	0.730	1.43	1.31	1.44
	11	0.670	0.668	1.31	1.14	1.23
	12	0.584	0.583	1.14	1.02	1.02
	13	0.525	0.523	1.02	0.97	1.07
	14	0.496	0.496	0.97	0.92	1.04
	15	0.471	0.472	0.92	0.93	1.07
	16	0.477	0.478	0.93	0.97	1.05
	17	0.496	0.497	0.97	1.07	1.02
	18	0.549	0.550	1.07	1.21	1.26
	19	0.618	0.619	1.21	1.27	1.41
	20	0.652	0.653	1.27	1.24	1.37
	21	0.635	0.631	1.24	1.18	1.37
	22	0.603	0.599	1.18	1.01	1.26
	23	0.520	0.515	1.01	0.76	0.84
Weekend	24	0.416	0.386	0.81	0.62	0.68
	25	0.318	0.316	0.62	0.49	0.40
	26	0.252	0.250	0.49	0.43	0.32
	27	0.221	0.220	0.43	0.41	0.32
	28	0.210	0.209	0.41	0.39	0.36
	29	0.201	0.200	0.39	0.43	0.50
	30	0.221	0.221	0.43	0.60	0.58
	31	0.307	0.312	0.60	1.03	0.61
	32	0.528	0.532	1.03	1.43	0.94
	33	0.732	0.733	1.43	1.58	1.35
	34	0.809	0.810	1.58	1.57	1.32
	35	0.802	0.803	1.57	1.46	1.35
	36	0.745	0.745	1.46	1.30	1.30
	37	0.666	0.663	1.30	1.20	1.23
	38	0.615	0.615	1.20	1.14	1.19
	39	0.584	0.584	1.14	1.16	1.25
	40	0.594	0.594	1.16	1.22	1.31
	41	0.625	0.626	1.22	1.25	1.14
	42	0.638	0.638	1.25	1.24	1.17
	43	0.638	0.638	1.24	1.20	1.17
	44	0.616	0.614	1.20	1.14	1.17
	45	0.585	0.583	1.14	1.05	1.11
	46	0.536	0.533	1.05	0.91	0.95
	47	0.466	0.462	0.91	0.81	1.04
Average						
	Weekday	0.512	0.511	1.00	1.00	1.02
	Weekend	0.514	0.512	1.00	1.00	0.95
	ADWF[(1)]	0.512	0.511	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.3%			

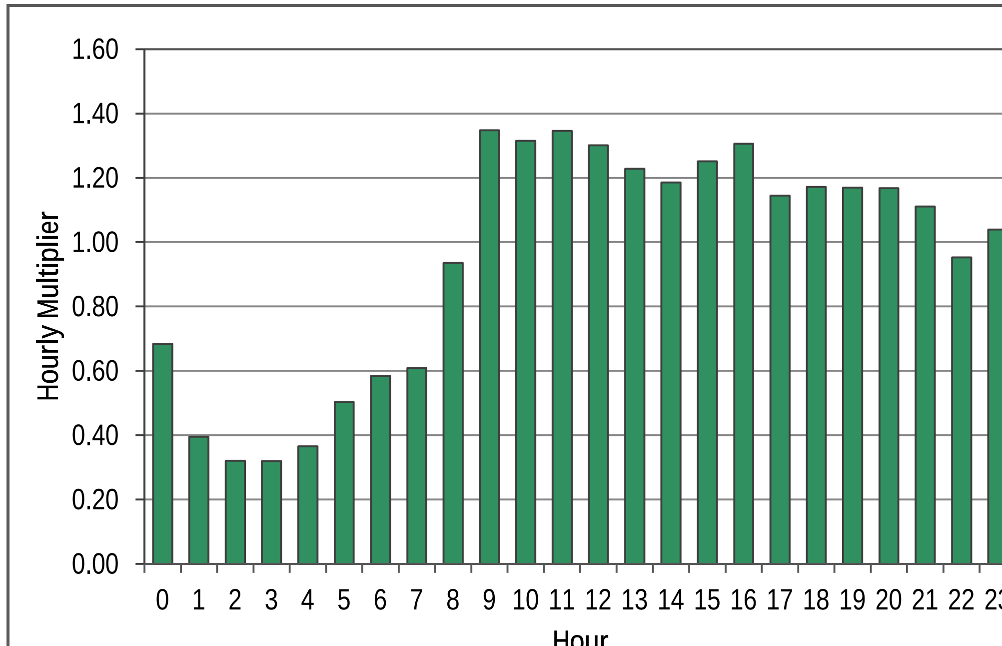
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

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City of Oakland

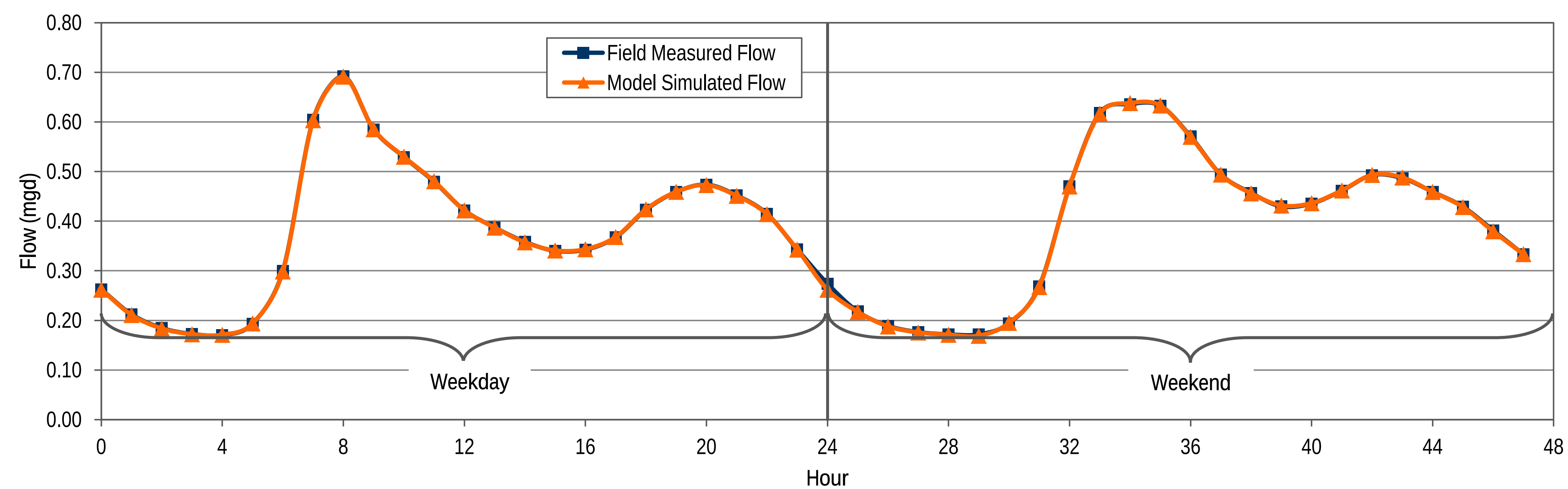
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54C.1 DRY WEATHER CALIBRATION

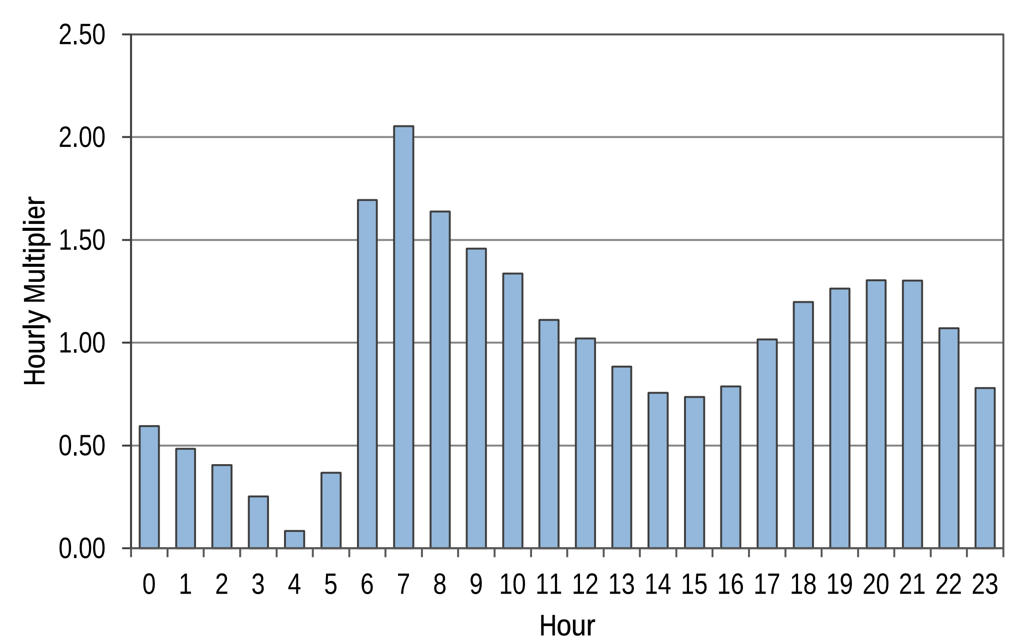
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.262	0.262	0.68	0.55	0.59
	1	0.212	0.211	0.55	0.48	0.48
	2	0.184	0.183	0.48	0.45	0.40
	3	0.172	0.172	0.45	0.44	0.25
	4	0.170	0.171	0.44	0.50	0.08
	5	0.193	0.194	0.50	0.78	0.37
	6	0.300	0.299	0.78	1.57	1.69
	7	0.604	0.603	1.57	1.80	2.05
	8	0.692	0.691	1.80	1.52	1.64
	9	0.585	0.585	1.52	1.37	1.46
	10	0.529	0.530	1.37	1.24	1.34
	11	0.479	0.481	1.24	1.09	1.11
	12	0.422	0.422	1.09	1.00	1.02
	13	0.387	0.387	1.00	0.93	0.88
	14	0.358	0.357	0.93	0.88	0.76
	15	0.340	0.341	0.88	0.89	0.74
	16	0.342	0.343	0.89	0.95	0.79
	17	0.367	0.368	0.95	1.10	1.02
	18	0.423	0.424	1.10	1.19	1.20
	19	0.459	0.459	1.19	1.23	1.26
	20	0.473	0.473	1.23	1.17	1.30
	21	0.452	0.451	1.17	1.08	1.30
	22	0.415	0.414	1.08	0.89	1.07
	23	0.343	0.343	0.89	0.68	0.78
Weekend	24	0.274	0.262	0.71	0.57	0.61
	25	0.218	0.217	0.57	0.49	0.51
	26	0.189	0.188	0.49	0.46	0.46
	27	0.176	0.176	0.46	0.45	0.41
	28	0.172	0.171	0.45	0.45	0.29
	29	0.172	0.169	0.45	0.50	0.16
	30	0.194	0.195	0.50	0.70	0.32
	31	0.269	0.267	0.70	1.22	1.11
	32	0.470	0.470	1.22	1.60	1.74
	33	0.618	0.617	1.60	1.65	1.82
	34	0.636	0.638	1.65	1.64	1.89
	35	0.632	0.633	1.64	1.48	1.67
	36	0.571	0.570	1.48	1.28	1.39
	37	0.494	0.494	1.28	1.19	1.23
	38	0.457	0.456	1.19	1.12	1.10
	39	0.430	0.432	1.12	1.13	1.09
	40	0.435	0.436	1.13	1.20	1.16
	41	0.461	0.462	1.20	1.28	1.30
	42	0.493	0.493	1.28	1.26	1.27
	43	0.487	0.488	1.26	1.19	1.27
	44	0.459	0.459	1.19	1.11	1.24
	45	0.429	0.429	1.11	0.99	1.15
	46	0.381	0.380	0.99	0.86	0.99
	47	0.333	0.334	0.86	0.71	0.83
Average						
	Weekday	0.382	0.382	0.99	0.99	0.98
	Weekend	0.394	0.393	1.02	1.02	1.04
	ADWF[(1)]	0.385	0.385	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.1%			

Notes:

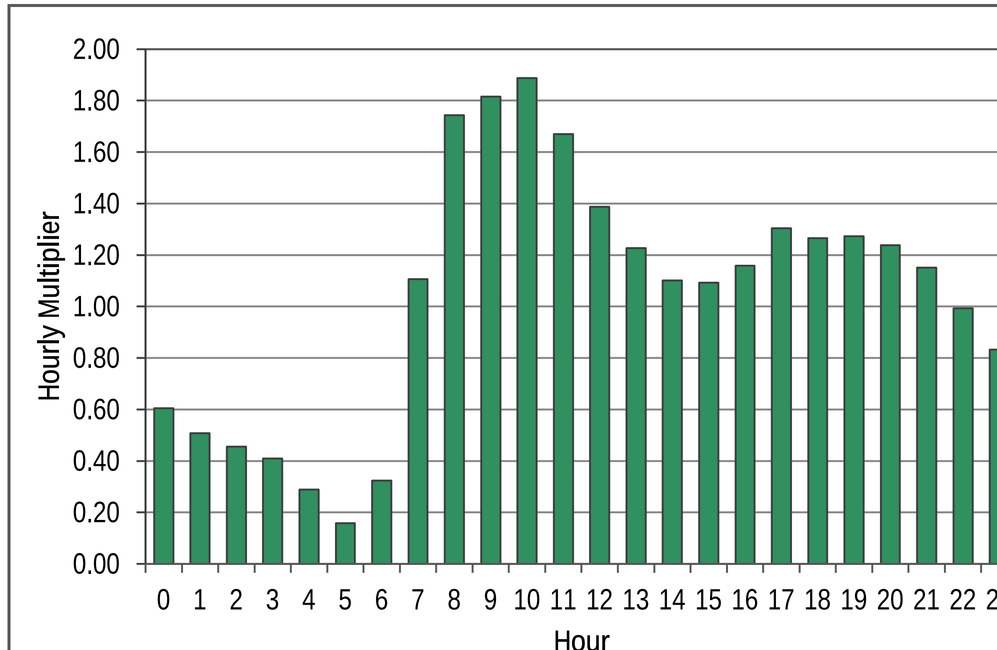
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_54.xlsx

City of Oakland

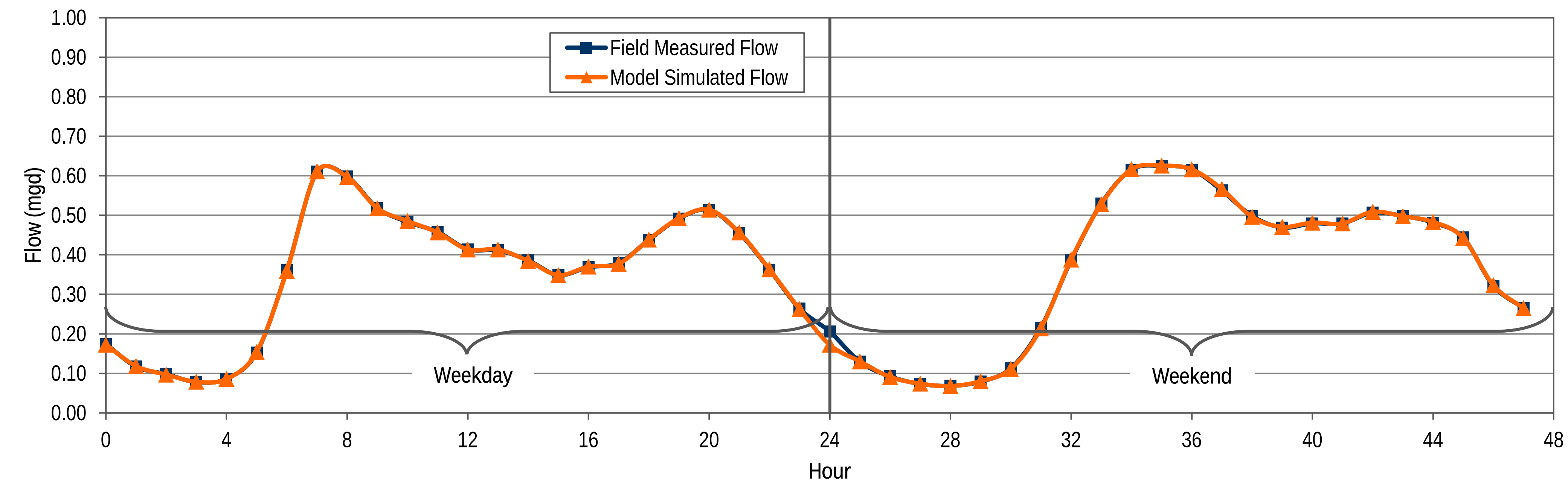
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56A DRY WEATHER CALIBRATION

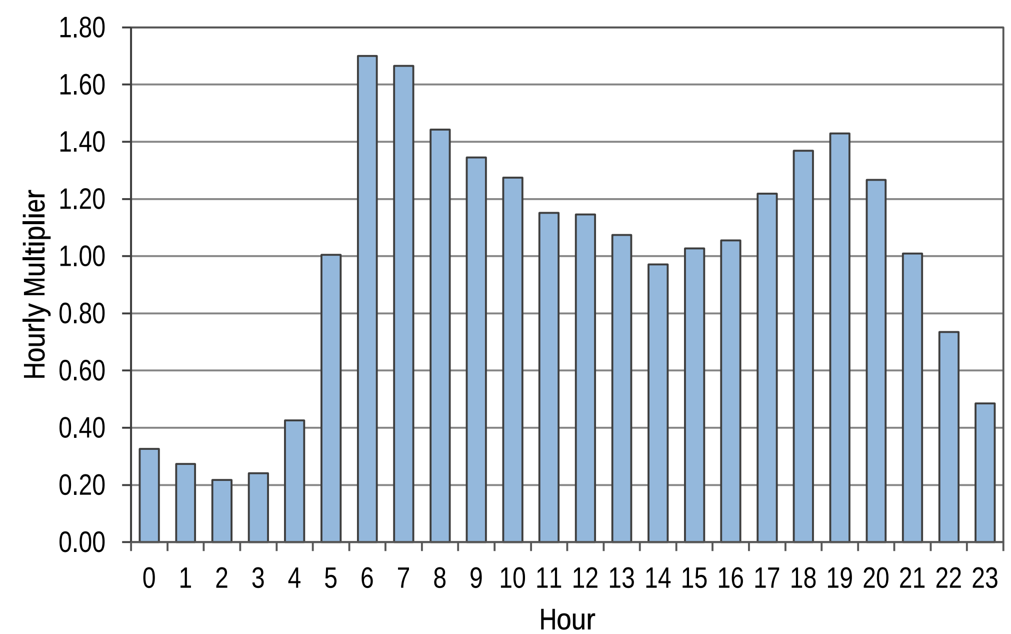
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.174	0.173	0.48	0.33	0.33
	1	0.117	0.119	0.33	0.27	0.27
	2	0.098	0.097	0.27	0.22	0.22
	3	0.078	0.079	0.22	0.24	0.24
	4	0.086	0.086	0.24	0.43	0.43
	5	0.153	0.155	0.43	1.00	1.00
	6	0.361	0.360	1.00	1.70	1.70
	7	0.611	0.612	1.70	1.66	1.66
	8	0.598	0.597	1.66	1.44	1.44
	9	0.518	0.518	1.44	1.35	1.35
	10	0.483	0.486	1.35	1.27	1.27
	11	0.458	0.457	1.27	1.15	1.15
	12	0.414	0.414	1.15	1.15	1.15
	13	0.411	0.414	1.15	1.07	1.07
	14	0.386	0.385	1.07	0.97	0.97
	15	0.349	0.349	0.97	1.03	1.03
	16	0.369	0.371	1.03	1.05	1.05
	17	0.379	0.378	1.05	1.22	1.22
	18	0.438	0.439	1.22	1.37	1.37
	19	0.492	0.493	1.37	1.43	1.43
	20	0.514	0.514	1.43	1.27	1.27
	21	0.455	0.457	1.27	1.01	1.01
	22	0.362	0.363	1.01	0.73	0.73
	23	0.264	0.263	0.73	0.48	0.48
Weekend	24	0.206	0.173	0.57	0.36	0.36
	25	0.129	0.131	0.36	0.26	0.26
	26	0.092	0.091	0.26	0.20	0.20
	27	0.074	0.074	0.20	0.19	0.19
	28	0.069	0.068	0.19	0.22	0.22
	29	0.079	0.080	0.22	0.31	0.31
	30	0.113	0.112	0.31	0.60	0.60
	31	0.216	0.214	0.60	1.07	1.07
	32	0.386	0.388	1.07	1.47	1.47
	33	0.529	0.528	1.47	1.71	1.71
	34	0.615	0.617	1.71	1.74	1.74
	35	0.625	0.626	1.74	1.71	1.71
	36	0.616	0.616	1.71	1.57	1.57
	37	0.563	0.567	1.57	1.39	1.39
	38	0.498	0.497	1.39	1.31	1.31
	39	0.469	0.471	1.31	1.33	1.33
	40	0.479	0.482	1.33	1.33	1.33
	41	0.480	0.480	1.33	1.41	1.41
	42	0.507	0.509	1.41	1.39	1.39
	43	0.498	0.498	1.39	1.34	1.34
	44	0.481	0.484	1.34	1.23	1.23
	45	0.444	0.443	1.23	0.90	0.90
	46	0.322	0.323	0.90	0.74	0.74
	47	0.265	0.265	0.74	0.57	0.57
Average						
	Weekday	0.357	0.357	0.99	0.99	0.99
	Weekend	0.365	0.364	1.02	1.02	1.02
	ADWF[1]	0.359	0.359	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.2%			

Notes:

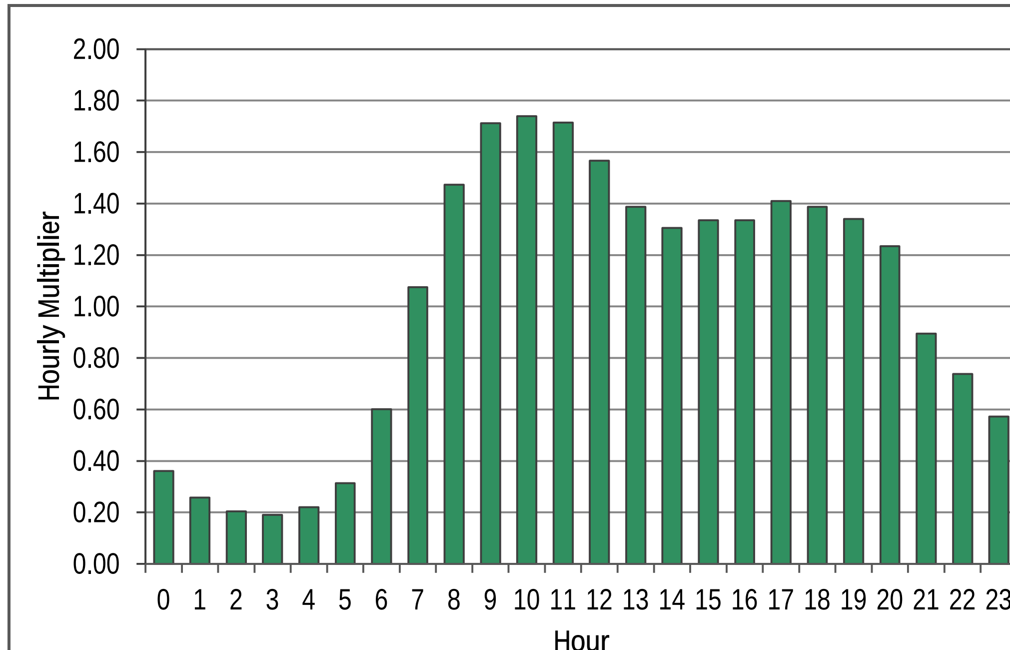
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

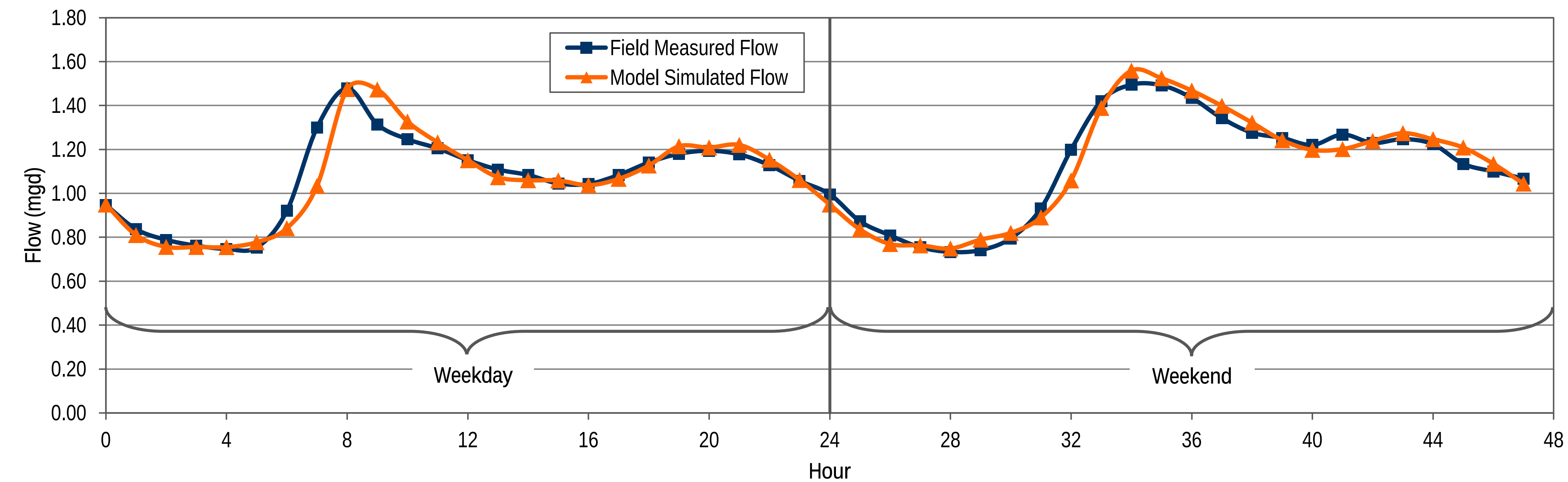
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56A.1 DRY WEATHER CALIBRATION

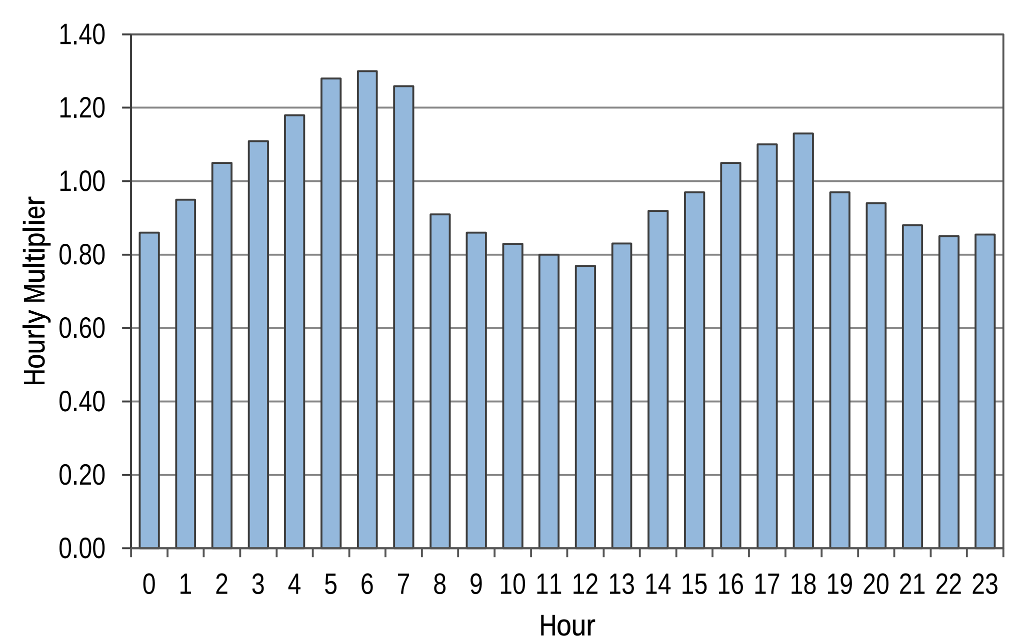
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.947	0.949	0.87	0.77	0.86
	1	0.836	0.810	0.77	0.73	0.95
	2	0.788	0.756	0.73	0.70	1.05
	3	0.761	0.756	0.70	0.69	1.11
	4	0.746	0.755	0.69	0.69	1.18
	5	0.753	0.778	0.69	0.85	1.28
	6	0.920	0.841	0.85	1.20	1.30
	7	1.299	1.034	1.20	1.36	1.26
	8	1.478	1.475	1.36	1.21	0.91
	9	1.314	1.473	1.21	1.15	0.86
	10	1.246	1.327	1.15	1.11	0.83
	11	1.205	1.232	1.11	1.06	0.80
	12	1.151	1.151	1.06	1.02	0.77
	13	1.108	1.074	1.02	1.00	0.83
	14	1.083	1.060	1.00	0.96	0.92
	15	1.044	1.059	0.96	0.96	0.97
	16	1.043	1.037	0.96	1.00	1.05
	17	1.083	1.066	1.00	1.05	1.10
	18	1.140	1.127	1.05	1.09	1.13
	19	1.180	1.215	1.09	1.10	0.97
	20	1.194	1.209	1.10	1.08	0.94
	21	1.177	1.221	1.08	1.04	0.88
	22	1.128	1.154	1.04	0.97	0.85
	23	1.057	1.061	0.97	0.87	0.85
Weekend	24	0.995	0.949	0.92	0.80	0.91
	25	0.873	0.836	0.80	0.74	0.95
	26	0.808	0.769	0.74	0.69	1.05
	27	0.754	0.763	0.69	0.67	1.08
	28	0.733	0.749	0.67	0.68	1.20
	29	0.741	0.790	0.68	0.73	1.27
	30	0.795	0.820	0.73	0.86	1.36
	31	0.931	0.891	0.86	1.10	1.45
	32	1.198	1.059	1.10	1.31	1.47
	33	1.420	1.389	1.31	1.38	1.30
	34	1.495	1.559	1.38	1.37	1.08
	35	1.492	1.524	1.37	1.32	0.97
	36	1.435	1.468	1.32	1.24	0.93
	37	1.342	1.399	1.24	1.17	0.92
	38	1.276	1.322	1.17	1.15	0.89
	39	1.253	1.242	1.15	1.12	0.86
	40	1.220	1.198	1.12	1.17	0.93
	41	1.268	1.202	1.17	1.13	0.98
	42	1.229	1.239	1.13	1.15	0.99
	43	1.247	1.274	1.15	1.13	0.93
	44	1.224	1.247	1.13	1.04	0.90
	45	1.134	1.209	1.04	1.01	0.85
	46	1.099	1.135	1.01	0.98	0.82
	47	1.067	1.044	0.98	0.92	0.80
Average						
	Weekday	1.070	1.068	0.99	0.99	0.99
	Weekend	1.126	1.128	1.04	1.04	1.04
	ADWF[(1)]	1.086	1.085	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		0.2%			

Notes:

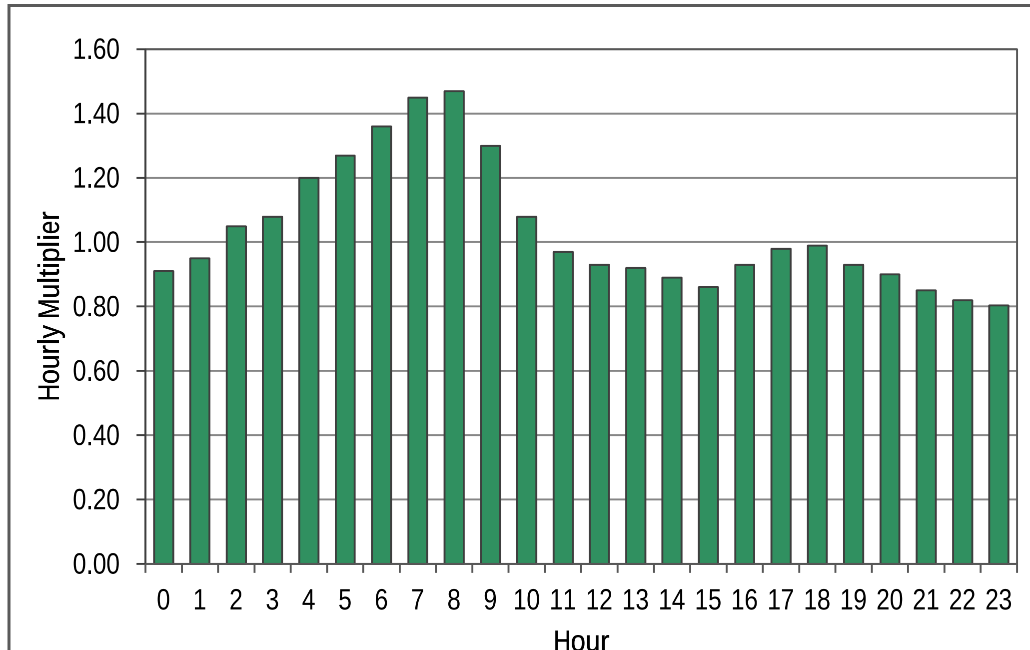
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_56.xlsx

City of Oakland

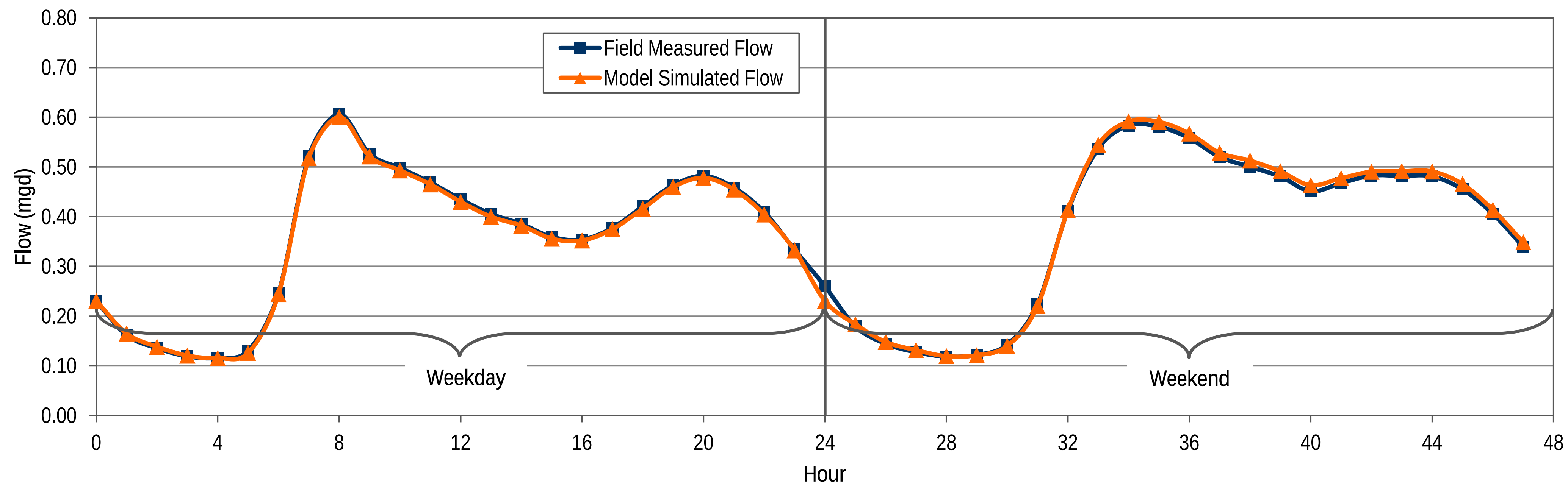
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56B DRY WEATHER CALIBRATION

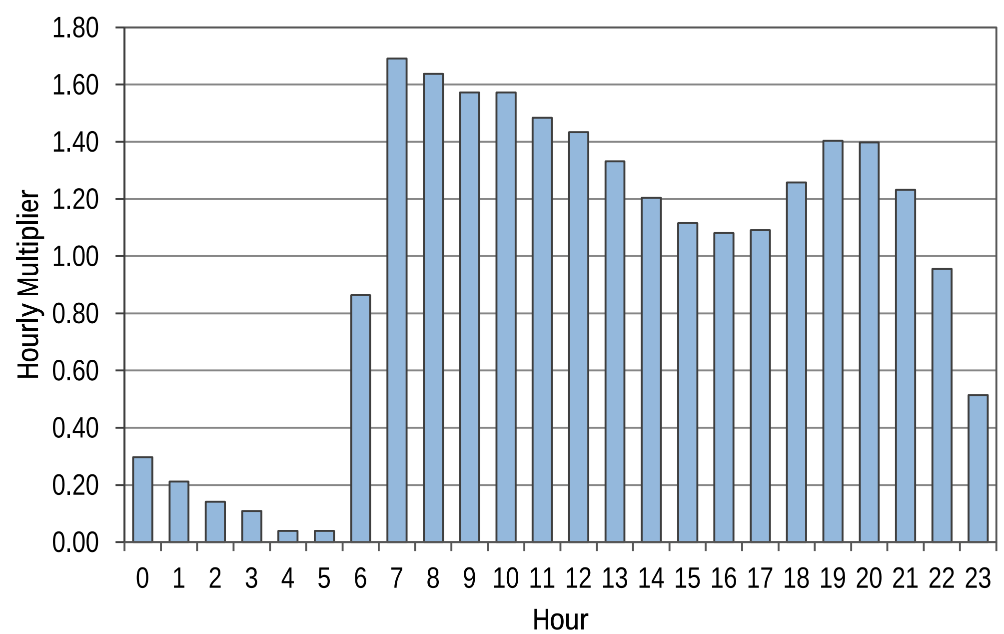
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.229	0.230	0.63	0.44	0.30
	1	0.161	0.165	0.44	0.37	0.21
	2	0.135	0.138	0.37	0.33	0.14
	3	0.119	0.121	0.33	0.32	0.11
	4	0.116	0.116	0.32	0.36	0.04
	5	0.131	0.126	0.36	0.67	0.04
	6	0.246	0.244	0.67	1.43	0.86
	7	0.522	0.518	1.43	1.66	1.69
	8	0.606	0.600	1.66	1.44	1.64
	9	0.526	0.521	1.44	1.36	1.57
	10	0.498	0.493	1.36	1.28	1.57
	11	0.469	0.465	1.28	1.19	1.48
	12	0.435	0.430	1.19	1.11	1.43
	13	0.405	0.400	1.11	1.06	1.33
	14	0.385	0.382	1.06	0.98	1.20
	15	0.359	0.356	0.98	0.97	1.12
	16	0.354	0.352	0.97	1.03	1.08
	17	0.377	0.375	1.03	1.15	1.09
	18	0.421	0.416	1.15	1.27	1.26
	19	0.463	0.460	1.27	1.32	1.40
	20	0.482	0.478	1.32	1.26	1.40
	21	0.458	0.455	1.26	1.12	1.23
	22	0.409	0.405	1.12	0.91	0.96
	23	0.334	0.332	0.91	0.63	0.51
Weekend	24	0.260	0.231	0.71	0.49	0.30
	25	0.179	0.183	0.49	0.40	0.19
	26	0.144	0.148	0.40	0.35	0.18
	27	0.127	0.132	0.35	0.32	0.11
	28	0.119	0.119	0.32	0.33	0.10
	29	0.122	0.121	0.33	0.39	0.09
	30	0.142	0.140	0.39	0.61	0.22
	31	0.223	0.220	0.61	1.13	0.85
	32	0.412	0.413	1.13	1.47	1.28
	33	0.537	0.545	1.47	1.60	1.46
	34	0.583	0.591	1.60	1.59	1.56
	35	0.581	0.591	1.59	1.53	1.72
	36	0.558	0.567	1.53	1.43	1.64
	37	0.520	0.528	1.43	1.37	1.67
	38	0.500	0.513	1.37	1.32	1.61
	39	0.481	0.491	1.32	1.24	1.47
	40	0.451	0.463	1.24	1.28	1.42
	41	0.467	0.477	1.28	1.32	1.39
	42	0.482	0.490	1.32	1.32	1.41
	43	0.482	0.491	1.32	1.32	1.50
	44	0.481	0.491	1.32	1.25	1.53
	45	0.455	0.466	1.25	1.11	1.30
	46	0.406	0.414	1.11	0.93	1.05
	47	0.340	0.349	0.93	0.71	0.74
Average						
	Weekday	0.360	0.357	0.99	0.99	0.99
	Weekend	0.377	0.382	1.03	1.03	1.03
	ADWF[(1)]	0.365	0.365	1.00	1.00	1.00
% Error						
	Weekday		-0.7%			
	Weekend		1.4%			

Notes:

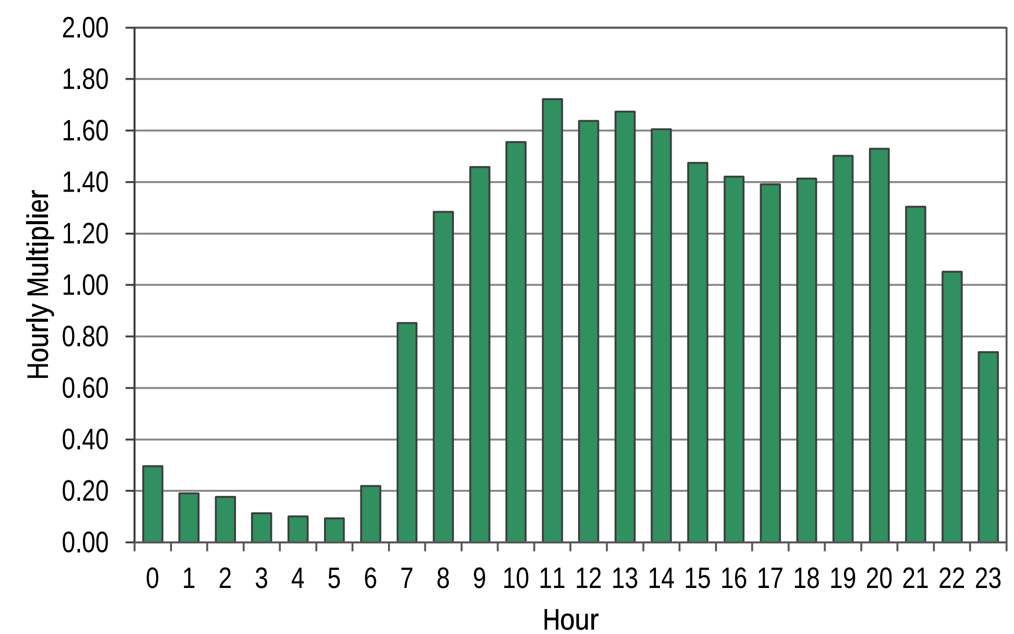
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

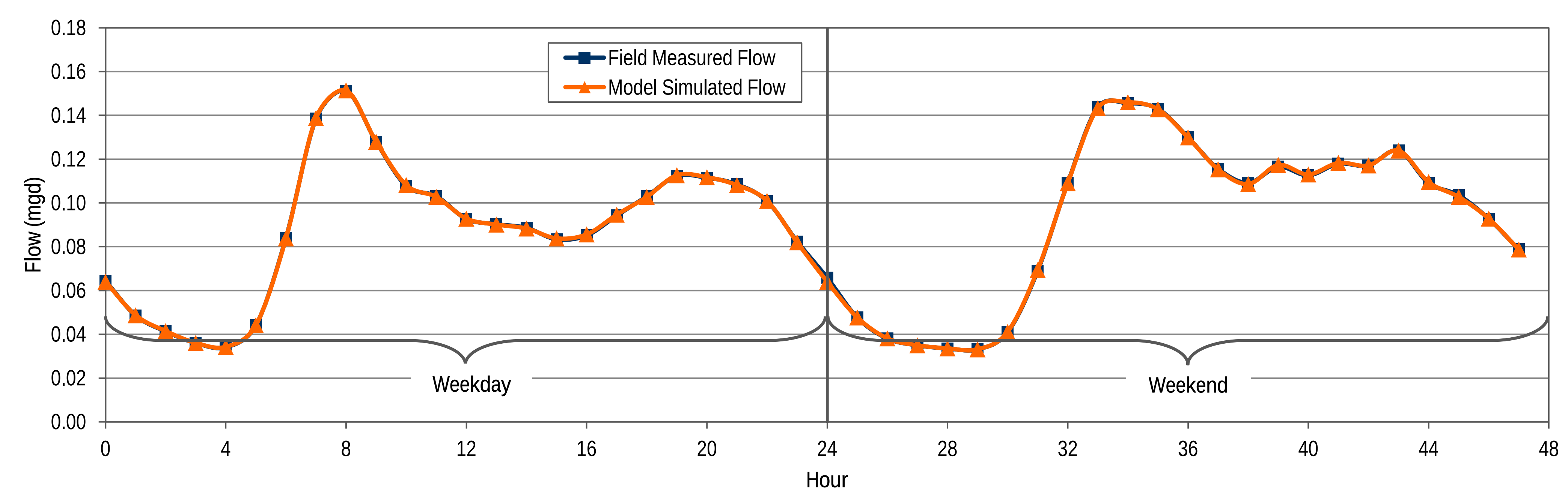
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56C DRY WEATHER CALIBRATION

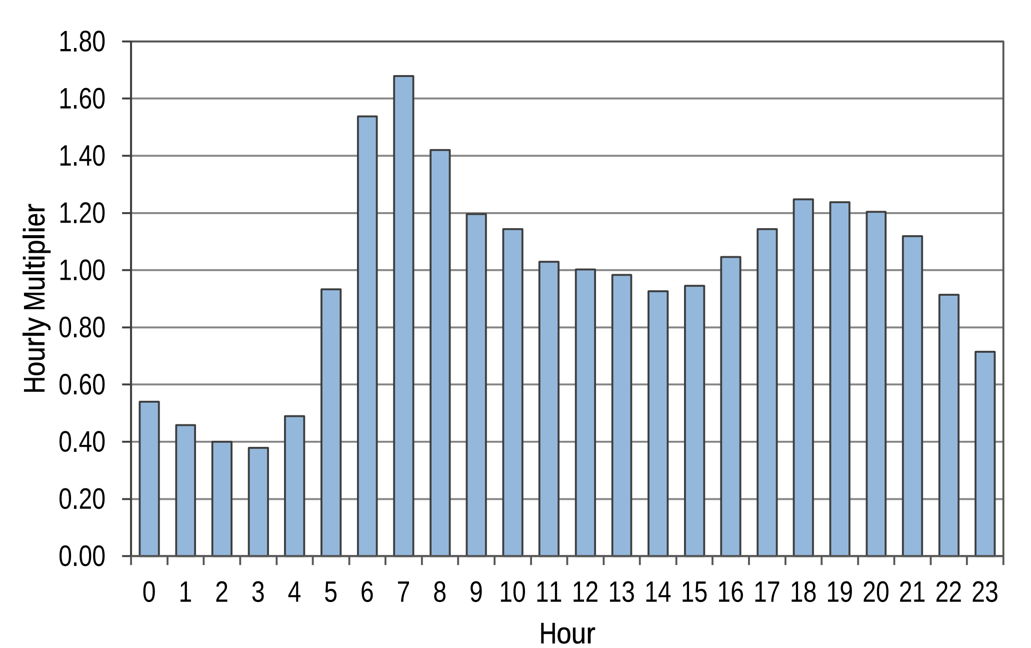
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.064	0.064	0.71	0.54	0.54
	1	0.049	0.049	0.54	0.46	0.46
	2	0.041	0.041	0.46	0.40	0.40
	3	0.036	0.036	0.40	0.38	0.38
	4	0.034	0.034	0.38	0.49	0.49
	5	0.044	0.044	0.49	0.93	0.93
	6	0.084	0.084	0.93	1.54	1.54
	7	0.139	0.139	1.54	1.68	1.68
	8	0.151	0.151	1.68	1.42	1.42
	9	0.128	0.128	1.42	1.20	1.20
	10	0.108	0.108	1.20	1.14	1.14
	11	0.103	0.103	1.14	1.03	1.03
	12	0.093	0.093	1.03	1.00	1.00
	13	0.090	0.090	1.00	0.98	0.98
	14	0.089	0.088	0.98	0.93	0.93
	15	0.083	0.084	0.93	0.95	0.95
	16	0.085	0.086	0.95	1.05	1.05
	17	0.094	0.095	1.05	1.14	1.14
	18	0.103	0.103	1.14	1.25	1.25
	19	0.113	0.113	1.25	1.24	1.24
	20	0.112	0.112	1.24	1.20	1.20
	21	0.108	0.108	1.20	1.12	1.12
	22	0.101	0.101	1.12	0.91	0.91
	23	0.082	0.082	0.91	0.71	0.71
Weekend	24	0.066	0.064	0.73	0.53	0.53
	25	0.048	0.048	0.53	0.42	0.42
	26	0.038	0.038	0.42	0.39	0.39
	27	0.035	0.035	0.39	0.37	0.37
	28	0.034	0.034	0.37	0.37	0.37
	29	0.033	0.033	0.37	0.45	0.45
	30	0.041	0.041	0.45	0.77	0.77
	31	0.069	0.069	0.77	1.21	1.21
	32	0.109	0.109	1.21	1.59	1.59
	33	0.144	0.143	1.59	1.62	1.62
	34	0.146	0.146	1.62	1.59	1.59
	35	0.143	0.143	1.59	1.44	1.44
	36	0.130	0.130	1.44	1.28	1.28
	37	0.116	0.115	1.28	1.21	1.21
	38	0.109	0.109	1.21	1.29	1.29
	39	0.117	0.117	1.29	1.25	1.25
	40	0.113	0.113	1.25	1.31	1.31
	41	0.118	0.118	1.31	1.30	1.30
	42	0.117	0.117	1.30	1.38	1.38
	43	0.124	0.124	1.38	1.21	1.21
	44	0.109	0.110	1.21	1.15	1.15
	45	0.104	0.103	1.15	1.03	1.03
	46	0.093	0.093	1.03	0.87	0.87
	47	0.079	0.079	0.87	0.73	0.73
Average						
Weekday		0.089	0.089	0.99	0.99	0.99
Weekend		0.093	0.093	1.03	1.03	1.03
ADWF[(1)]		0.090	0.090	1.00	1.00	1.00
% Error						
Weekday			0.0%			
Weekend			-0.1%			

Notes:

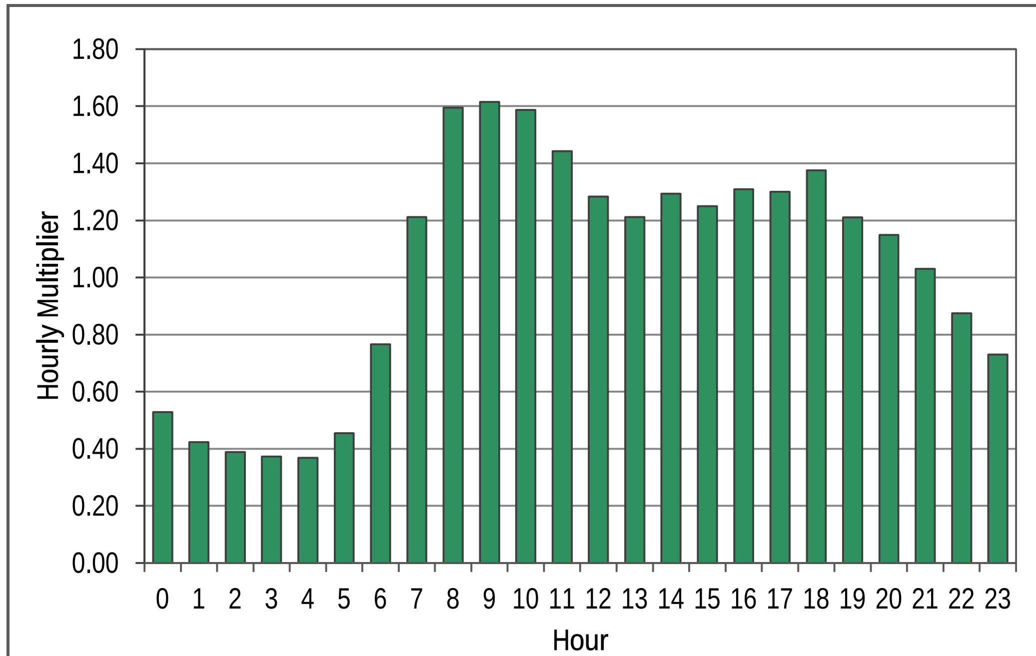
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_56.xlsx

City of Oakland

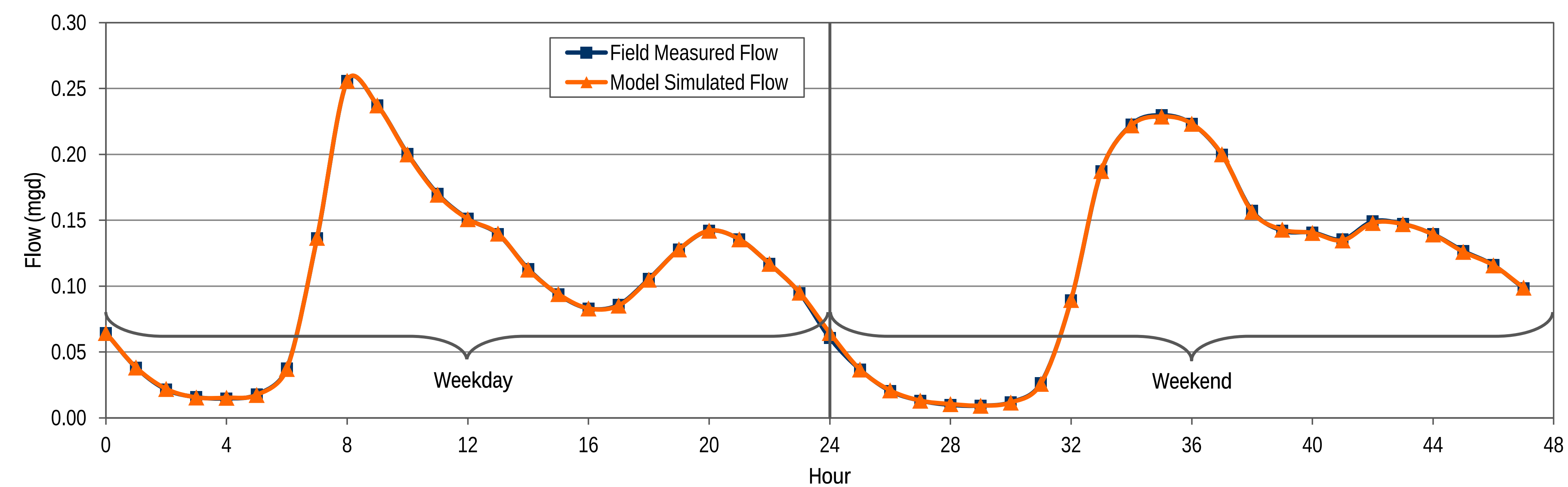
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56D DRY WEATHER CALIBRATION

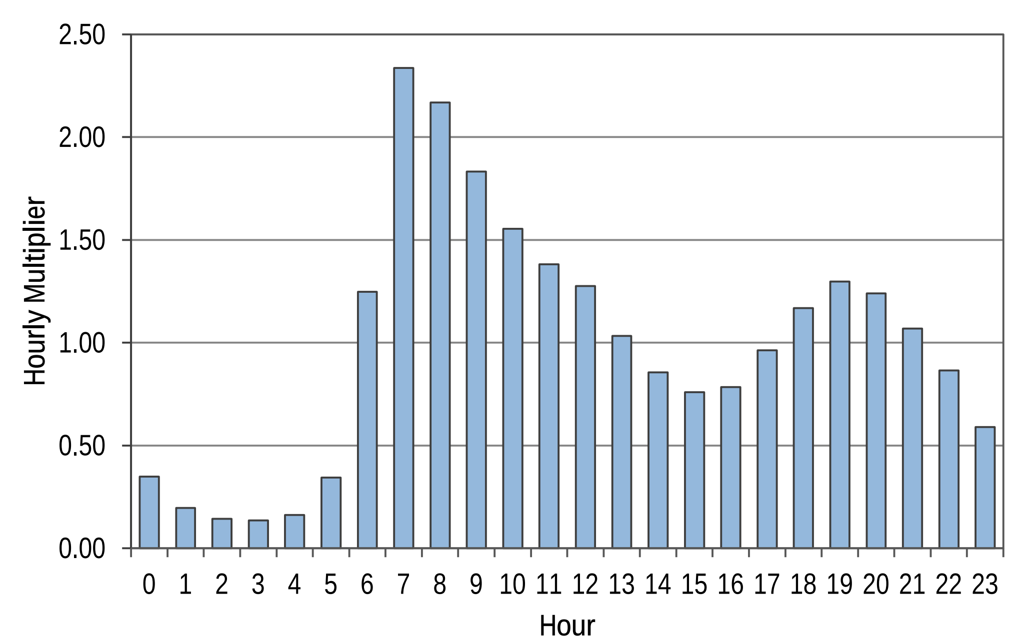
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.064	0.064	0.59	0.35	0.35
	1	0.038	0.038	0.35	0.20	0.20
	2	0.021	0.022	0.20	0.14	0.14
	3	0.016	0.016	0.14	0.14	0.14
	4	0.015	0.015	0.14	0.16	0.16
	5	0.018	0.017	0.16	0.34	0.34
	6	0.038	0.037	0.34	1.25	1.25
	7	0.136	0.137	1.25	2.34	2.34
	8	0.256	0.256	2.34	2.17	2.17
	9	0.237	0.237	2.17	1.83	1.83
	10	0.200	0.200	1.83	1.55	1.55
	11	0.170	0.169	1.55	1.38	1.38
	12	0.151	0.151	1.38	1.28	1.28
	13	0.140	0.140	1.28	1.03	1.03
	14	0.113	0.113	1.03	0.86	0.86
	15	0.094	0.094	0.86	0.76	0.76
	16	0.083	0.083	0.76	0.78	0.78
	17	0.086	0.085	0.78	0.96	0.96
	18	0.105	0.105	0.96	1.17	1.17
	19	0.128	0.128	1.17	1.30	1.30
	20	0.142	0.142	1.30	1.24	1.24
	21	0.136	0.136	1.24	1.07	1.07
	22	0.117	0.117	1.07	0.87	0.87
	23	0.095	0.095	0.87	0.59	0.59
Weekend	24	0.061	0.064	0.55	0.34	0.34
	25	0.037	0.037	0.34	0.19	0.19
	26	0.020	0.021	0.19	0.12	0.12
	27	0.013	0.013	0.12	0.09	0.09
	28	0.010	0.010	0.09	0.08	0.08
	29	0.009	0.009	0.08	0.11	0.11
	30	0.012	0.012	0.11	0.24	0.24
	31	0.026	0.026	0.24	0.82	0.82
	32	0.089	0.090	0.82	1.71	1.71
	33	0.187	0.187	1.71	2.03	2.03
	34	0.223	0.222	2.03	2.10	2.10
	35	0.230	0.229	2.10	2.04	2.04
	36	0.223	0.223	2.04	1.83	1.83
	37	0.200	0.200	1.83	1.44	1.44
	38	0.157	0.156	1.44	1.30	1.30
	39	0.142	0.143	1.30	1.29	1.29
	40	0.141	0.140	1.29	1.24	1.24
	41	0.135	0.135	1.24	1.36	1.36
	42	0.149	0.148	1.36	1.35	1.35
	43	0.147	0.147	1.35	1.27	1.27
	44	0.139	0.139	1.27	1.16	1.16
	45	0.127	0.126	1.16	1.06	1.06
	46	0.116	0.116	1.06	0.90	0.90
	47	0.099	0.099	0.90	0.55	0.55
Average						
Weekday		0.108	0.108	0.99	0.99	0.99
Weekend		0.112	0.112	1.03	1.03	1.03
ADWF[1]		0.109	0.109	1.00	1.00	1.00
% Error						
Weekday			0.0%			
Weekend			0.0%			

Notes:

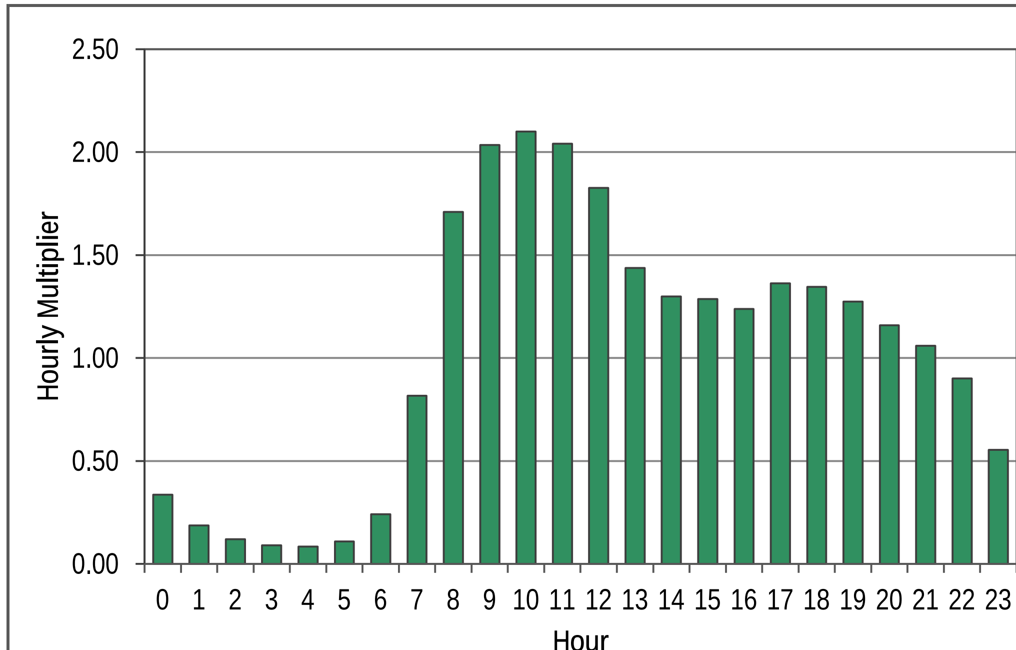
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

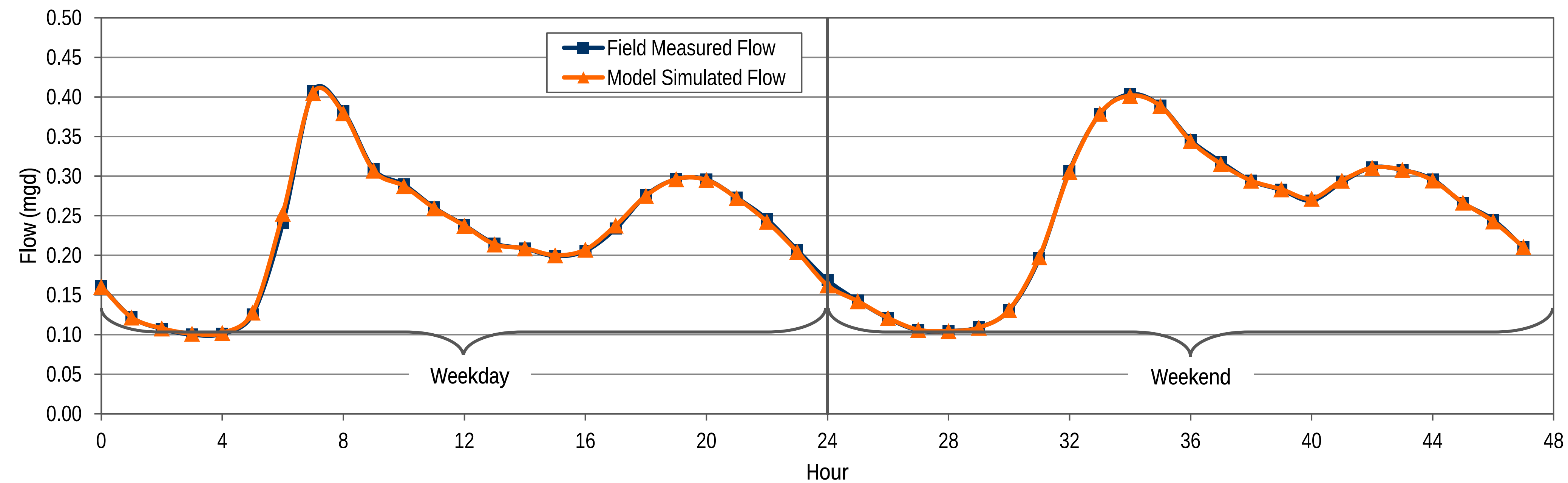
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56E DRY WEATHER CALIBRATION

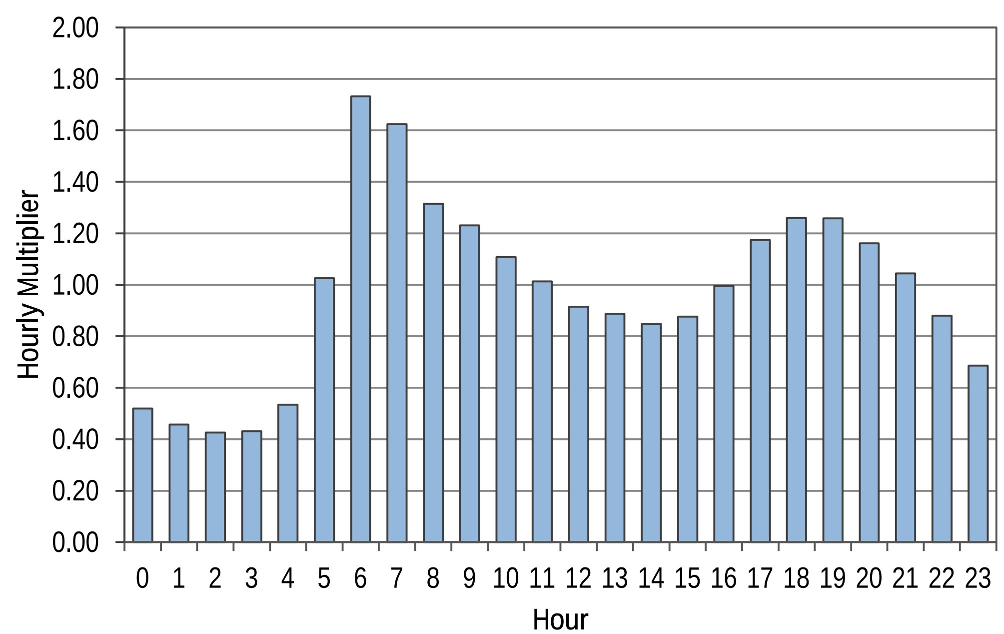
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.161	0.160	0.69	0.52	0.52
	1	0.122	0.122	0.52	0.46	0.46
	2	0.107	0.108	0.46	0.43	0.43
	3	0.100	0.101	0.43	0.43	0.43
	4	0.101	0.102	0.43	0.53	0.53
	5	0.126	0.128	0.53	1.03	1.03
	6	0.241	0.253	1.03	1.73	1.73
	7	0.407	0.405	1.73	1.62	1.62
	8	0.382	0.380	1.62	1.31	1.31
	9	0.309	0.307	1.31	1.23	1.23
	10	0.289	0.287	1.23	1.11	1.11
	11	0.260	0.260	1.11	1.01	1.01
	12	0.238	0.237	1.01	0.91	0.91
	13	0.215	0.214	0.91	0.89	0.89
	14	0.209	0.209	0.89	0.85	0.85
	15	0.199	0.200	0.85	0.88	0.88
	16	0.206	0.207	0.88	1.00	1.00
	17	0.234	0.238	1.00	1.17	1.17
	18	0.276	0.275	1.17	1.26	1.26
	19	0.296	0.296	1.26	1.26	1.26
	20	0.296	0.295	1.26	1.16	1.16
	21	0.273	0.272	1.16	1.04	1.04
	22	0.246	0.242	1.04	0.88	0.88
	23	0.207	0.205	0.88	0.69	0.69
Weekend	24	0.169	0.162	0.72	0.61	0.61
	25	0.143	0.142	0.61	0.51	0.51
	26	0.121	0.121	0.51	0.45	0.45
	27	0.106	0.106	0.45	0.44	0.44
	28	0.105	0.104	0.44	0.46	0.46
	29	0.109	0.109	0.46	0.56	0.56
	30	0.131	0.131	0.56	0.84	0.84
	31	0.196	0.198	0.84	1.31	1.31
	32	0.307	0.305	1.31	1.61	1.61
	33	0.379	0.379	1.61	1.72	1.72
	34	0.404	0.402	1.72	1.66	1.66
	35	0.389	0.389	1.66	1.47	1.47
	36	0.346	0.344	1.47	1.35	1.35
	37	0.318	0.315	1.35	1.25	1.25
	38	0.294	0.294	1.25	1.20	1.20
	39	0.283	0.283	1.20	1.15	1.15
	40	0.269	0.272	1.15	1.24	1.24
	41	0.292	0.294	1.24	1.32	1.32
	42	0.311	0.311	1.32	1.31	1.31
	43	0.308	0.308	1.31	1.26	1.26
	44	0.296	0.295	1.26	1.13	1.13
	45	0.266	0.267	1.13	1.04	1.04
	46	0.245	0.243	1.04	0.89	0.89
	47	0.210	0.211	0.89	0.72	0.72
Average						
	Weekday	0.229	0.229	0.97	0.97	0.97
	Weekend	0.250	0.249	1.06	1.06	1.06
	ADWF[(1)]	0.235	0.235	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.2%			

Notes:

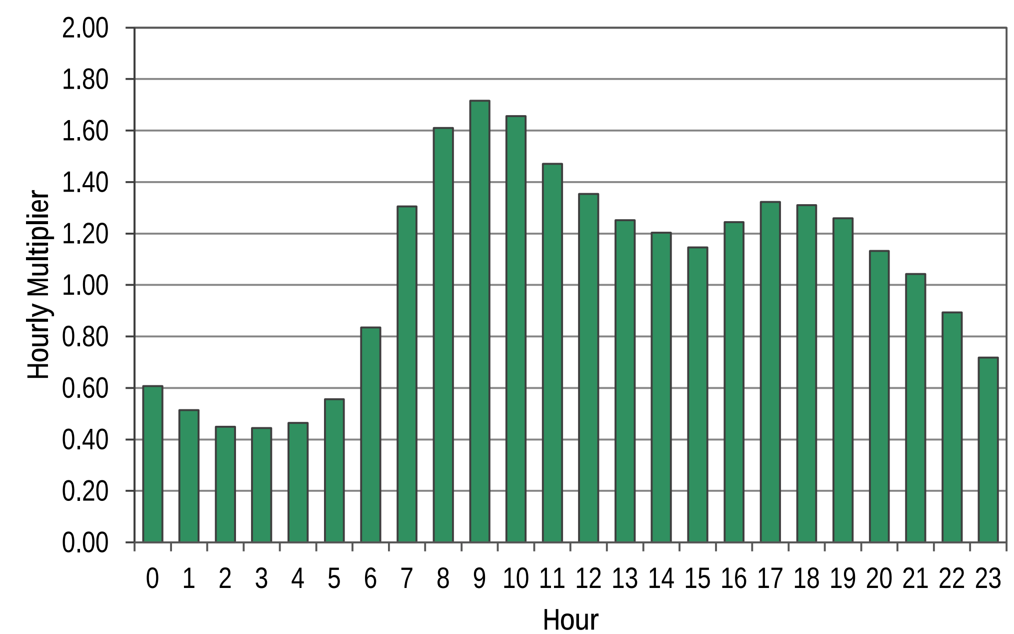
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

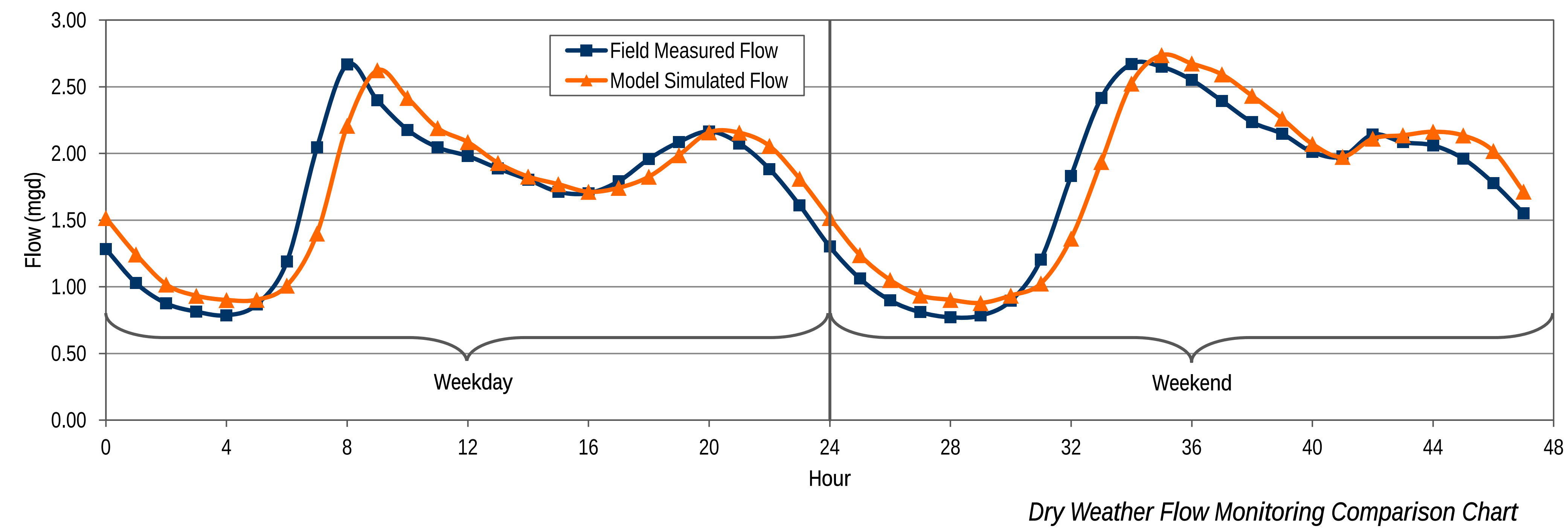
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56-1 DRY WEATHER CALIBRATION

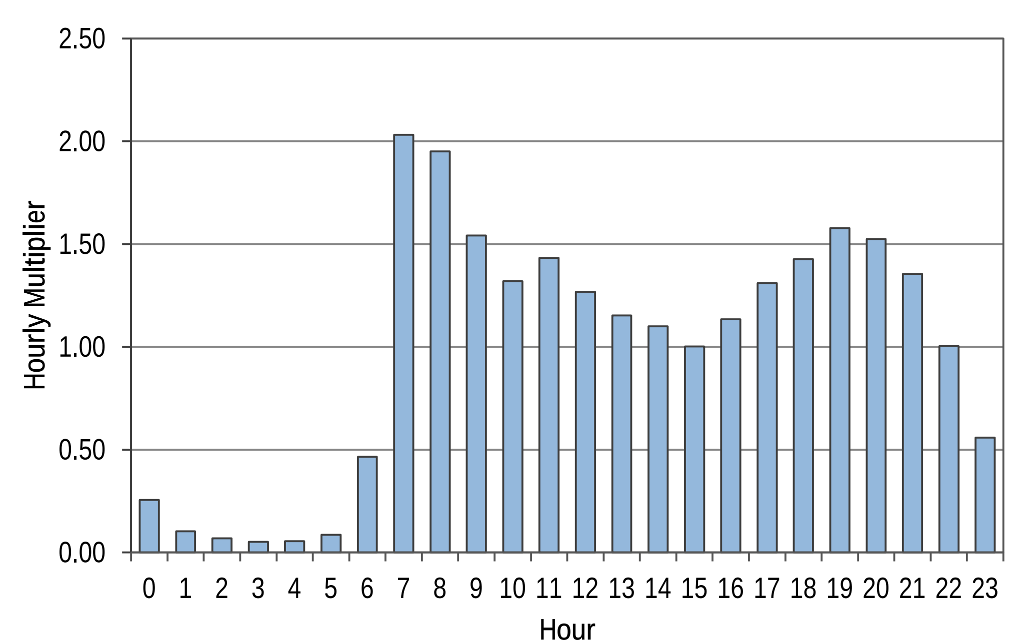
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.283	1.516	0.75	0.60	0.26
	1	1.028	1.243	0.60	0.51	0.10
	2	0.876	1.017	0.51	0.47	0.07
	3	0.814	0.932	0.47	0.46	0.05
	4	0.787	0.901	0.46	0.51	0.06
	5	0.868	0.903	0.51	0.69	0.09
	6	1.189	1.009	0.69	1.19	0.47
	7	2.046	1.400	1.19	1.55	2.03
	8	2.666	2.208	1.55	1.40	1.95
	9	2.399	2.624	1.40	1.27	1.54
	10	2.178	2.417	1.27	1.19	1.32
	11	2.046	2.190	1.19	1.15	1.43
	12	1.981	2.086	1.15	1.10	1.27
	13	1.888	1.929	1.10	1.05	1.15
	14	1.804	1.827	1.05	1.00	1.10
	15	1.713	1.770	1.00	0.99	1.00
	16	1.703	1.713	0.99	1.04	1.13
	17	1.792	1.742	1.04	1.14	1.31
	18	1.959	1.826	1.14	1.21	1.43
	19	2.086	1.987	1.21	1.26	1.58
	20	2.165	2.159	1.26	1.21	1.52
	21	2.075	2.156	1.21	1.10	1.35
	22	1.884	2.057	1.10	0.94	1.00
	23	1.612	1.810	0.94	0.75	0.56
Weekend	24	1.302	1.516	0.76	0.62	0.22
	25	1.062	1.238	0.62	0.52	0.09
	26	0.899	1.051	0.52	0.47	0.06
	27	0.810	0.934	0.47	0.45	0.04
	28	0.772	0.902	0.45	0.46	0.06
	29	0.785	0.879	0.46	0.52	0.09
	30	0.896	0.934	0.52	0.70	0.22
	31	1.205	1.025	0.70	1.07	0.92
	32	1.832	1.362	1.07	1.41	1.74
	33	2.416	1.936	1.41	1.56	2.09
	34	2.671	2.524	1.56	1.54	1.99
	35	2.650	2.737	1.54	1.48	1.86
	36	2.551	2.675	1.48	1.39	1.82
	37	2.394	2.593	1.39	1.30	1.72
	38	2.235	2.433	1.30	1.25	1.58
	39	2.147	2.261	1.25	1.17	1.16
	40	2.011	2.071	1.17	1.15	0.86
	41	1.978	1.974	1.15	1.25	1.51
	42	2.141	2.111	1.25	1.21	1.26
	43	2.084	2.136	1.21	1.20	1.32
	44	2.061	2.163	1.20	1.14	1.43
	45	1.961	2.135	1.14	1.04	1.33
	46	1.779	2.019	1.04	0.90	0.82
	47	1.552	1.714	0.90	0.76	0.37
Average						
	Weekday	1.702	1.726	0.99	0.99	0.99
	Weekend	1.758	1.805	1.02	1.02	1.02
	ADWF[1]	1.718	1.749	1.00	1.00	1.00
% Error						
	Weekday		1.4%			
	Weekend		2.7%			

Notes:

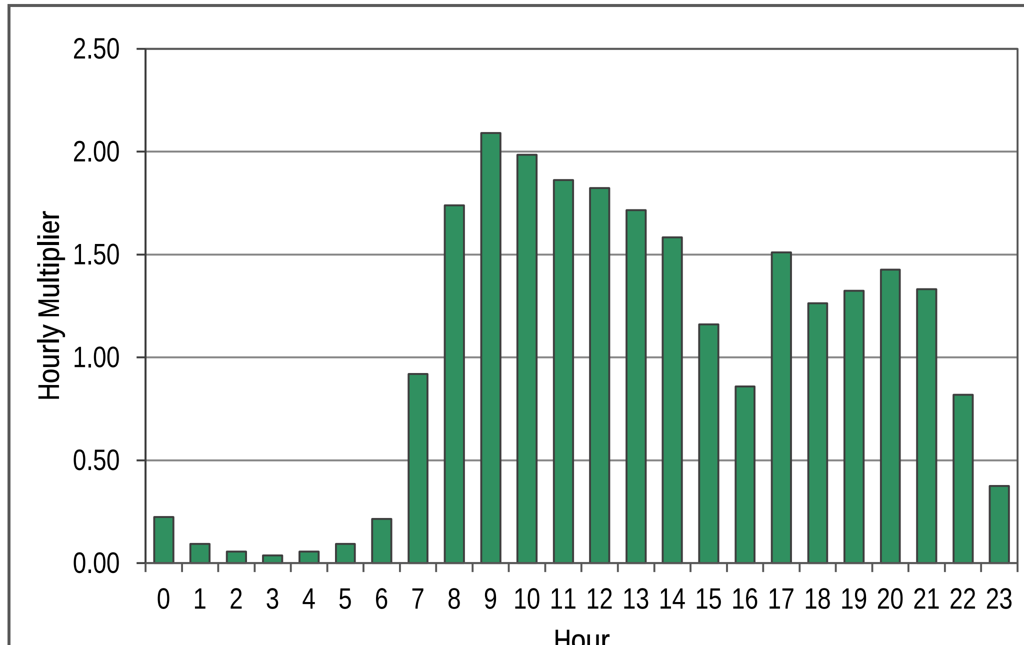
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

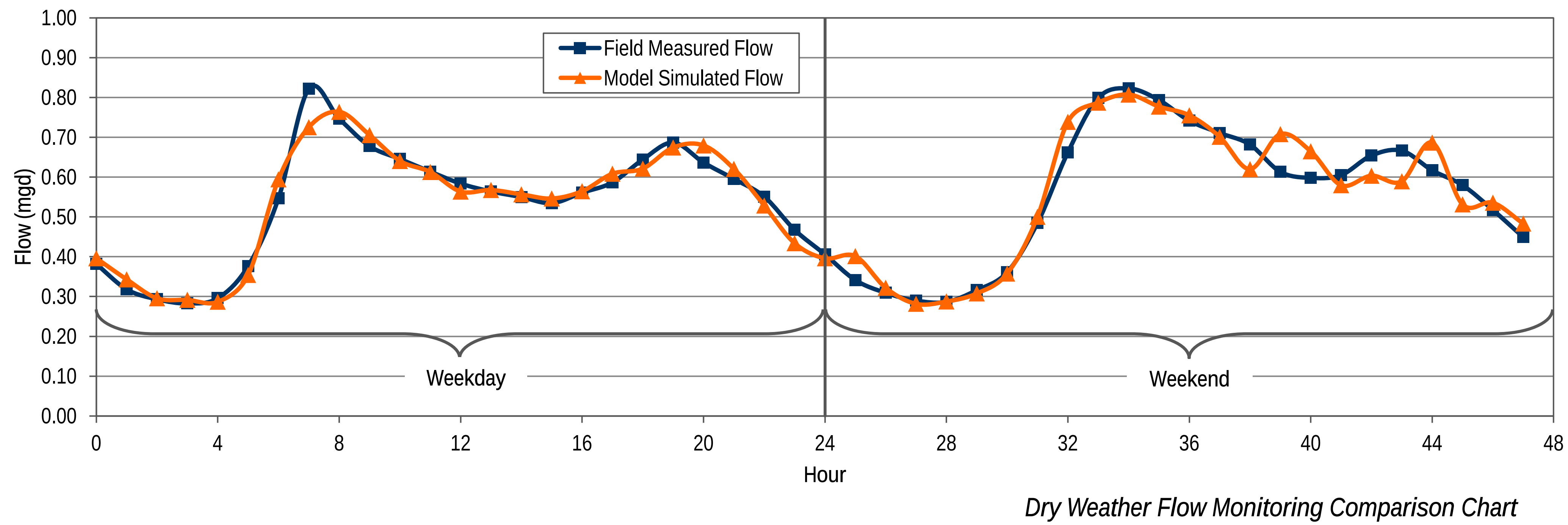
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58A DRY WEATHER CALIBRATION

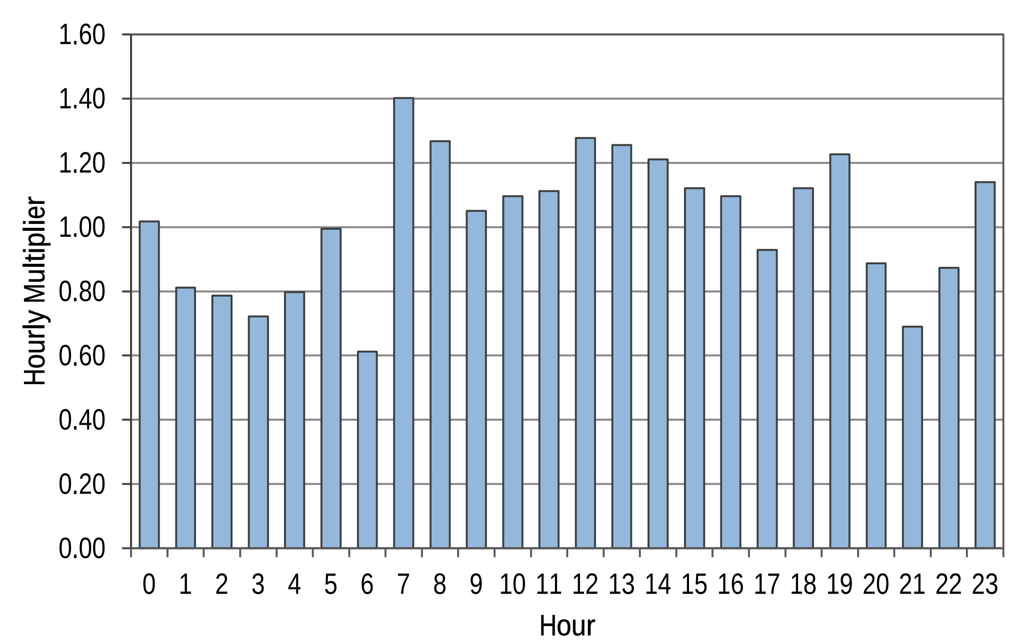
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.382	0.396	0.70	0.58	1.02
	1	0.318	0.343	0.58	0.54	0.81
	2	0.293	0.296	0.54	0.52	0.79
	3	0.283	0.292	0.52	0.54	0.72
	4	0.296	0.287	0.54	0.69	0.80
	5	0.377	0.354	0.69	1.01	0.99
	6	0.547	0.594	1.01	1.51	0.61
	7	0.822	0.725	1.51	1.37	1.40
	8	0.747	0.764	1.37	1.25	1.27
	9	0.678	0.706	1.25	1.19	1.05
	10	0.646	0.640	1.19	1.13	1.10
	11	0.614	0.613	1.13	1.07	1.11
	12	0.584	0.564	1.07	1.04	1.28
	13	0.564	0.568	1.04	1.01	1.26
	14	0.550	0.557	1.01	0.98	1.21
	15	0.535	0.546	0.98	1.03	1.12
	16	0.561	0.565	1.03	1.08	1.10
	17	0.587	0.609	1.08	1.18	0.93
	18	0.644	0.621	1.18	1.26	1.12
	19	0.687	0.674	1.26	1.17	1.23
	20	0.637	0.679	1.17	1.09	0.89
	21	0.596	0.621	1.09	1.01	0.69
	22	0.551	0.529	1.01	0.86	0.87
	23	0.468	0.434	0.86	0.70	1.14
Weekend	24	0.406	0.396	0.75	0.63	1.21
	25	0.342	0.402	0.63	0.57	0.73
	26	0.310	0.322	0.57	0.53	0.63
	27	0.290	0.282	0.53	0.53	0.69
	28	0.287	0.288	0.53	0.58	0.69
	29	0.316	0.308	0.58	0.66	0.76
	30	0.361	0.358	0.66	0.89	0.80
	31	0.485	0.500	0.89	1.22	0.68
	32	0.662	0.739	1.22	1.47	0.77
	33	0.799	0.787	1.47	1.51	0.88
	34	0.823	0.807	1.51	1.46	1.00
	35	0.794	0.777	1.46	1.36	1.14
	36	0.742	0.755	1.36	1.31	1.04
	37	0.711	0.701	1.31	1.25	1.12
	38	0.682	0.620	1.25	1.13	1.63
	39	0.613	0.708	1.13	1.10	0.86
	40	0.598	0.665	1.10	1.11	0.32
	41	0.605	0.580	1.11	1.20	0.54
	42	0.654	0.603	1.20	1.22	0.96
	43	0.666	0.589	1.22	1.13	1.58
	44	0.617	0.687	1.13	1.07	1.03
	45	0.580	0.532	1.07	0.95	1.43
	46	0.518	0.536	0.95	0.83	1.28
	47	0.450	0.483	0.83	0.75	1.01
Average						
	Weekday	0.540	0.541	0.99	0.99	1.02
	Weekend	0.555	0.559	1.02	1.02	0.95
	ADWF(1)	0.544	0.546	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		0.8%			

Notes:

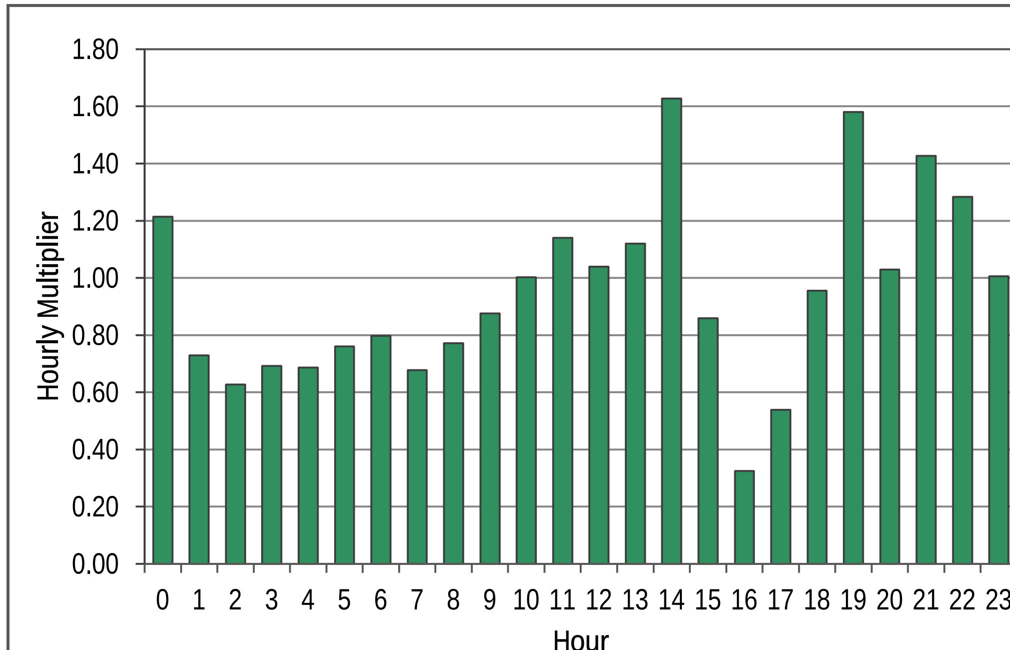
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

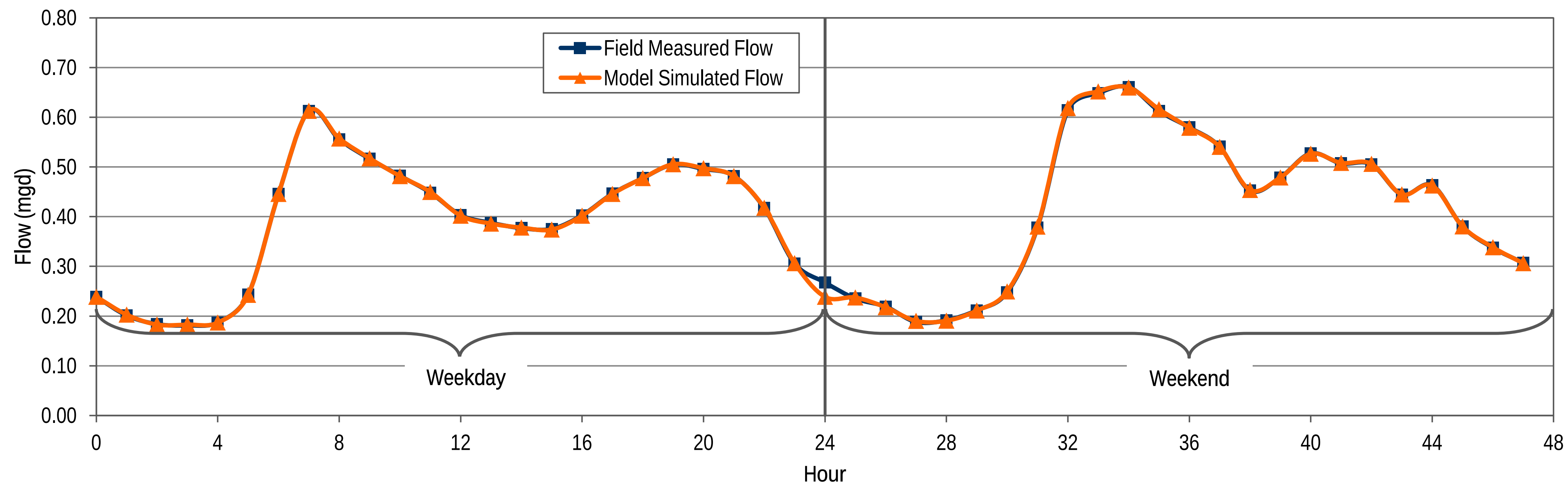
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58B DRY WEATHER CALIBRATION

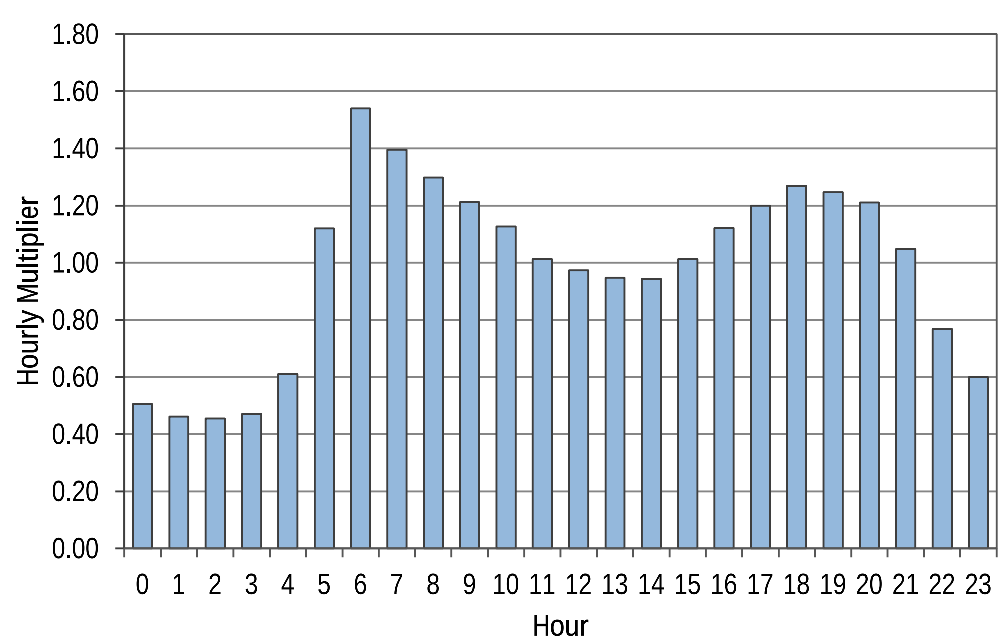
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.239	0.239	0.60	0.51	0.51
	1	0.201	0.203	0.51	0.46	0.46
	2	0.184	0.183	0.46	0.46	0.46
	3	0.181	0.183	0.46	0.47	0.47
	4	0.187	0.187	0.47	0.61	0.61
	5	0.243	0.243	0.61	1.12	1.12
	6	0.446	0.446	1.12	1.54	1.54
	7	0.613	0.613	1.54	1.40	1.40
	8	0.556	0.557	1.40	1.30	1.30
	9	0.517	0.517	1.30	1.21	1.21
	10	0.482	0.482	1.21	1.13	1.13
	11	0.448	0.450	1.13	1.01	1.01
	12	0.403	0.402	1.01	0.97	0.97
	13	0.388	0.386	0.97	0.95	0.95
	14	0.377	0.378	0.95	0.94	0.94
	15	0.375	0.374	0.94	1.01	1.01
	16	0.403	0.402	1.01	1.12	1.12
	17	0.446	0.446	1.12	1.20	1.20
	18	0.478	0.478	1.20	1.27	1.27
	19	0.505	0.505	1.27	1.25	1.25
	20	0.496	0.498	1.25	1.21	1.21
	21	0.482	0.482	1.21	1.05	1.05
	22	0.417	0.418	1.05	0.77	0.77
	23	0.306	0.306	0.77	0.60	0.60
Weekend	24	0.268	0.239	0.67	0.59	0.59
	25	0.235	0.237	0.59	0.55	0.55
	26	0.219	0.218	0.55	0.47	0.47
	27	0.188	0.190	0.47	0.48	0.48
	28	0.192	0.191	0.48	0.53	0.53
	29	0.212	0.211	0.53	0.62	0.62
	30	0.248	0.250	0.62	0.95	0.95
	31	0.378	0.380	0.95	1.54	1.54
	32	0.614	0.619	1.54	1.63	1.63
	33	0.649	0.652	1.63	1.66	1.66
	34	0.661	0.660	1.66	1.54	1.54
	35	0.613	0.616	1.54	1.46	1.46
	36	0.580	0.579	1.46	1.36	1.36
	37	0.541	0.540	1.36	1.14	1.14
	38	0.452	0.454	1.14	1.20	1.20
	39	0.479	0.479	1.20	1.33	1.33
	40	0.527	0.527	1.33	1.27	1.27
	41	0.507	0.508	1.27	1.27	1.27
	42	0.505	0.506	1.27	1.12	1.12
	43	0.445	0.445	1.12	1.16	1.16
	44	0.463	0.463	1.16	0.96	0.96
	45	0.380	0.380	0.96	0.85	0.85
	46	0.337	0.339	0.85	0.77	0.77
	47	0.307	0.306	0.77	0.67	0.67
Average						
Weekday		0.391	0.391	0.98	0.98	0.98
Weekend		0.417	0.416	1.05	1.05	1.05
ADWF(1)		0.398	0.398	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			-0.1%			

Notes:

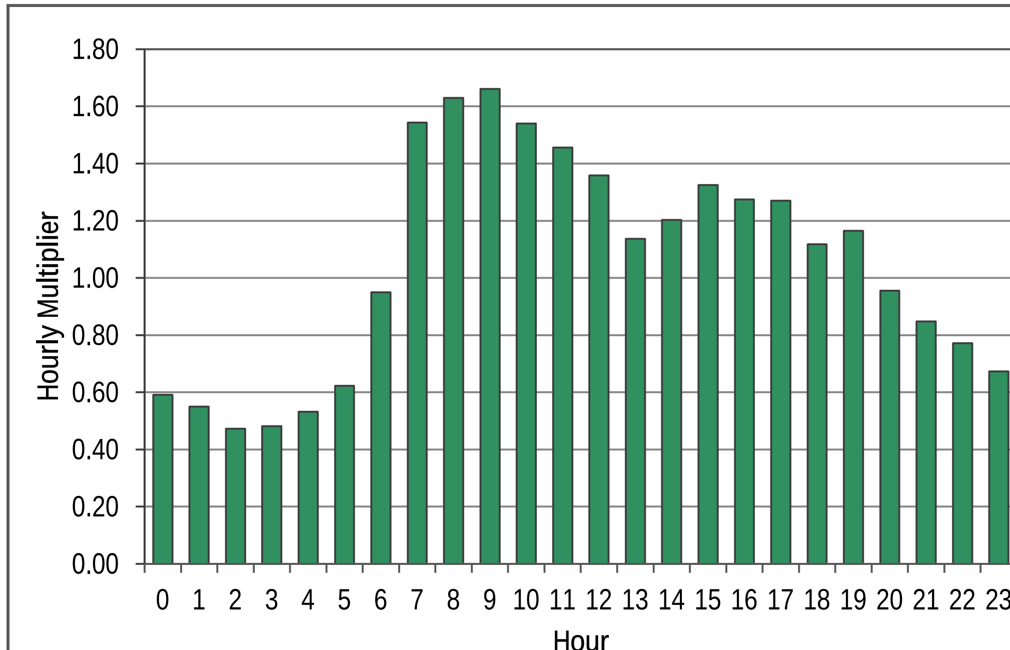
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_58.xlsx

City of Oakland

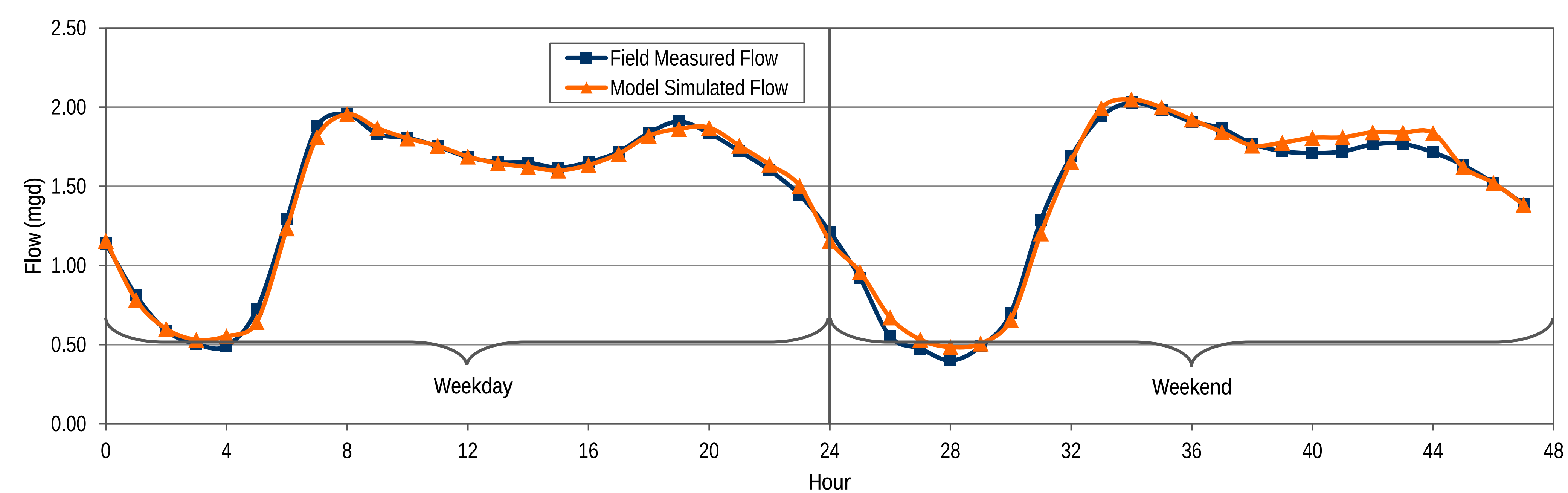
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58-1 DRY WEATHER CALIBRATION

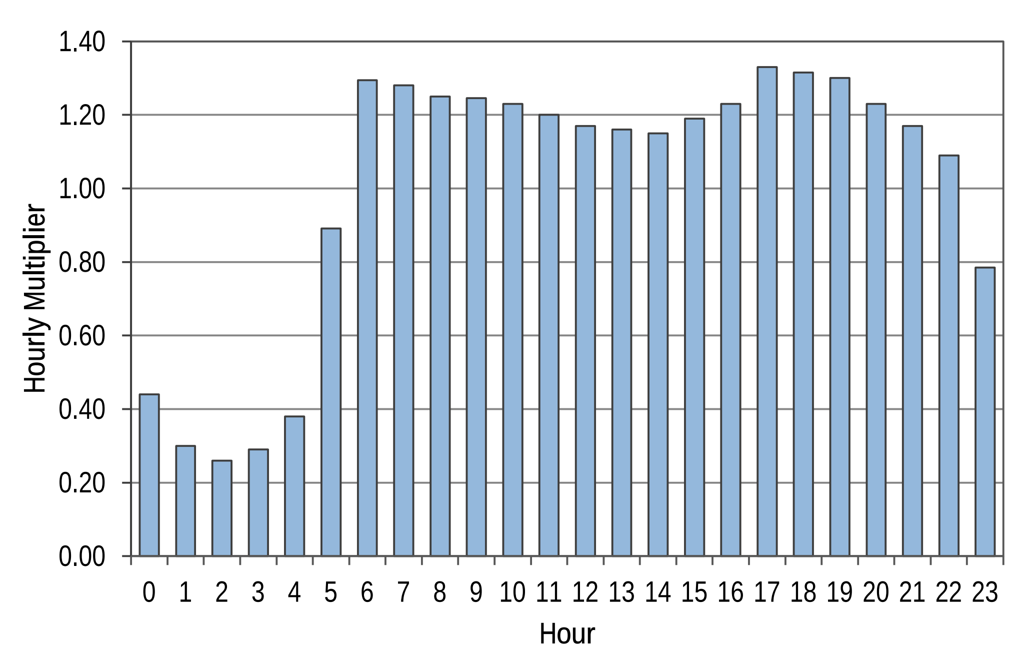
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.139	1.155	0.78	0.56	0.44
	1	0.812	0.782	0.56	0.41	0.30
	2	0.589	0.600	0.41	0.35	0.26
	3	0.504	0.531	0.35	0.34	0.29
	4	0.491	0.553	0.34	0.50	0.38
	5	0.723	0.642	0.50	0.89	0.89
	6	1.293	1.234	0.89	1.29	1.29
	7	1.878	1.811	1.29	1.35	1.28
	8	1.955	1.955	1.35	1.26	1.25
	9	1.829	1.867	1.26	1.25	1.25
	10	1.807	1.802	1.25	1.21	1.23
	11	1.752	1.755	1.21	1.16	1.20
	12	1.684	1.688	1.16	1.14	1.17
	13	1.653	1.645	1.14	1.14	1.16
	14	1.649	1.621	1.14	1.11	1.15
	15	1.618	1.599	1.11	1.14	1.19
	16	1.652	1.634	1.14	1.18	1.23
	17	1.717	1.705	1.18	1.27	1.33
	18	1.837	1.818	1.27	1.32	1.32
	19	1.909	1.863	1.32	1.26	1.30
	20	1.835	1.870	1.26	1.19	1.23
	21	1.722	1.756	1.19	1.10	1.17
	22	1.602	1.637	1.10	1.00	1.09
	23	1.445	1.502	1.00	0.78	0.78
Weekend	24	1.213	1.155	0.84	0.63	0.61
	25	0.921	0.959	0.63	0.38	0.34
	26	0.552	0.672	0.38	0.33	0.24
	27	0.476	0.532	0.33	0.28	0.22
	28	0.400	0.485	0.28	0.34	0.24
	29	0.488	0.507	0.34	0.48	0.37
	30	0.701	0.657	0.48	0.89	0.89
	31	1.287	1.202	0.89	1.16	1.16
	32	1.688	1.656	1.16	1.34	1.34
	33	1.940	1.994	1.34	1.40	1.35
	34	2.028	2.048	1.40	1.37	1.32
	35	1.981	1.999	1.37	1.31	1.26
	36	1.907	1.922	1.31	1.29	1.23
	37	1.865	1.842	1.29	1.22	1.19
	38	1.769	1.757	1.22	1.19	1.18
	39	1.721	1.775	1.19	1.18	1.27
	40	1.709	1.806	1.18	1.19	1.33
	41	1.720	1.809	1.19	1.22	1.36
	42	1.764	1.841	1.22	1.22	1.33
	43	1.767	1.839	1.22	1.18	1.27
	44	1.715	1.836	1.18	1.13	1.13
	45	1.633	1.621	1.13	1.05	1.05
	46	1.521	1.521	1.05	0.96	0.96
	47	1.388	1.384	0.96	0.84	0.87
Average						
	Weekday	1.462	1.459	1.01	1.01	1.01
	Weekend	1.423	1.451	0.98	0.98	0.98
	ADWF[(1)]	1.451	1.457	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		1.9%			

Notes:

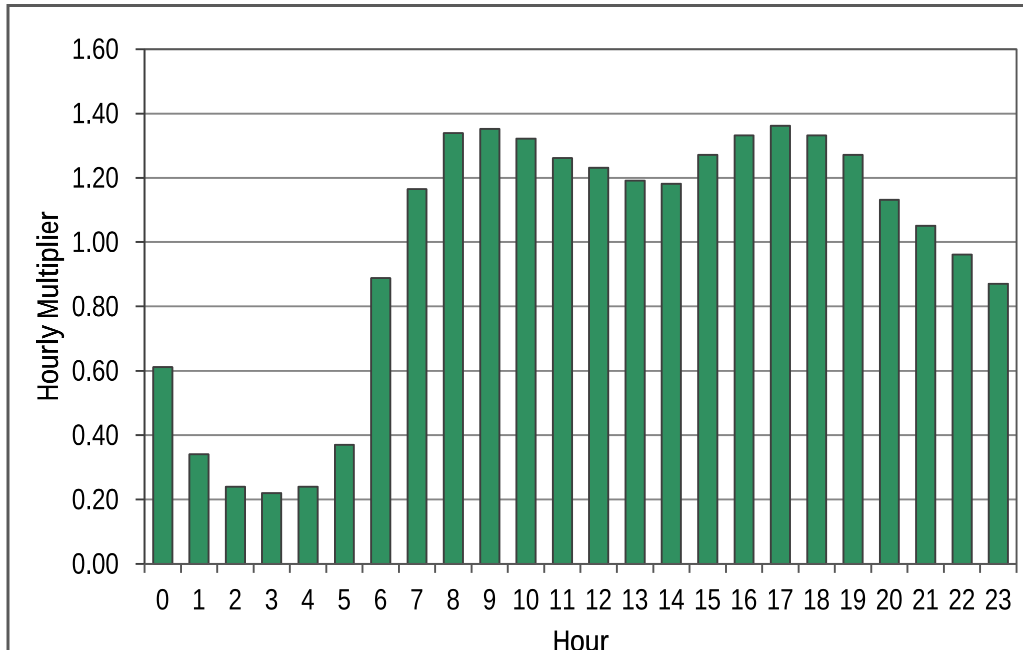
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

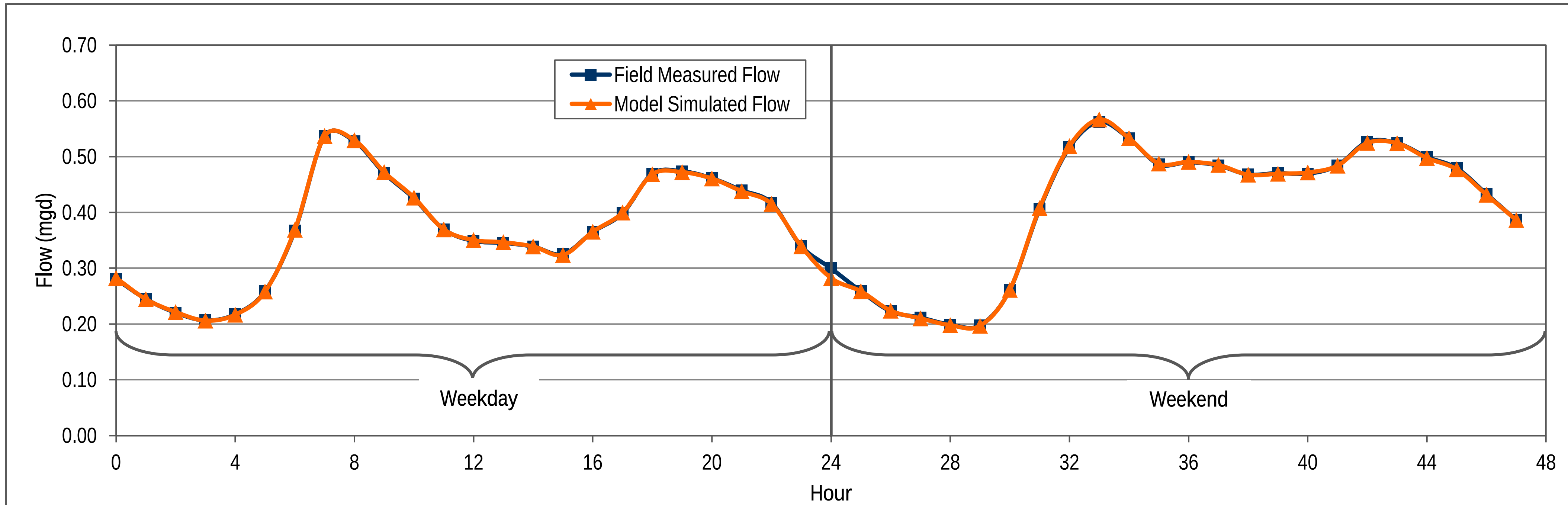
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_58.xlsx

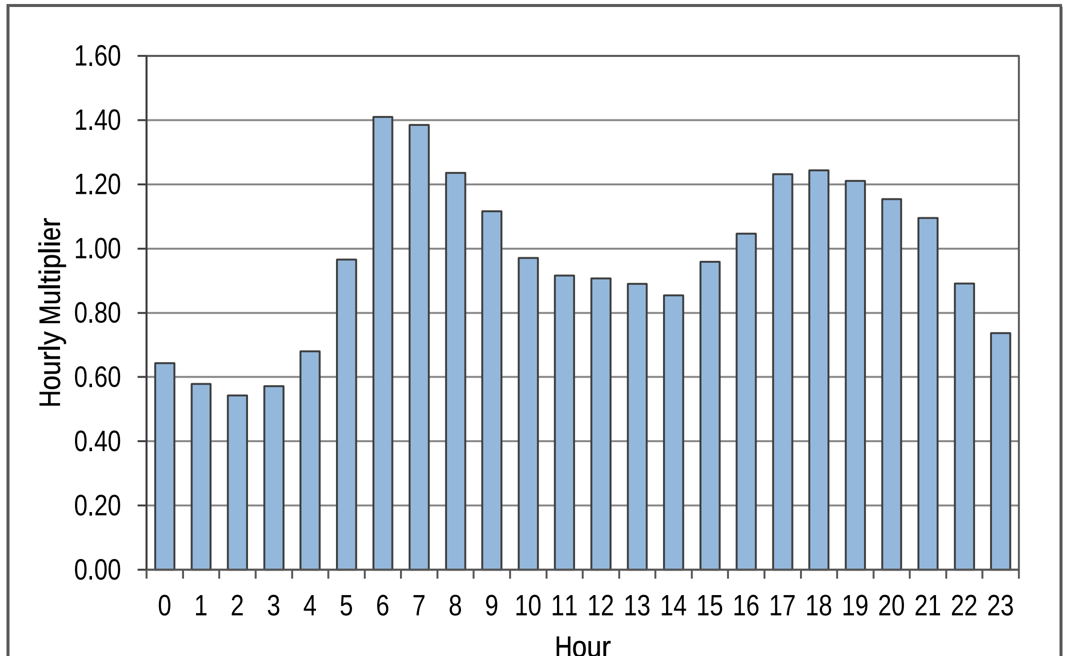
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 59A DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.281	0.282	0.74	0.64	0.64
	1	0.245	0.244	0.64	0.58	0.58
	2	0.221	0.221	0.58	0.54	0.54
	3	0.207	0.206	0.54	0.57	0.57
	4	0.218	0.217	0.57	0.68	0.68
	5	0.259	0.258	0.68	0.97	0.97
	6	0.368	0.369	0.97	1.41	1.41
	7	0.537	0.537	1.41	1.39	1.39
	8	0.528	0.529	1.39	1.24	1.24
	9	0.470	0.472	1.24	1.12	1.12
	10	0.425	0.427	1.12	0.97	0.97
	11	0.370	0.370	0.97	0.92	0.92
	12	0.349	0.350	0.92	0.91	0.91
	13	0.346	0.347	0.91	0.89	0.89
	14	0.339	0.339	0.89	0.85	0.85
	15	0.325	0.324	0.85	0.96	0.96
	16	0.365	0.365	0.96	1.05	1.05
	17	0.399	0.400	1.05	1.23	1.23
	18	0.469	0.468	1.23	1.24	1.24
	19	0.474	0.472	1.24	1.21	1.21
	20	0.461	0.461	1.21	1.15	1.15
	21	0.440	0.438	1.15	1.09	1.09
	22	0.417	0.415	1.09	0.89	0.89
	23	0.339	0.339	0.89	0.74	0.74
Weekend	24	0.300	0.282	0.79	0.68	0.68
	25	0.259	0.259	0.68	0.59	0.59
	26	0.223	0.224	0.59	0.56	0.56
	27	0.212	0.210	0.56	0.52	0.52
	28	0.199	0.198	0.52	0.52	0.52
	29	0.198	0.197	0.52	0.69	0.69
	30	0.261	0.261	0.69	1.07	1.07
	31	0.406	0.408	1.07	1.36	1.36
	32	0.517	0.519	1.36	1.48	1.48
	33	0.562	0.567	1.48	1.40	1.40
	34	0.533	0.533	1.40	1.28	1.28
	35	0.486	0.488	1.28	1.29	1.29
	36	0.490	0.491	1.29	1.27	1.27
	37	0.484	0.485	1.27	1.23	1.23
	38	0.468	0.468	1.23	1.24	1.24
	39	0.471	0.469	1.24	1.23	1.23
	40	0.469	0.472	1.23	1.27	1.27
	41	0.484	0.484	1.27	1.38	1.38
	42	0.526	0.525	1.38	1.38	1.38
	43	0.524	0.524	1.38	1.31	1.31
	44	0.499	0.498	1.31	1.26	1.26
	45	0.479	0.477	1.26	1.14	1.14
	46	0.433	0.432	1.14	1.01	1.01
	47	0.386	0.387	1.01	0.79	0.79
Average						
	Weekday	0.369	0.369	0.97	0.97	0.97
	Weekend	0.411	0.411	1.08	1.08	1.08
	ADWF[(1)]	0.381	0.381	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.2%			

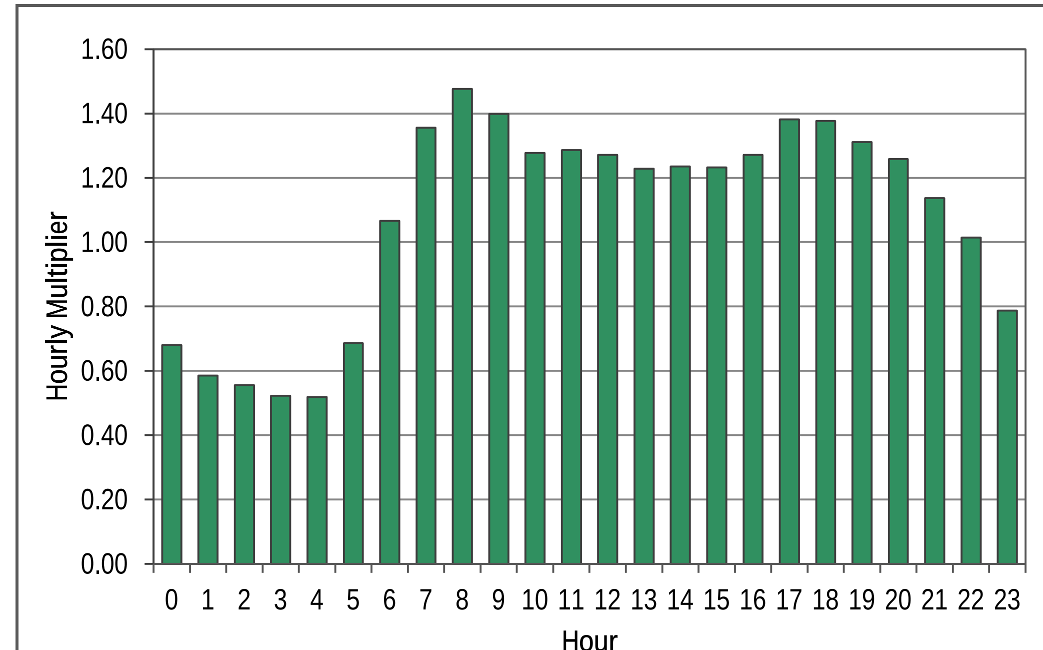
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_59.xlsx

City of Oakland

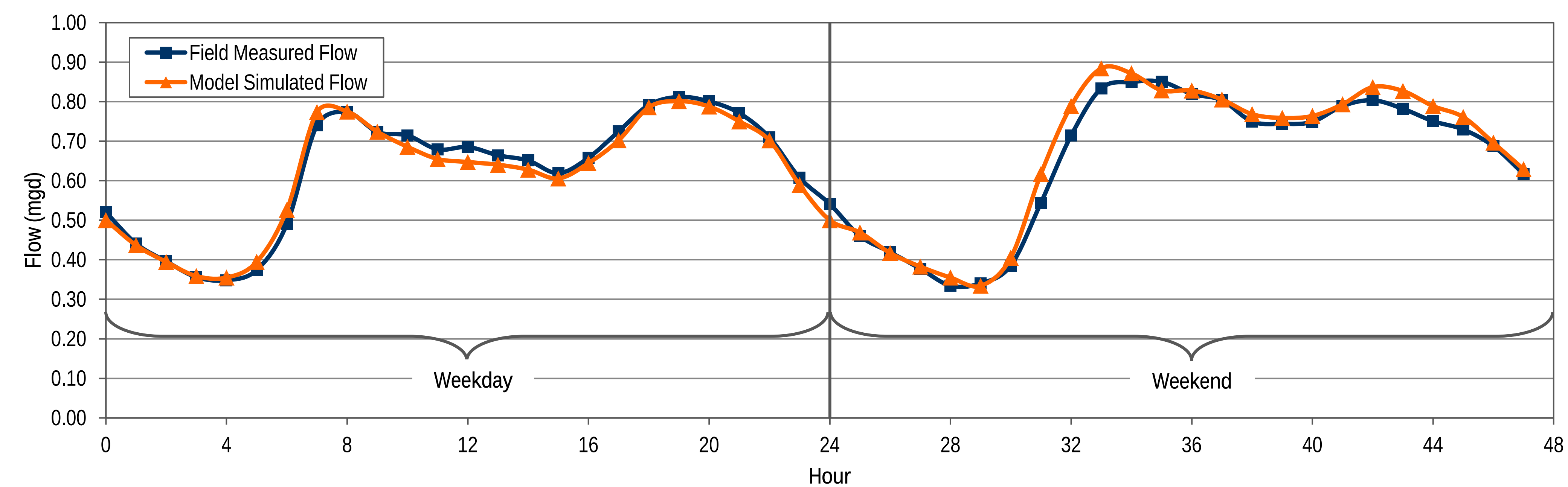
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 59-1 DRY WEATHER CALIBRATION

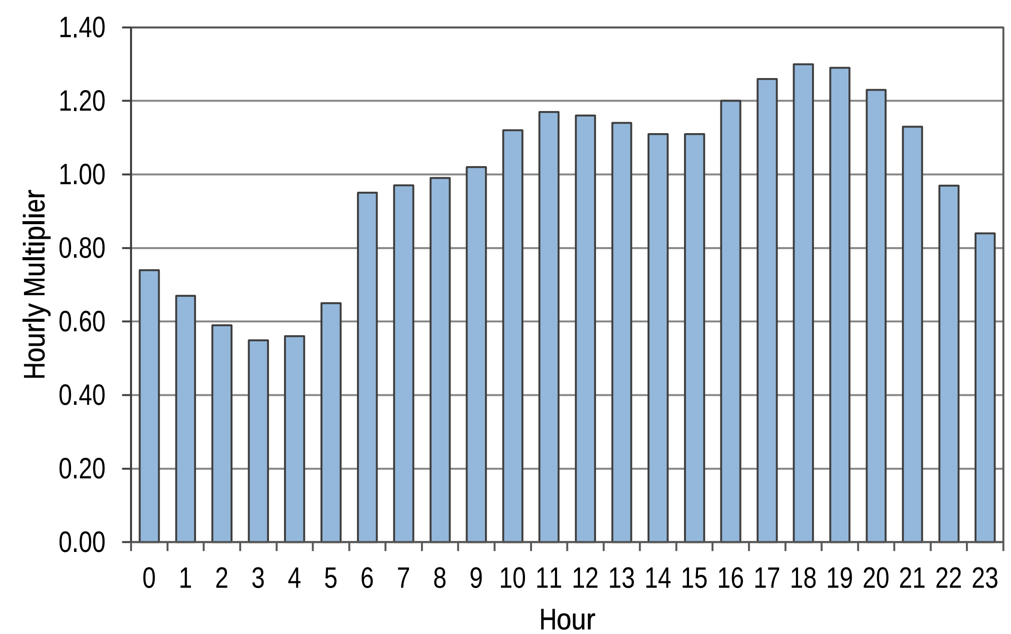
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.520	0.500	0.82	0.70	0.74
	1	0.441	0.437	0.70	0.62	0.67
	2	0.396	0.395	0.62	0.56	0.59
	3	0.356	0.359	0.56	0.55	0.55
	4	0.348	0.355	0.55	0.59	0.56
	5	0.374	0.395	0.59	0.77	0.65
	6	0.491	0.526	0.77	1.17	0.95
	7	0.741	0.774	1.17	1.22	0.97
	8	0.774	0.775	1.22	1.14	0.99
	9	0.723	0.724	1.14	1.13	1.02
	10	0.715	0.686	1.13	1.07	1.12
	11	0.679	0.655	1.07	1.08	1.17
	12	0.685	0.647	1.08	1.05	1.16
	13	0.664	0.641	1.05	1.03	1.14
	14	0.651	0.628	1.03	0.98	1.11
	15	0.619	0.606	0.98	1.04	1.11
	16	0.658	0.645	1.04	1.14	1.20
	17	0.725	0.702	1.14	1.25	1.26
	18	0.792	0.786	1.25	1.28	1.30
	19	0.812	0.801	1.28	1.26	1.29
	20	0.801	0.788	1.26	1.22	1.23
	21	0.771	0.750	1.22	1.12	1.13
	22	0.709	0.702	1.12	0.96	0.97
	23	0.607	0.589	0.96	0.82	0.84
Weekend	24	0.541	0.500	0.85	0.73	0.82
	25	0.460	0.469	0.73	0.66	0.74
	26	0.419	0.417	0.66	0.59	0.67
	27	0.378	0.383	0.59	0.53	0.61
	28	0.335	0.355	0.53	0.54	0.54
	29	0.340	0.334	0.54	0.61	0.61
	30	0.385	0.405	0.61	0.86	0.85
	31	0.544	0.617	0.86	1.13	1.08
	32	0.714	0.789	1.13	1.31	1.26
	33	0.834	0.884	1.31	1.34	1.34
	34	0.850	0.872	1.34	1.34	1.34
	35	0.851	0.829	1.34	1.29	1.33
	36	0.820	0.828	1.29	1.27	1.27
	37	0.804	0.806	1.27	1.18	1.18
	38	0.750	0.768	1.18	1.17	1.14
	39	0.744	0.759	1.17	1.18	1.15
	40	0.749	0.764	1.18	1.24	1.22
	41	0.789	0.793	1.24	1.27	1.23
	42	0.804	0.837	1.27	1.23	1.20
	43	0.782	0.827	1.23	1.18	1.15
	44	0.751	0.789	1.18	1.15	1.12
	45	0.730	0.761	1.15	1.08	1.04
	46	0.688	0.696	1.08	0.97	0.95
	47	0.617	0.629	0.97	0.85	0.85
Average						
	Weekday	0.627	0.619	0.99	0.99	0.99
	Weekend	0.653	0.671	1.03	1.03	1.03
	ADWF[1]	0.635	0.634	1.00	1.00	1.00
% Error						
	Weekday		-1.2%			
	Weekend		2.8%			

Notes:

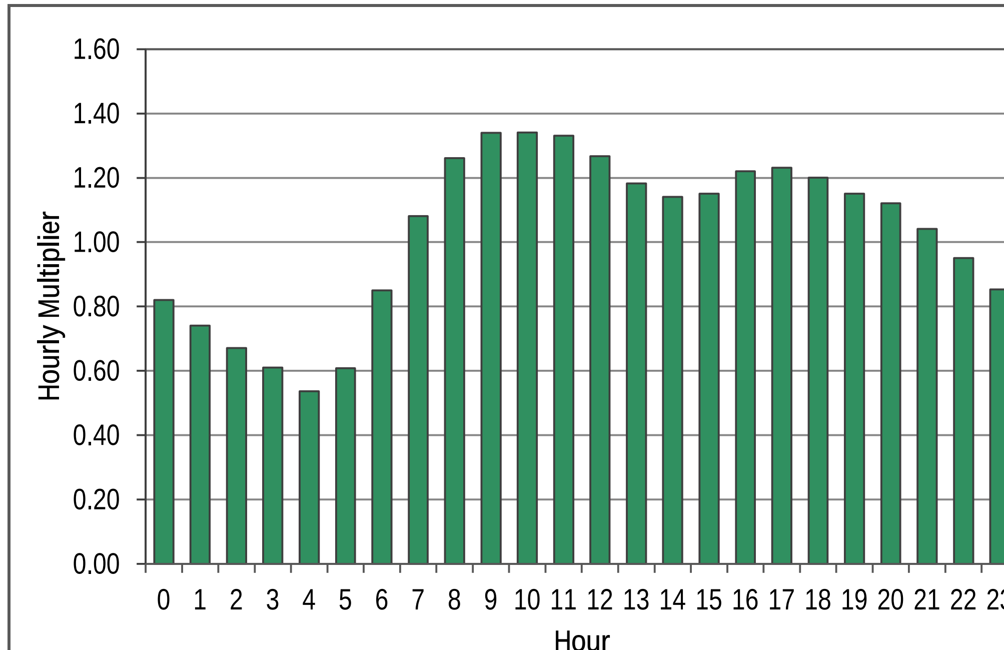
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_59.xlsx

City of Oakland

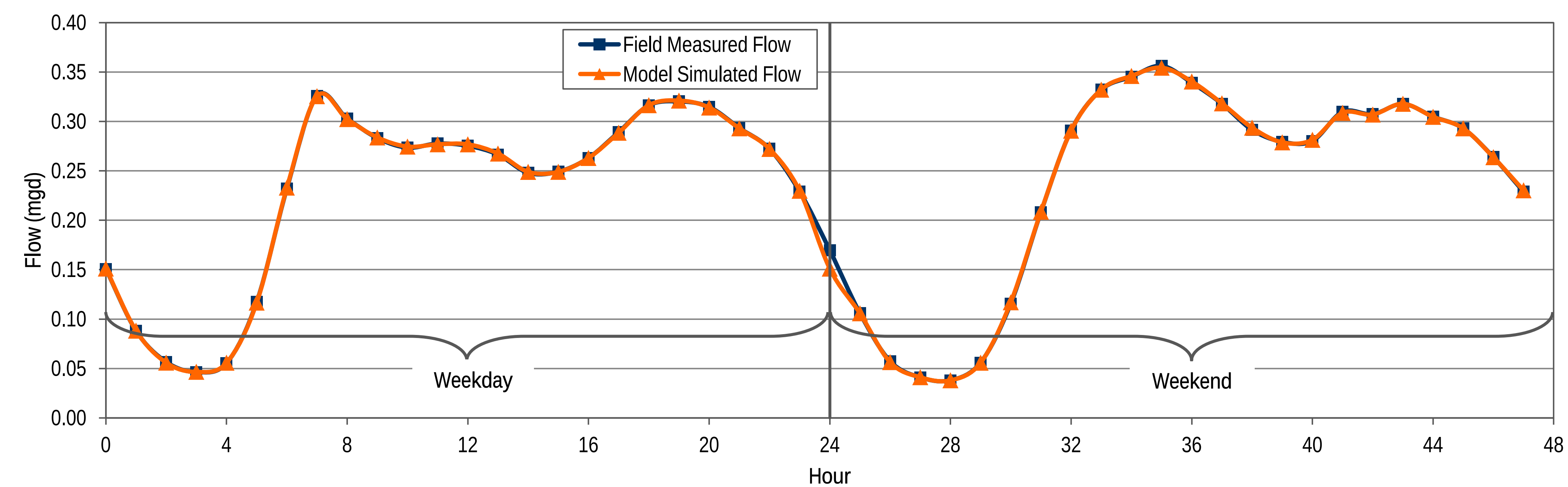
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60A DRY WEATHER CALIBRATION

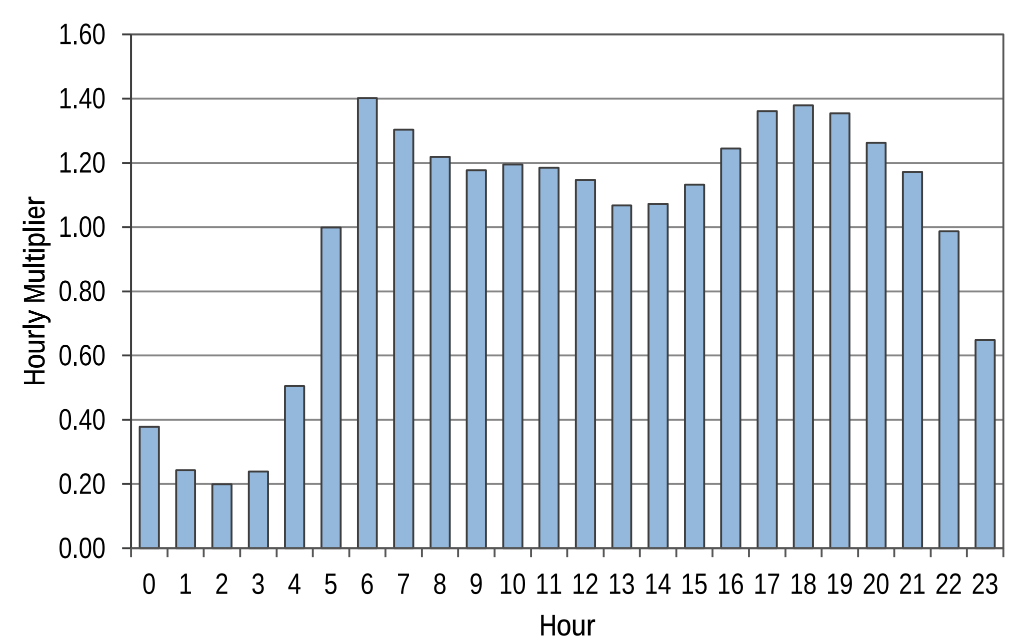
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.151	0.151	0.65	0.38	0.38
	1	0.088	0.088	0.38	0.24	0.24
	2	0.057	0.056	0.24	0.20	0.20
	3	0.046	0.047	0.20	0.24	0.24
	4	0.055	0.056	0.24	0.50	0.50
	5	0.117	0.117	0.50	1.00	1.00
	6	0.232	0.233	1.00	1.40	1.40
	7	0.326	0.326	1.40	1.30	1.30
	8	0.303	0.302	1.30	1.22	1.22
	9	0.283	0.284	1.22	1.18	1.18
	10	0.273	0.275	1.18	1.19	1.19
	11	0.278	0.277	1.19	1.19	1.19
	12	0.275	0.277	1.19	1.15	1.15
	13	0.266	0.267	1.15	1.07	1.07
	14	0.248	0.249	1.07	1.07	1.07
	15	0.249	0.249	1.07	1.13	1.13
	16	0.263	0.263	1.13	1.24	1.24
	17	0.289	0.289	1.24	1.36	1.36
	18	0.316	0.316	1.36	1.38	1.38
	19	0.320	0.321	1.38	1.35	1.35
	20	0.315	0.314	1.35	1.26	1.26
	21	0.293	0.293	1.26	1.17	1.17
	22	0.272	0.272	1.17	0.99	0.99
	23	0.229	0.230	0.99	0.65	0.65
Weekend	24	0.170	0.151	0.73	0.46	0.46
	25	0.106	0.106	0.46	0.25	0.25
	26	0.057	0.057	0.25	0.18	0.18
	27	0.041	0.041	0.18	0.16	0.16
	28	0.038	0.038	0.16	0.24	0.24
	29	0.056	0.056	0.24	0.50	0.50
	30	0.116	0.117	0.50	0.90	0.90
	31	0.208	0.209	0.90	1.25	1.25
	32	0.291	0.291	1.25	1.43	1.43
	33	0.332	0.332	1.43	1.49	1.49
	34	0.345	0.346	1.49	1.53	1.53
	35	0.356	0.354	1.53	1.46	1.46
	36	0.339	0.340	1.46	1.37	1.37
	37	0.318	0.318	1.37	1.25	1.25
	38	0.292	0.294	1.25	1.20	1.20
	39	0.279	0.279	1.20	1.21	1.21
	40	0.280	0.281	1.21	1.33	1.33
	41	0.310	0.309	1.33	1.32	1.32
	42	0.307	0.307	1.32	1.37	1.37
	43	0.318	0.318	1.37	1.31	1.31
	44	0.305	0.305	1.31	1.26	1.26
	45	0.293	0.293	1.26	1.14	1.14
	46	0.264	0.264	1.14	0.99	0.99
	47	0.229	0.230	0.99	0.73	0.73
Average						
	Weekday	0.231	0.231	0.99	0.99	0.99
	Weekend	0.235	0.235	1.01	1.01	1.01
	ADWF[(1)]	0.232	0.232	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.3%			

Notes:

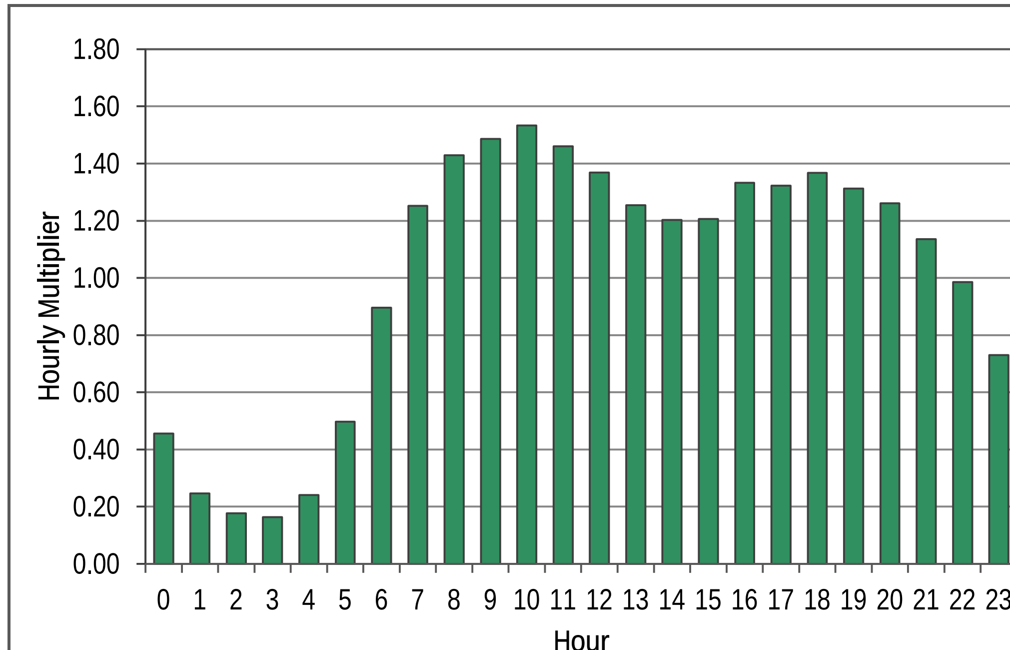
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_60.xlsx

City of Oakland

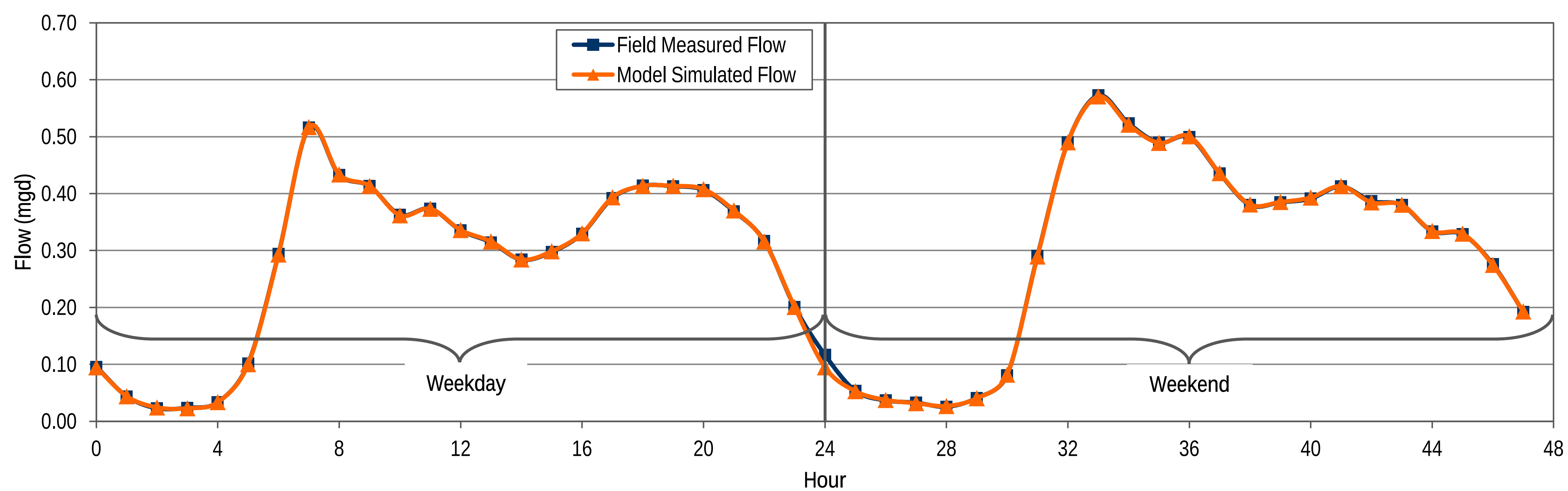
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60B DRY WEATHER CALIBRATION

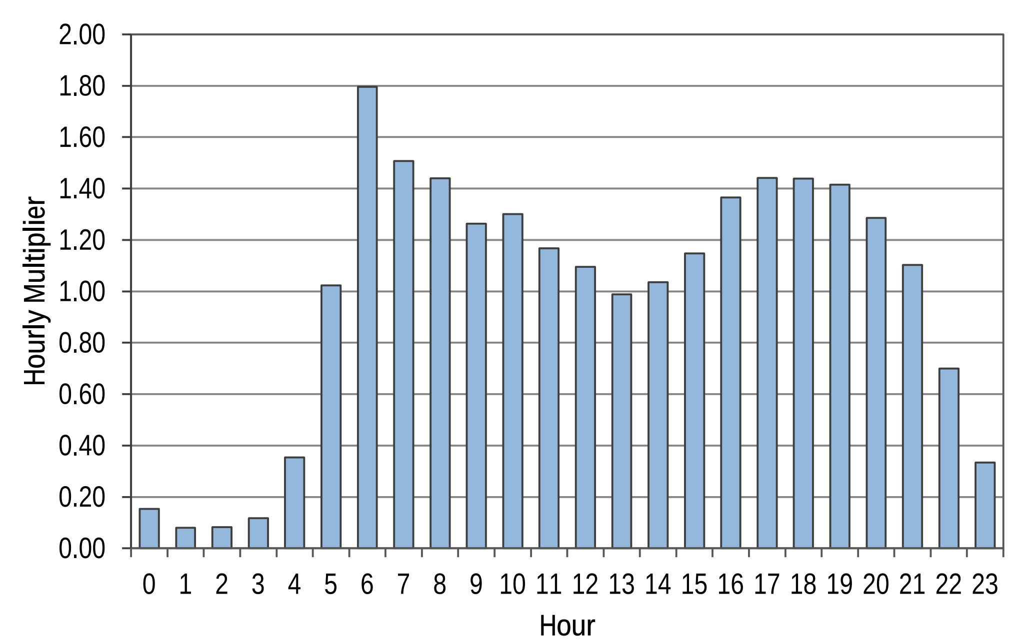
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.096	0.095	0.33	0.15	0.15
	1	0.044	0.044	0.15	0.08	0.08
	2	0.023	0.024	0.08	0.08	0.08
	3	0.024	0.023	0.08	0.12	0.12
	4	0.034	0.034	0.12	0.35	0.35
	5	0.101	0.100	0.35	1.02	1.02
	6	0.294	0.293	1.02	1.80	1.80
	7	0.516	0.517	1.80	1.51	1.51
	8	0.433	0.434	1.51	1.44	1.44
	9	0.413	0.414	1.44	1.26	1.26
	10	0.363	0.362	1.26	1.30	1.30
	11	0.374	0.373	1.30	1.17	1.17
	12	0.335	0.336	1.17	1.10	1.10
	13	0.314	0.316	1.10	0.99	0.99
	14	0.284	0.284	0.99	1.04	1.04
	15	0.298	0.299	1.04	1.15	1.15
	16	0.330	0.330	1.15	1.37	1.37
	17	0.392	0.393	1.37	1.44	1.44
	18	0.414	0.414	1.44	1.44	1.44
	19	0.413	0.414	1.44	1.42	1.42
	20	0.406	0.408	1.42	1.29	1.29
	21	0.369	0.370	1.29	1.10	1.10
	22	0.317	0.316	1.10	0.70	0.70
	23	0.201	0.201	0.70	0.33	0.33
Weekend	24	0.117	0.095	0.41	0.19	0.19
	25	0.054	0.053	0.19	0.13	0.13
	26	0.037	0.038	0.13	0.11	0.11
	27	0.033	0.032	0.11	0.09	0.09
	28	0.026	0.027	0.09	0.14	0.14
	29	0.041	0.041	0.14	0.28	0.28
	30	0.081	0.082	0.28	1.01	1.01
	31	0.291	0.290	1.01	1.71	1.71
	32	0.490	0.490	1.71	1.99	1.99
	33	0.572	0.571	1.99	1.82	1.82
	34	0.523	0.521	1.82	1.71	1.71
	35	0.490	0.489	1.71	1.74	1.74
	36	0.499	0.501	1.74	1.52	1.52
	37	0.435	0.436	1.52	1.32	1.32
	38	0.380	0.381	1.32	1.34	1.34
	39	0.385	0.385	1.34	1.36	1.36
	40	0.391	0.393	1.36	1.44	1.44
	41	0.413	0.413	1.44	1.35	1.35
	42	0.387	0.385	1.35	1.32	1.32
	43	0.380	0.380	1.32	1.16	1.16
	44	0.334	0.334	1.16	1.14	1.14
	45	0.329	0.330	1.14	0.96	0.96
	46	0.276	0.275	0.96	0.67	0.67
	47	0.192	0.193	0.67	0.41	0.41
Average						
	Weekday	0.283	0.283	0.98	0.98	0.98
	Weekend	0.298	0.297	1.04	1.04	1.04
	ADWF[(1)]	0.287	0.287	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.3%			

Notes:

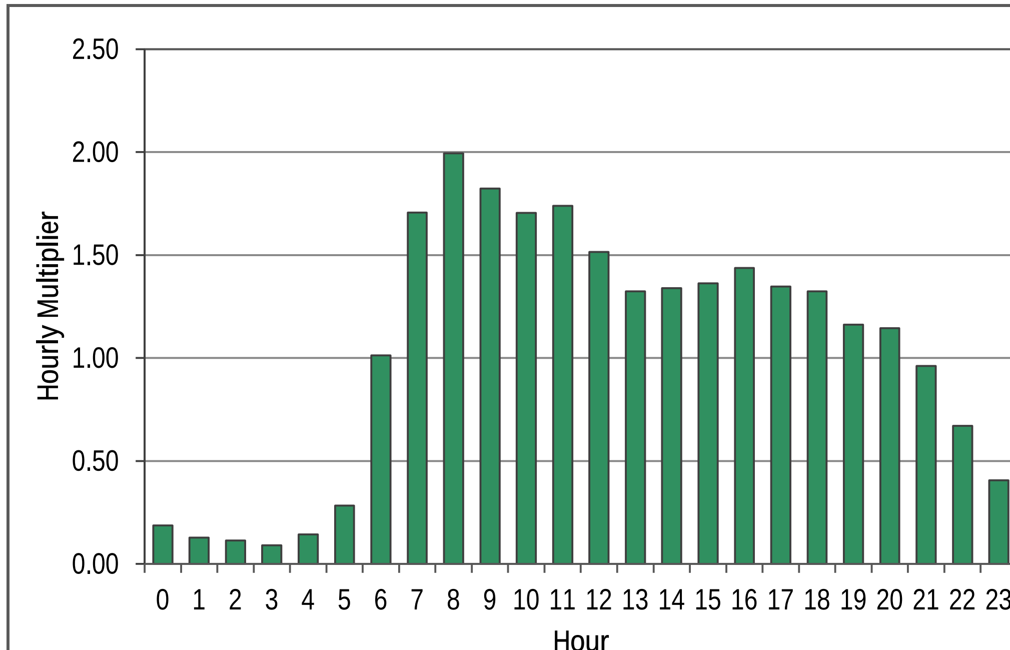
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_60.xlsx

City of Oakland

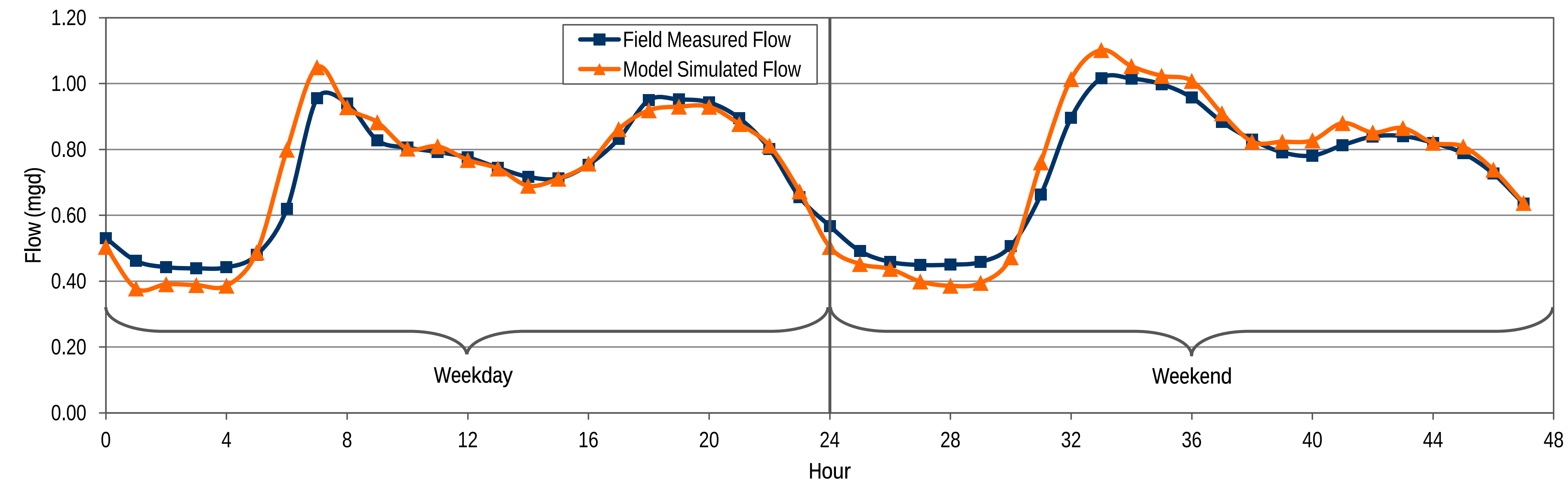
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60-1 DRY WEATHER CALIBRATION

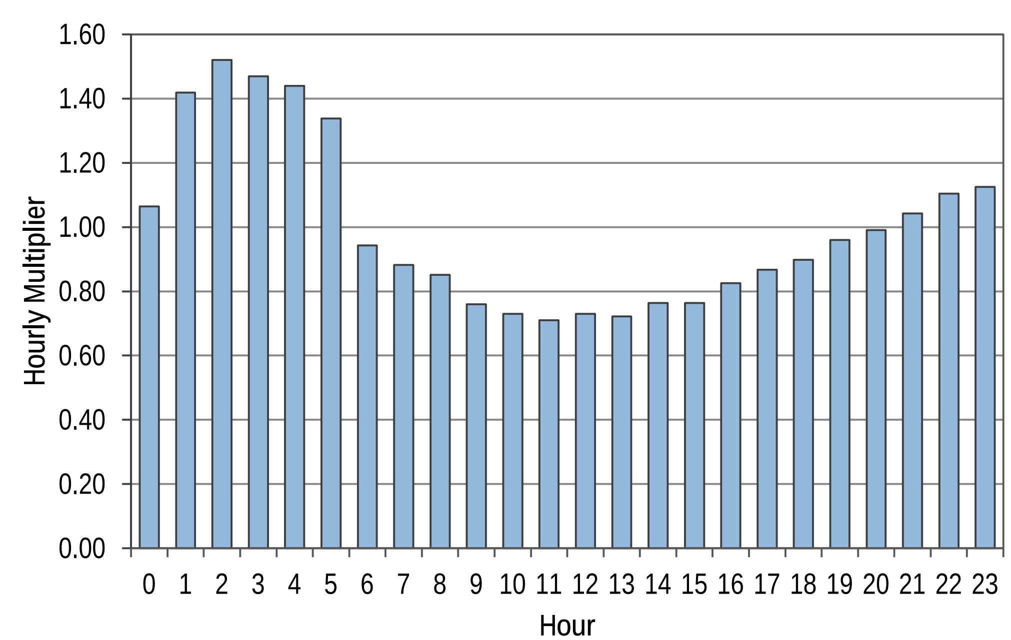
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.531	0.504	0.73	0.63	1.06
	1	0.462	0.378	0.63	0.61	1.42
	2	0.443	0.391	0.61	0.60	1.52
	3	0.439	0.388	0.60	0.61	1.47
	4	0.442	0.386	0.61	0.66	1.44
	5	0.480	0.488	0.66	0.85	1.34
	6	0.620	0.799	0.85	1.31	0.94
	7	0.955	1.050	1.31	1.29	0.88
	8	0.939	0.928	1.29	1.13	0.85
	9	0.828	0.883	1.13	1.10	0.76
	10	0.806	0.803	1.10	1.08	0.73
	11	0.792	0.810	1.08	1.06	0.71
	12	0.776	0.768	1.06	1.02	0.73
	13	0.744	0.742	1.02	0.98	0.72
	14	0.717	0.690	0.98	0.97	0.76
	15	0.712	0.711	0.97	1.03	0.76
	16	0.754	0.757	1.03	1.14	0.83
	17	0.832	0.862	1.14	1.30	0.87
	18	0.950	0.919	1.30	1.30	0.90
	19	0.952	0.930	1.30	1.29	0.96
	20	0.943	0.930	1.29	1.23	0.99
	21	0.895	0.877	1.23	1.10	1.04
	22	0.802	0.812	1.10	0.90	1.10
	23	0.655	0.673	0.90	0.73	1.12
Weekend	24	0.568	0.504	0.78	0.67	1.33
	25	0.492	0.452	0.67	0.63	1.57
	26	0.459	0.437	0.63	0.62	1.54
	27	0.449	0.399	0.62	0.62	1.52
	28	0.451	0.386	0.62	0.63	1.49
	29	0.459	0.395	0.63	0.69	1.42
	30	0.507	0.473	0.69	0.91	1.30
	31	0.663	0.761	0.91	1.23	1.07
	32	0.896	1.014	1.23	1.39	0.90
	33	1.016	1.102	1.39	1.39	0.84
	34	1.015	1.053	1.39	1.37	0.82
	35	0.998	1.023	1.37	1.31	0.75
	36	0.957	1.008	1.31	1.21	0.70
	37	0.884	0.910	1.21	1.14	0.68
	38	0.829	0.824	1.14	1.08	0.73
	39	0.791	0.823	1.08	1.07	0.70
	40	0.781	0.828	1.07	1.11	0.72
	41	0.813	0.880	1.11	1.15	0.73
	42	0.839	0.852	1.15	1.15	0.76
	43	0.841	0.865	1.15	1.12	0.83
	44	0.820	0.820	1.12	1.08	0.86
	45	0.788	0.809	1.08	1.00	0.93
	46	0.727	0.739	1.00	0.87	0.98
	47	0.636	0.638	0.87	0.78	1.01
Average						
Weekday		0.728	0.728	1.00	1.00	1.00
Weekend		0.737	0.750	1.01	1.01	1.01
ADWF[1]		0.730	0.734	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			1.8%			

Notes:

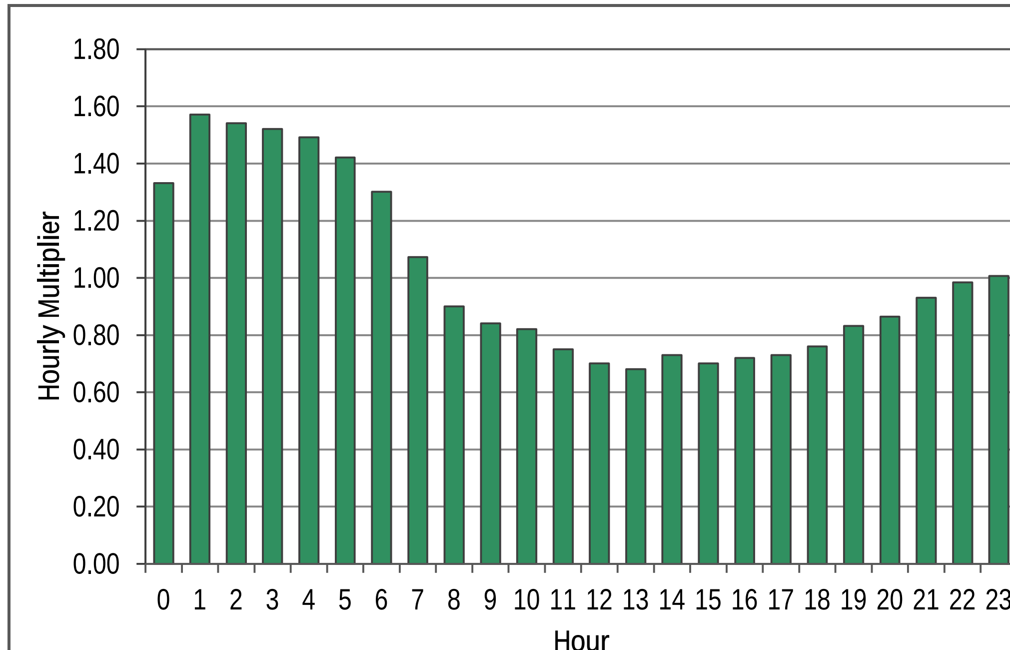
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

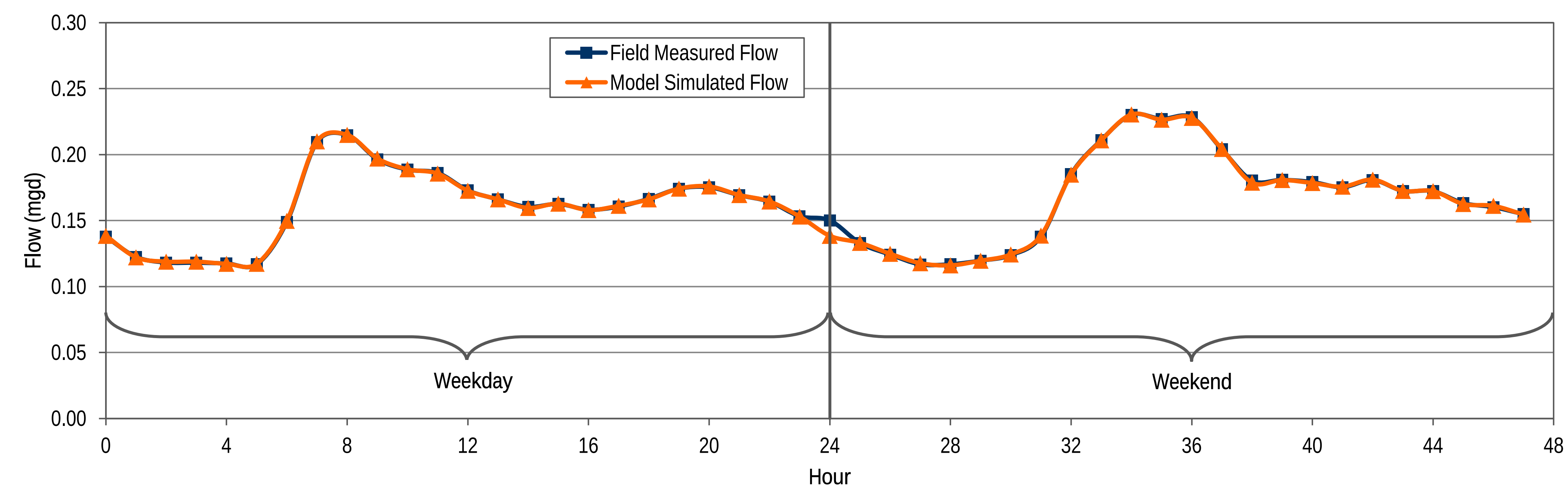
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 61A DRY WEATHER CALIBRATION

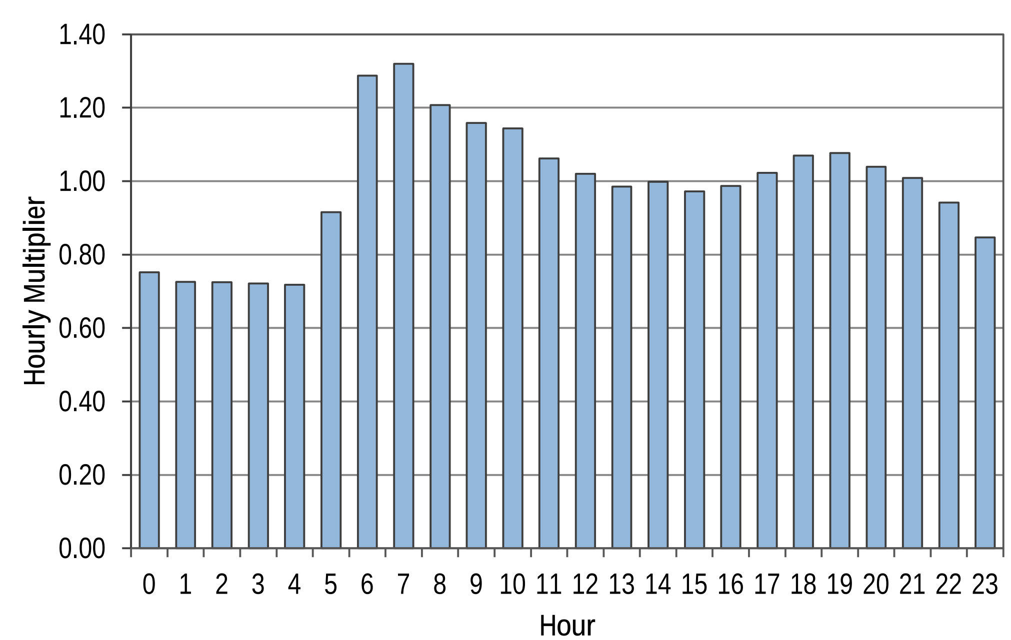
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.138	0.138	0.85	0.75	0.75
	1	0.122	0.122	0.75	0.73	0.73
	2	0.118	0.119	0.73	0.73	0.73
	3	0.118	0.119	0.73	0.72	0.72
	4	0.117	0.117	0.72	0.72	0.72
	5	0.117	0.117	0.72	0.92	0.92
	6	0.149	0.150	0.92	1.29	1.29
	7	0.210	0.210	1.29	1.32	1.32
	8	0.215	0.215	1.32	1.21	1.21
	9	0.196	0.197	1.21	1.16	1.16
	10	0.189	0.189	1.16	1.14	1.14
	11	0.186	0.186	1.14	1.06	1.06
	12	0.173	0.173	1.06	1.02	1.02
	13	0.166	0.166	1.02	0.98	0.98
	14	0.160	0.160	0.98	1.00	1.00
	15	0.163	0.163	1.00	0.97	0.97
	16	0.158	0.158	0.97	0.99	0.99
	17	0.161	0.161	0.99	1.02	1.02
	18	0.166	0.166	1.02	1.07	1.07
	19	0.174	0.174	1.07	1.08	1.08
	20	0.175	0.176	1.08	1.04	1.04
	21	0.169	0.169	1.04	1.01	1.01
	22	0.164	0.164	1.01	0.94	0.94
	23	0.153	0.153	0.94	0.85	0.85
Weekend	24	0.150	0.138	0.92	0.82	0.82
	25	0.133	0.133	0.82	0.76	0.76
	26	0.124	0.125	0.76	0.72	0.72
	27	0.117	0.118	0.72	0.72	0.72
	28	0.117	0.116	0.72	0.73	0.73
	29	0.120	0.120	0.73	0.76	0.76
	30	0.124	0.124	0.76	0.85	0.85
	31	0.138	0.139	0.85	1.14	1.14
	32	0.185	0.185	1.14	1.30	1.30
	33	0.211	0.211	1.30	1.41	1.41
	34	0.230	0.230	1.41	1.39	1.39
	35	0.227	0.226	1.39	1.40	1.40
	36	0.228	0.228	1.40	1.25	1.25
	37	0.204	0.204	1.25	1.11	1.11
	38	0.180	0.179	1.11	1.11	1.11
	39	0.181	0.181	1.11	1.10	1.10
	40	0.179	0.178	1.10	1.08	1.08
	41	0.175	0.176	1.08	1.11	1.11
	42	0.181	0.181	1.11	1.06	1.06
	43	0.172	0.172	1.06	1.06	1.06
	44	0.172	0.172	1.06	1.00	1.00
	45	0.163	0.163	1.00	0.98	0.98
	46	0.160	0.161	0.98	0.95	0.95
	47	0.155	0.155	0.95	0.92	0.92
Average						
Weekday		0.161	0.161	0.99	0.99	0.99
Weekend		0.168	0.167	1.03	1.03	1.03
ADWF[(1)]		0.163	0.163	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			-0.3%			

Notes:

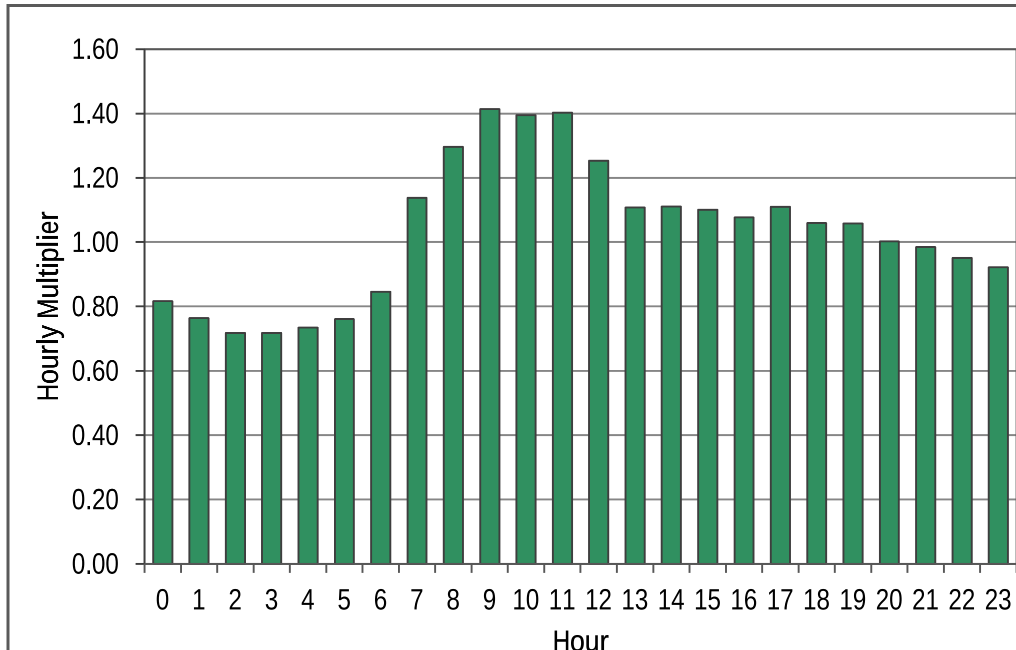
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_61.xlsx

City of Oakland

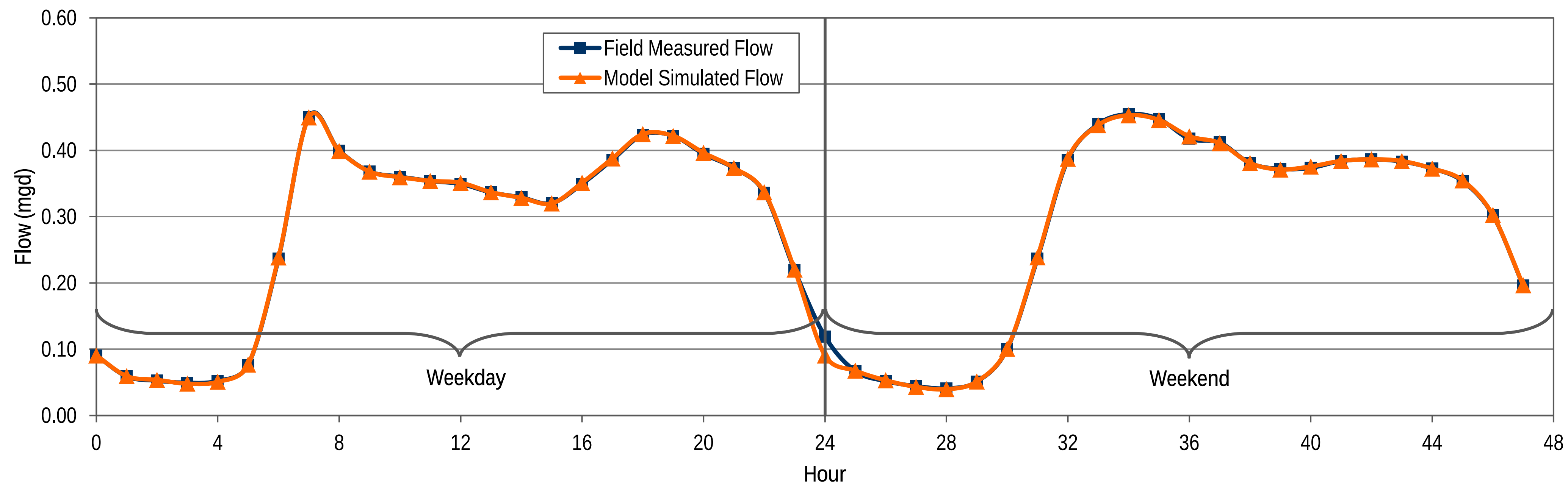
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 62A DRY WEATHER CALIBRATION

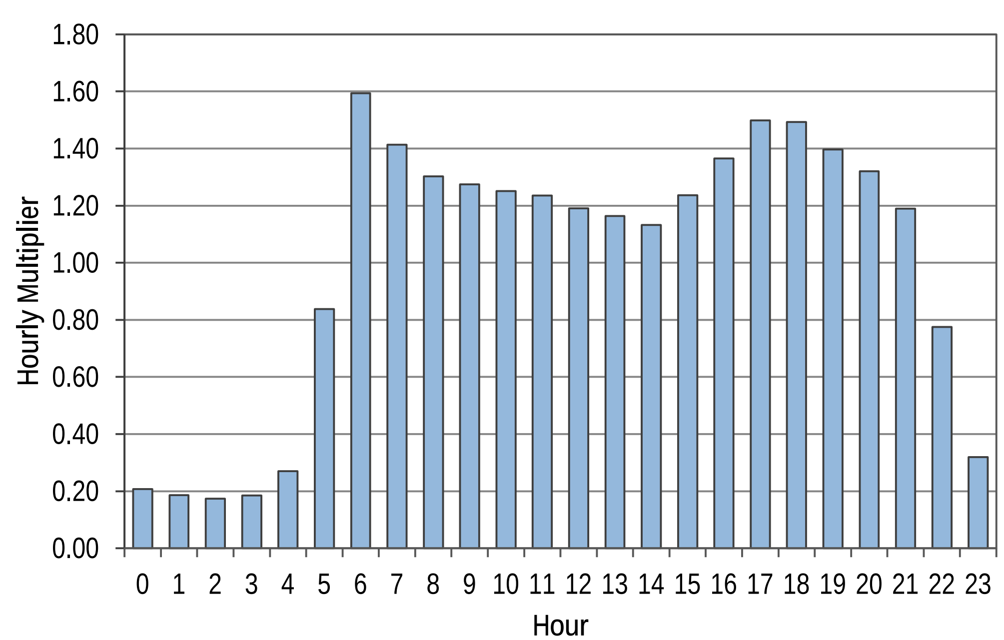
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.090	0.091	0.32	0.21	0.21
	1	0.059	0.059	0.21	0.19	0.19
	2	0.053	0.054	0.19	0.17	0.17
	3	0.049	0.048	0.17	0.18	0.18
	4	0.052	0.051	0.18	0.27	0.27
	5	0.076	0.077	0.27	0.84	0.84
	6	0.237	0.238	0.84	1.59	1.59
	7	0.451	0.450	1.59	1.41	1.41
	8	0.400	0.399	1.41	1.30	1.30
	9	0.368	0.368	1.30	1.27	1.27
	10	0.360	0.360	1.27	1.25	1.25
	11	0.354	0.354	1.25	1.24	1.24
	12	0.349	0.351	1.24	1.19	1.19
	13	0.336	0.337	1.19	1.16	1.16
	14	0.329	0.328	1.16	1.13	1.13
	15	0.320	0.320	1.13	1.24	1.24
	16	0.349	0.351	1.24	1.37	1.37
	17	0.386	0.388	1.37	1.50	1.50
	18	0.424	0.425	1.50	1.49	1.49
	19	0.422	0.422	1.49	1.40	1.40
	20	0.395	0.396	1.40	1.32	1.32
	21	0.373	0.373	1.32	1.19	1.19
	22	0.336	0.337	1.19	0.78	0.78
	23	0.219	0.220	0.78	0.32	0.32
Weekend	24	0.119	0.091	0.42	0.24	0.24
	25	0.067	0.068	0.24	0.18	0.18
	26	0.052	0.053	0.18	0.16	0.16
	27	0.044	0.043	0.16	0.14	0.14
	28	0.041	0.040	0.14	0.18	0.18
	29	0.051	0.051	0.18	0.35	0.35
	30	0.100	0.101	0.35	0.84	0.84
	31	0.237	0.239	0.84	1.37	1.37
	32	0.386	0.387	1.37	1.55	1.55
	33	0.440	0.438	1.55	1.61	1.61
	34	0.455	0.453	1.61	1.58	1.58
	35	0.447	0.446	1.58	1.48	1.48
	36	0.418	0.421	1.48	1.46	1.46
	37	0.412	0.411	1.46	1.35	1.35
	38	0.381	0.381	1.35	1.32	1.32
	39	0.372	0.371	1.32	1.32	1.32
	40	0.374	0.376	1.32	1.36	1.36
	41	0.384	0.384	1.36	1.37	1.37
	42	0.386	0.386	1.37	1.36	1.36
	43	0.383	0.384	1.36	1.32	1.32
	44	0.373	0.373	1.32	1.25	1.25
	45	0.354	0.355	1.25	1.07	1.07
	46	0.302	0.303	1.07	0.69	0.69
	47	0.196	0.196	0.69	0.42	0.42
Average						
	Weekday	0.283	0.283	1.00	1.00	1.00
	Weekend	0.282	0.281	1.00	1.00	1.00
	ADWF [1]	0.283	0.283	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.3%			

Notes:

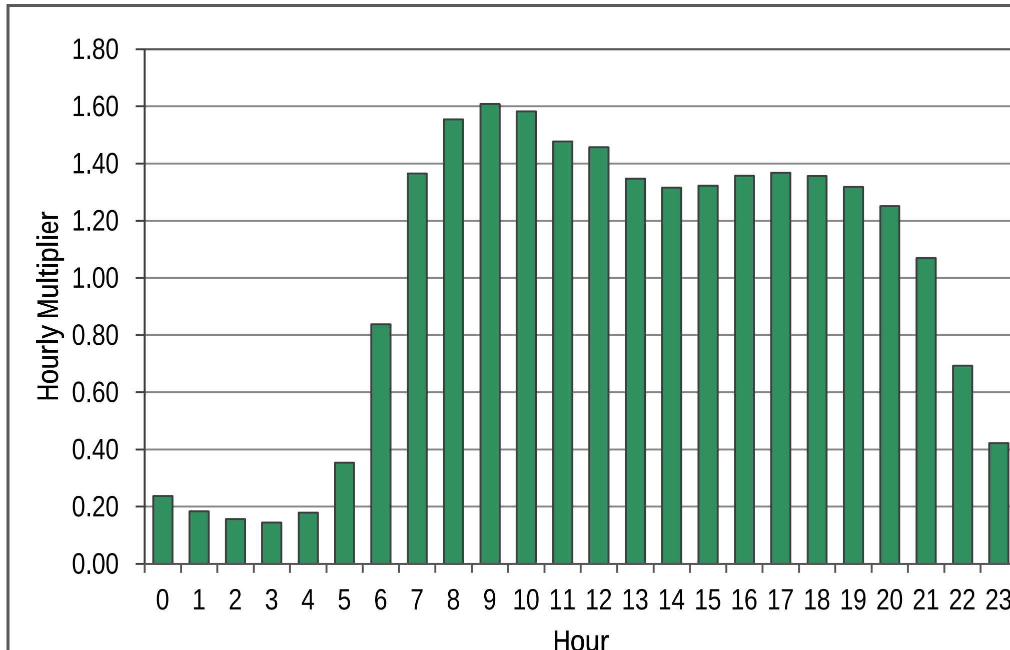
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

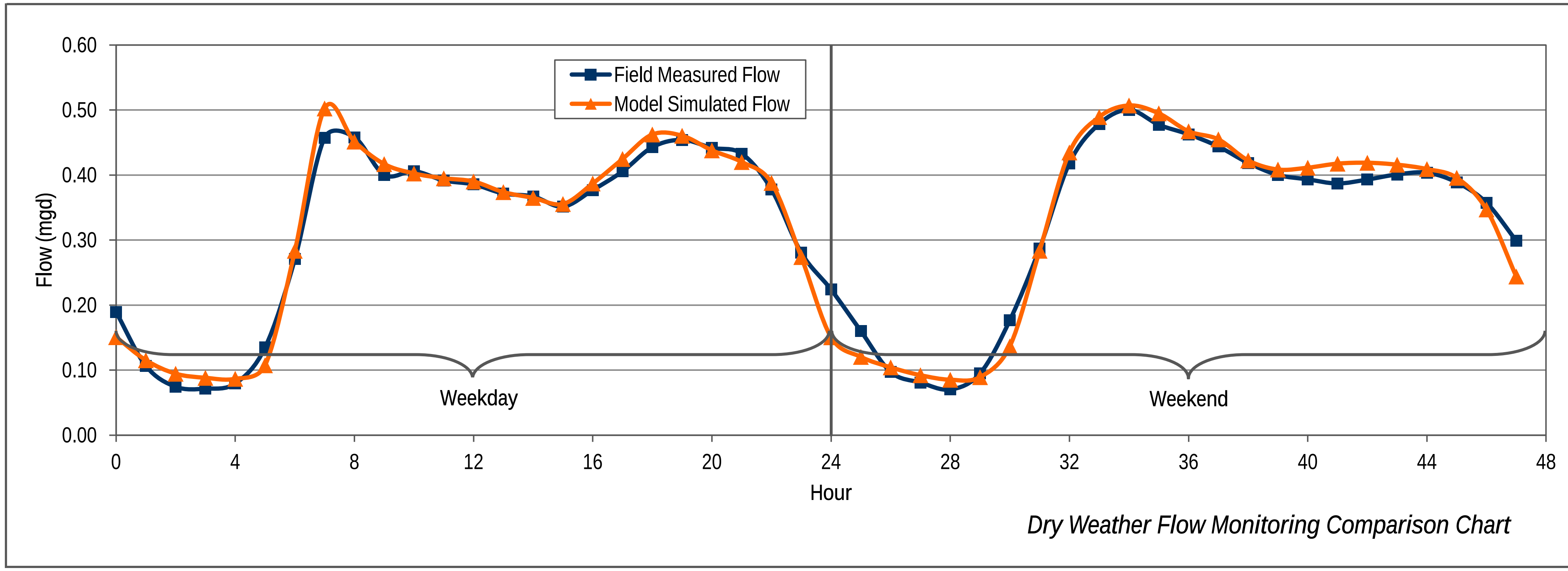
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 62-1 DRY WEATHER CALIBRATION

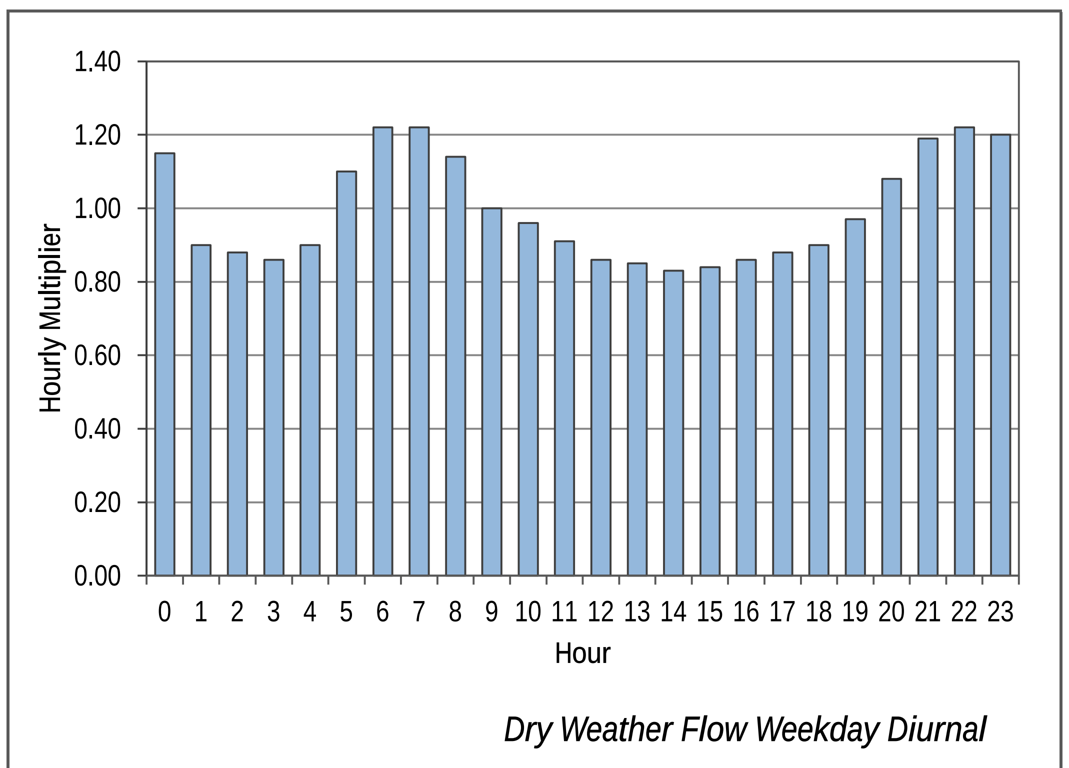
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.189	0.151	0.59	0.33	1.15
	1	0.107	0.115	0.33	0.23	0.90
	2	0.075	0.094	0.23	0.22	0.88
	3	0.072	0.088	0.22	0.25	0.86
	4	0.080	0.087	0.25	0.42	0.90
	5	0.135	0.107	0.42	0.84	1.10
	6	0.271	0.284	0.84	1.42	1.22
	7	0.457	0.502	1.42	1.42	1.22
	8	0.458	0.451	1.42	1.24	1.14
	9	0.400	0.417	1.24	1.26	1.00
	10	0.406	0.402	1.26	1.21	0.96
	11	0.392	0.395	1.21	1.19	0.91
	12	0.386	0.390	1.19	1.15	0.86
	13	0.372	0.374	1.15	1.14	0.85
	14	0.367	0.365	1.14	1.09	0.83
	15	0.351	0.355	1.09	1.17	0.84
	16	0.377	0.387	1.17	1.26	0.86
	17	0.406	0.425	1.26	1.37	0.88
	18	0.443	0.462	1.37	1.41	0.90
	19	0.454	0.460	1.41	1.37	0.97
	20	0.442	0.438	1.37	1.34	1.08
	21	0.433	0.420	1.34	1.17	1.19
	22	0.378	0.388	1.17	0.87	1.22
	23	0.281	0.274	0.87	0.59	1.20
Weekend	24	0.224	0.151	0.69	0.50	1.13
	25	0.160	0.120	0.50	0.30	1.08
	26	0.097	0.104	0.30	0.25	1.05
	27	0.081	0.092	0.25	0.22	1.02
	28	0.070	0.085	0.22	0.29	1.00
	29	0.095	0.089	0.29	0.55	1.03
	30	0.177	0.137	0.55	0.89	1.07
	31	0.287	0.284	0.89	1.29	1.11
	32	0.418	0.435	1.29	1.48	1.20
	33	0.478	0.489	1.48	1.55	1.26
	34	0.500	0.507	1.55	1.48	1.14
	35	0.477	0.495	1.48	1.43	1.07
	36	0.463	0.467	1.43	1.37	1.02
	37	0.444	0.455	1.37	1.30	0.97
	38	0.419	0.422	1.30	1.24	0.87
	39	0.400	0.408	1.24	1.22	0.83
	40	0.393	0.411	1.22	1.20	0.78
	41	0.387	0.417	1.20	1.22	0.76
	42	0.393	0.419	1.22	1.24	0.75
	43	0.401	0.416	1.24	1.25	0.85
	44	0.403	0.409	1.25	1.20	0.95
	45	0.389	0.396	1.20	1.11	1.02
	46	0.357	0.347	1.11	0.93	1.08
	47	0.299	0.244	0.93	0.69	1.15
Average						
	Weekday	0.322	0.326	1.00	1.00	1.00
	Weekend	0.326	0.325	1.01	1.01	1.01
	ADWF[1]	0.323	0.326	1.00	1.00	1.00
% Error						
	Weekday		1.3%			
	Weekend		-0.2%			

Notes:

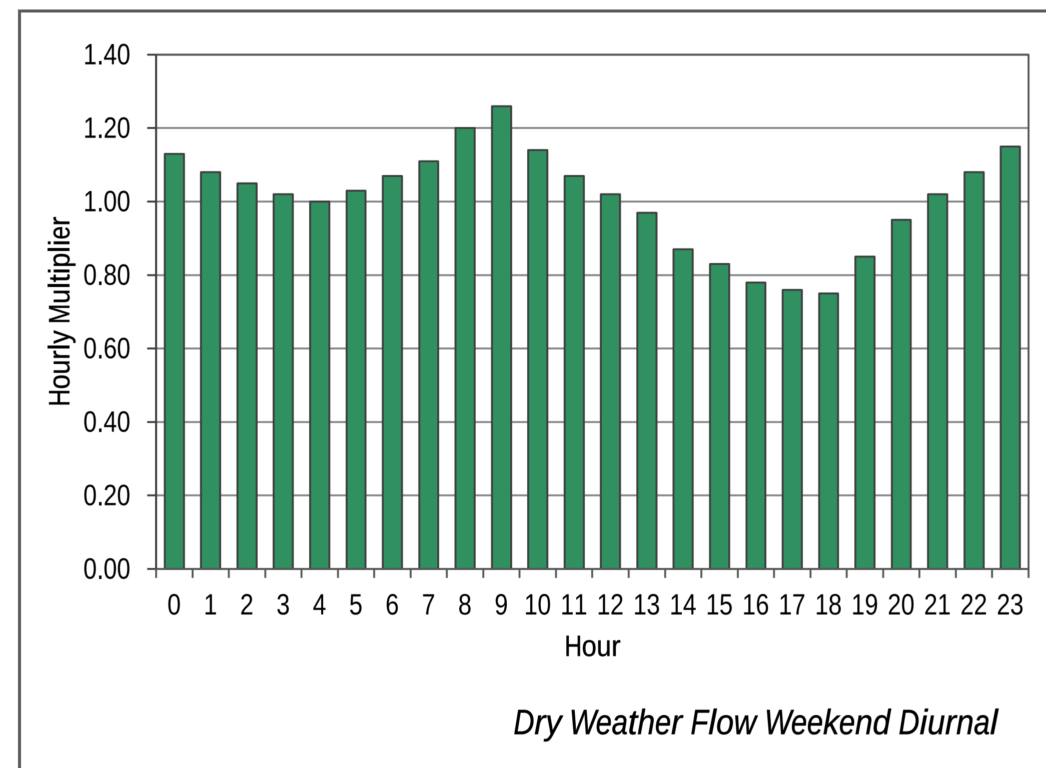
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_62.xlsx

City of Oakland

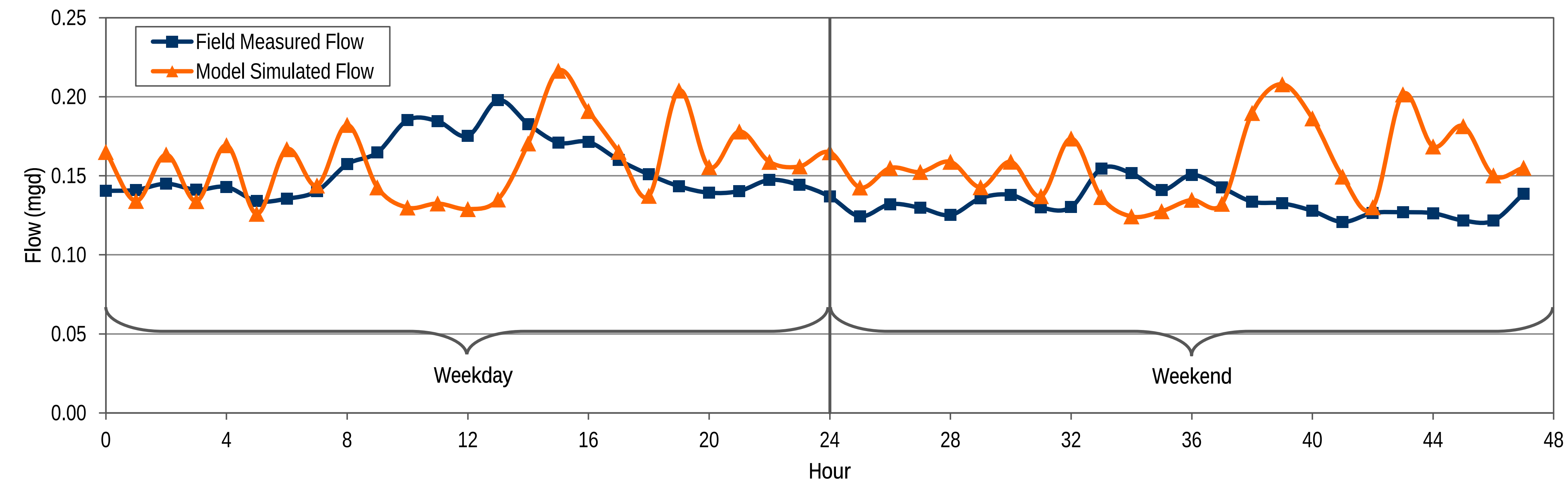
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-1 DRY WEATHER CALIBRATION

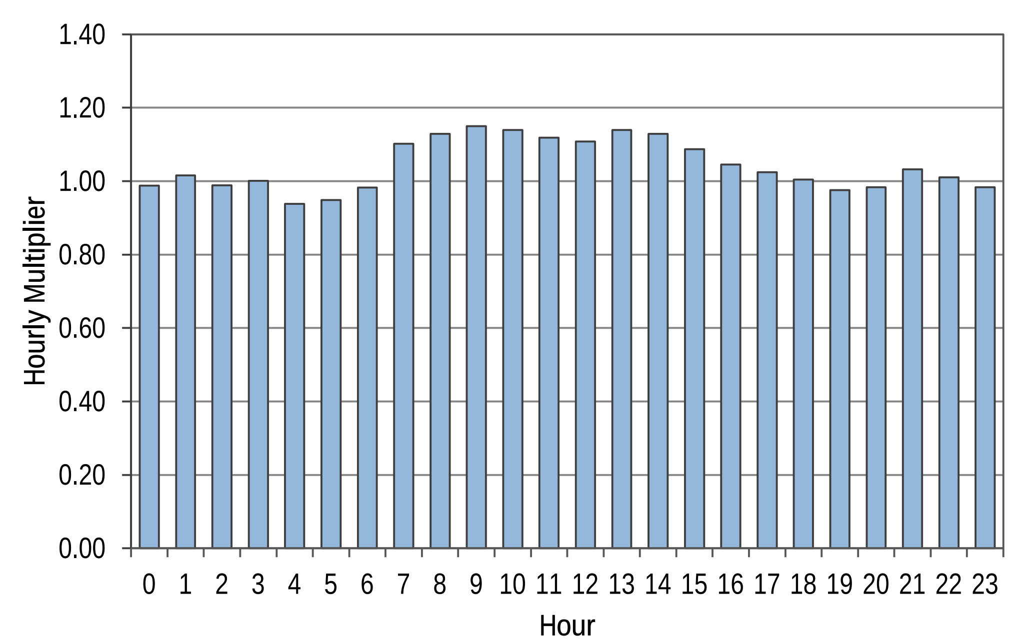
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.140	0.165	0.94	0.94	0.99
	1	0.141	0.134	0.94	0.97	1.02
	2	0.145	0.163	0.97	0.95	0.99
	3	0.141	0.134	0.95	0.96	1.00
	4	0.143	0.169	0.96	0.90	0.94
	5	0.134	0.126	0.90	0.91	0.95
	6	0.136	0.167	0.91	0.94	0.98
	7	0.140	0.144	0.94	1.05	1.10
	8	0.157	0.182	1.05	1.10	1.13
	9	0.165	0.143	1.10	1.24	1.15
	10	0.185	0.130	1.24	1.24	1.14
	11	0.185	0.133	1.24	1.17	1.12
	12	0.175	0.129	1.17	1.33	1.11
	13	0.198	0.135	1.33	1.22	1.14
	14	0.183	0.170	1.22	1.15	1.13
	15	0.171	0.216	1.15	1.15	1.09
	16	0.171	0.191	1.15	1.07	1.05
	17	0.160	0.165	1.07	1.01	1.02
	18	0.151	0.137	1.01	0.96	1.00
	19	0.143	0.204	0.96	0.93	0.98
	20	0.139	0.156	0.93	0.94	0.98
	21	0.140	0.178	0.94	0.99	1.03
	22	0.147	0.159	0.99	0.97	1.01
	23	0.144	0.156	0.97	0.94	0.98
Weekend	24	0.137	0.165	0.92	0.83	0.83
	25	0.124	0.143	0.83	0.88	0.88
	26	0.132	0.155	0.88	0.87	0.87
	27	0.130	0.152	0.87	0.84	0.84
	28	0.125	0.159	0.84	0.91	0.91
	29	0.136	0.143	0.91	0.92	0.92
	30	0.138	0.159	0.92	0.87	0.87
	31	0.130	0.137	0.87	0.87	0.87
	32	0.130	0.174	0.87	1.03	1.03
	33	0.155	0.137	1.03	1.02	1.02
	34	0.152	0.124	1.02	0.94	0.94
	35	0.141	0.128	0.94	1.01	1.01
	36	0.151	0.135	1.01	0.96	0.96
	37	0.143	0.132	0.96	0.90	0.90
	38	0.134	0.190	0.90	0.89	0.89
	39	0.133	0.208	0.89	0.86	0.86
	40	0.128	0.186	0.86	0.81	0.81
	41	0.121	0.150	0.81	0.85	0.85
	42	0.126	0.130	0.85	0.85	0.85
	43	0.127	0.201	0.85	0.85	0.85
	44	0.126	0.169	0.85	0.82	0.82
	45	0.122	0.181	0.82	0.81	0.81
	46	0.122	0.150	0.81	0.93	0.93
	47	0.139	0.155	0.93	0.92	0.92
Average						
	Weekday	0.156	0.158	1.04	1.04	1.04
	Weekend	0.133	0.157	0.89	0.89	0.89
	ADWF[(1)]	0.149	0.157	1.00	1.00	1.00
% Error						
	Weekday		1.3%			
	Weekend		17.6%			

Notes:

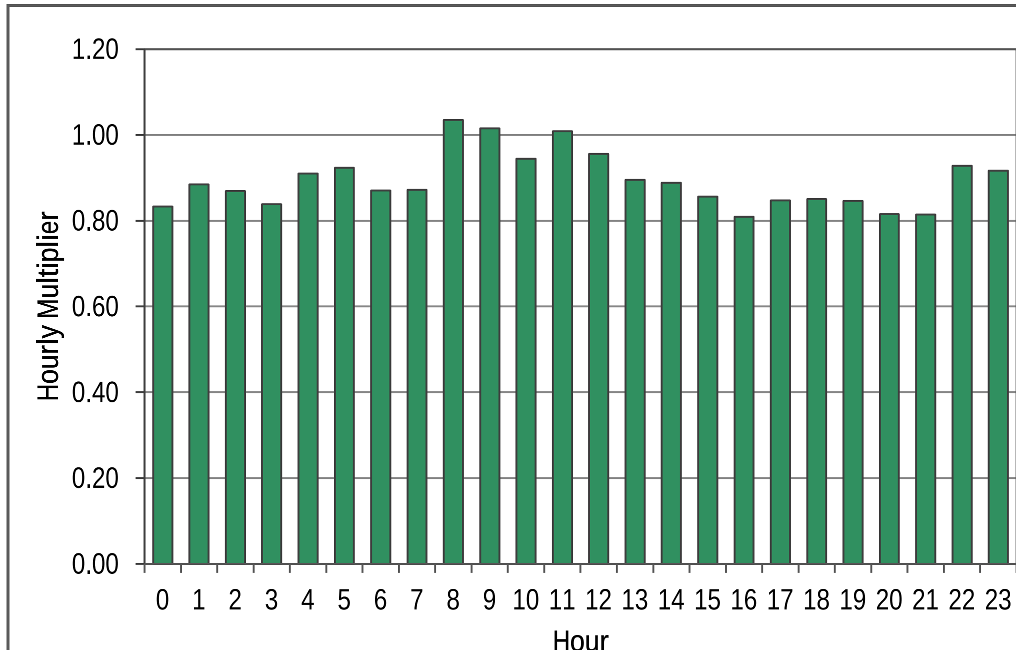
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

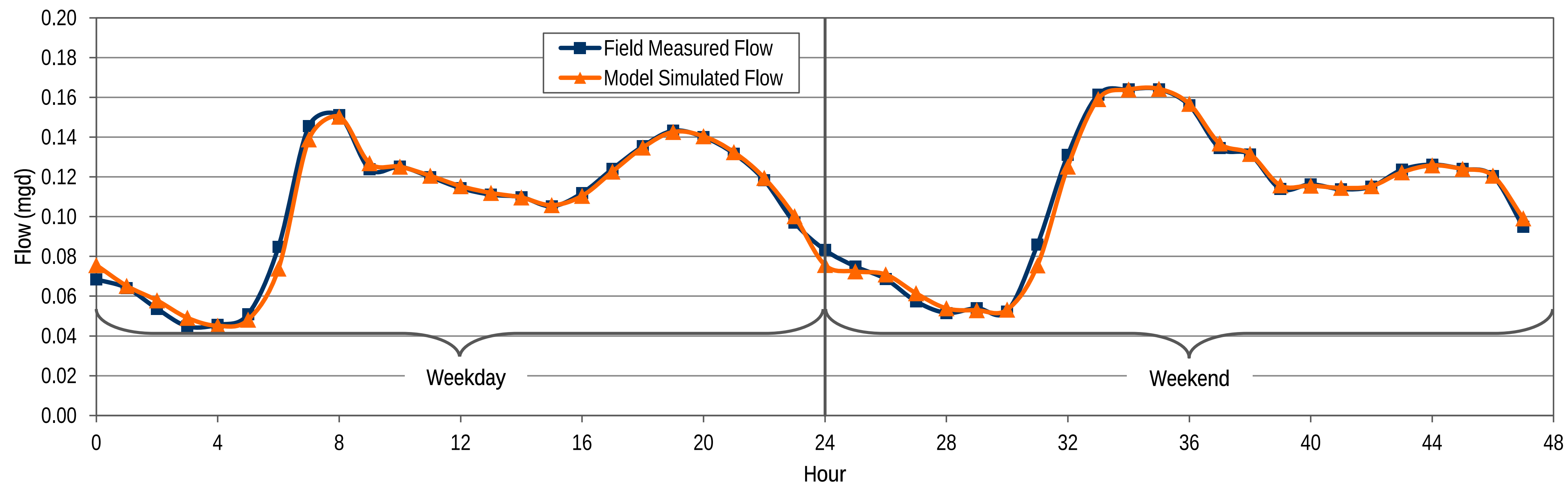
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-2 DRY WEATHER CALIBRATION

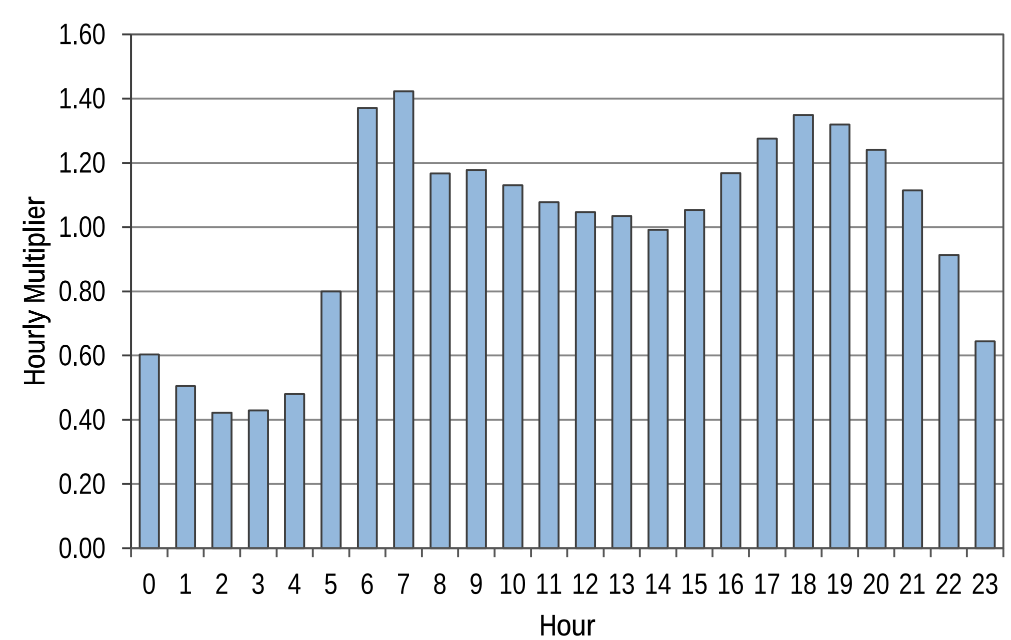
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.068	0.076	0.64	0.60	0.60
	1	0.064	0.065	0.60	0.51	0.51
	2	0.054	0.058	0.51	0.42	0.42
	3	0.045	0.049	0.42	0.43	0.43
	4	0.046	0.045	0.43	0.48	0.48
	5	0.051	0.048	0.48	0.80	0.80
	6	0.085	0.074	0.80	1.37	1.37
	7	0.146	0.139	1.37	1.42	1.42
	8	0.151	0.150	1.42	1.17	1.17
	9	0.124	0.127	1.17	1.18	1.18
	10	0.125	0.125	1.18	1.13	1.13
	11	0.120	0.121	1.13	1.08	1.08
	12	0.114	0.115	1.08	1.05	1.05
	13	0.111	0.112	1.05	1.03	1.03
	14	0.110	0.110	1.03	0.99	0.99
	15	0.105	0.106	0.99	1.05	1.05
	16	0.112	0.110	1.05	1.17	1.17
	17	0.124	0.123	1.17	1.28	1.28
	18	0.135	0.135	1.28	1.35	1.35
	19	0.143	0.143	1.35	1.32	1.32
	20	0.140	0.140	1.32	1.24	1.24
	21	0.132	0.132	1.24	1.11	1.11
	22	0.118	0.119	1.11	0.91	0.91
	23	0.097	0.100	0.91	0.64	0.64
Weekend	24	0.083	0.076	0.78	0.71	0.71
	25	0.075	0.073	0.71	0.65	0.65
	26	0.069	0.071	0.65	0.54	0.54
	27	0.057	0.062	0.54	0.49	0.49
	28	0.052	0.054	0.49	0.51	0.51
	29	0.054	0.053	0.51	0.49	0.49
	30	0.052	0.053	0.49	0.81	0.81
	31	0.086	0.076	0.81	1.23	1.23
	32	0.131	0.125	1.23	1.52	1.52
	33	0.161	0.159	1.52	1.54	1.54
	34	0.164	0.164	1.54	1.55	1.55
	35	0.164	0.164	1.55	1.47	1.47
	36	0.156	0.157	1.47	1.27	1.27
	37	0.135	0.137	1.27	1.24	1.24
	38	0.131	0.132	1.24	1.07	1.07
	39	0.114	0.116	1.07	1.09	1.09
	40	0.116	0.116	1.09	1.07	1.07
	41	0.114	0.115	1.07	1.08	1.08
	42	0.115	0.115	1.08	1.16	1.16
	43	0.124	0.122	1.16	1.19	1.19
	44	0.126	0.126	1.19	1.17	1.17
	45	0.124	0.124	1.17	1.13	1.13
	46	0.120	0.121	1.13	0.89	0.89
	47	0.095	0.099	0.89	0.78	0.78
Average						
	Weekday	0.105	0.105	0.99	0.99	0.99
	Weekend	0.109	0.109	1.03	1.03	1.03
	ADWF[(1)]	0.106	0.106	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.4%			

Notes:

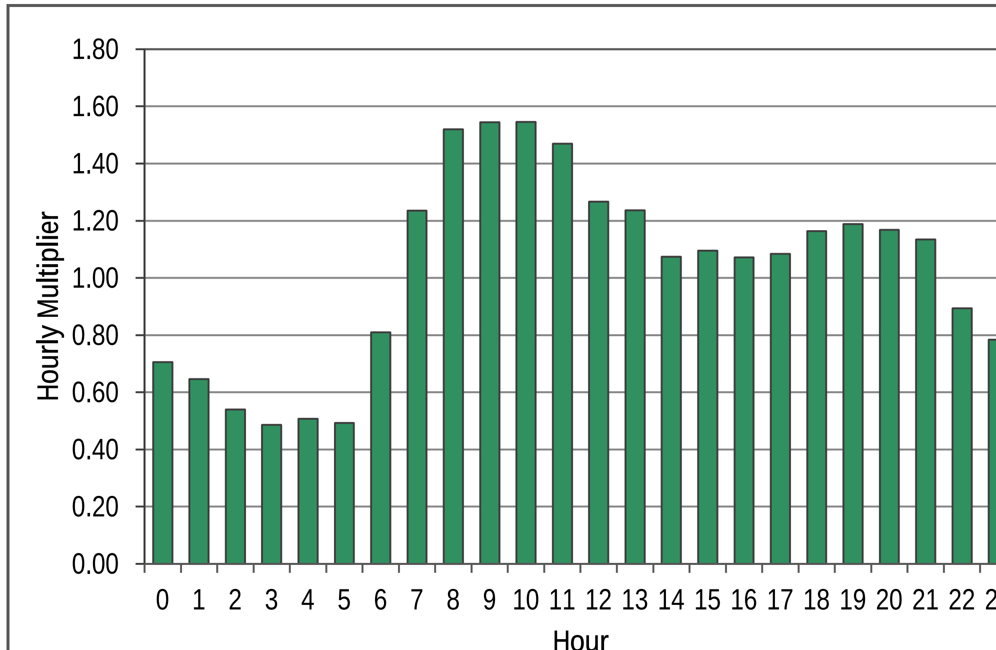
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

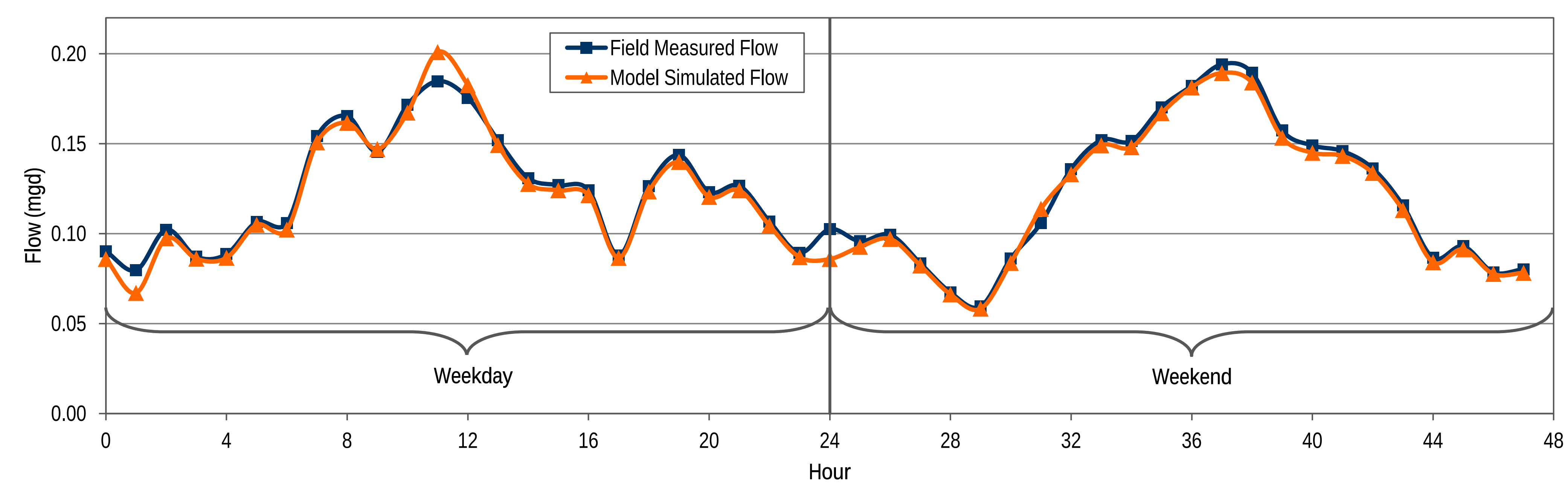
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-3 DRY WEATHER CALIBRATION

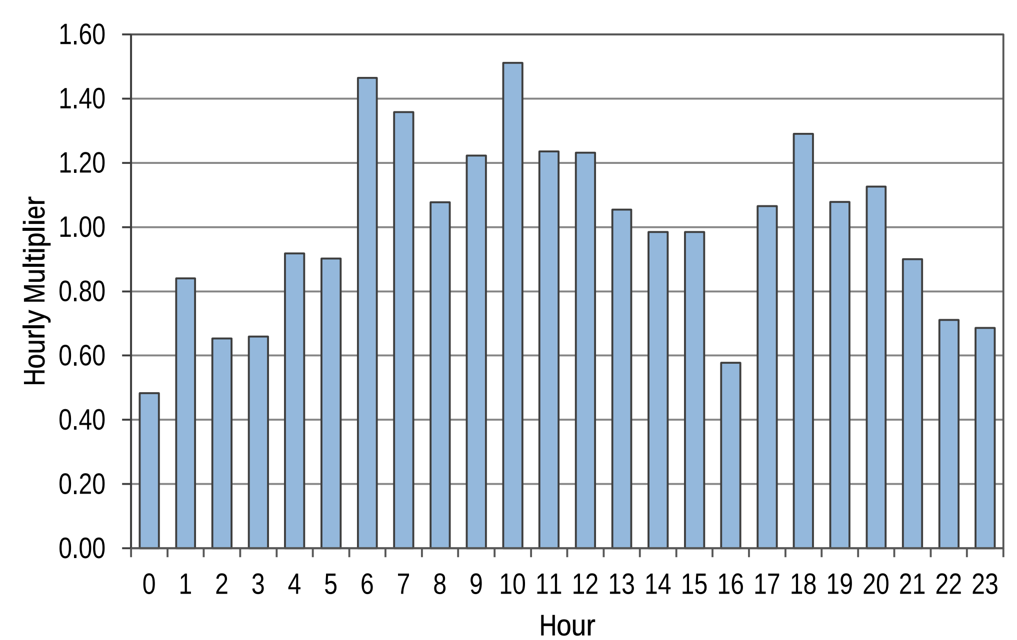
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.090	0.086	0.73	0.64	0.48
	1	0.080	0.067	0.64	0.83	0.84
	2	0.102	0.097	0.83	0.70	0.65
	3	0.087	0.086	0.70	0.72	0.66
	4	0.089	0.087	0.72	0.86	0.92
	5	0.106	0.105	0.86	0.86	0.90
	6	0.106	0.102	0.86	1.24	1.46
	7	0.154	0.151	1.24	1.34	1.36
	8	0.165	0.162	1.34	1.17	1.08
	9	0.145	0.147	1.17	1.39	1.22
	10	0.172	0.167	1.39	1.49	1.51
	11	0.185	0.201	1.49	1.42	1.24
	12	0.175	0.183	1.42	1.23	1.23
	13	0.152	0.149	1.23	1.06	1.05
	14	0.131	0.128	1.06	1.02	0.98
	15	0.127	0.124	1.02	1.00	0.98
	16	0.124	0.121	1.00	0.71	0.58
	17	0.088	0.087	0.71	1.02	1.07
	18	0.126	0.124	1.02	1.16	1.29
	19	0.144	0.140	1.16	0.99	1.08
	20	0.123	0.120	0.99	1.02	1.13
	21	0.127	0.124	1.02	0.86	0.90
	22	0.107	0.105	0.86	0.72	0.71
	23	0.089	0.087	0.72	0.73	0.69
Weekend	24	0.102	0.086	0.83	0.77	0.78
	25	0.096	0.093	0.77	0.80	0.84
	26	0.099	0.097	0.80	0.67	0.61
	27	0.084	0.082	0.67	0.54	0.42
	28	0.067	0.066	0.54	0.48	0.38
	29	0.060	0.058	0.48	0.70	0.68
	30	0.086	0.084	0.70	0.85	0.91
	31	0.106	0.114	0.85	1.10	1.23
	32	0.136	0.133	1.10	1.23	1.24
	33	0.152	0.149	1.23	1.22	1.10
	34	0.151	0.148	1.22	1.37	1.26
	35	0.170	0.167	1.37	1.47	1.58
	36	0.182	0.181	1.47	1.57	1.75
	37	0.194	0.189	1.57	1.53	1.73
	38	0.189	0.184	1.53	1.27	1.35
	39	0.157	0.153	1.27	1.20	1.28
	40	0.149	0.145	1.20	1.18	1.24
	41	0.146	0.143	1.18	1.10	1.18
	42	0.136	0.134	1.10	0.93	0.98
	43	0.116	0.113	0.93	0.70	0.66
	44	0.087	0.084	0.70	0.75	0.74
	45	0.093	0.091	0.75	0.63	0.58
	46	0.078	0.078	0.63	0.65	0.61
	47	0.080	0.078	0.65	0.83	0.86
Average						
Weekday		0.125	0.123	1.01	1.01	1.00
Weekend		0.122	0.119	0.98	0.98	1.00
ADWF[1]		0.124	0.122	1.00	1.00	1.00
% Error						
Weekday			-1.5%			
Weekend			-2.3%			

Notes:

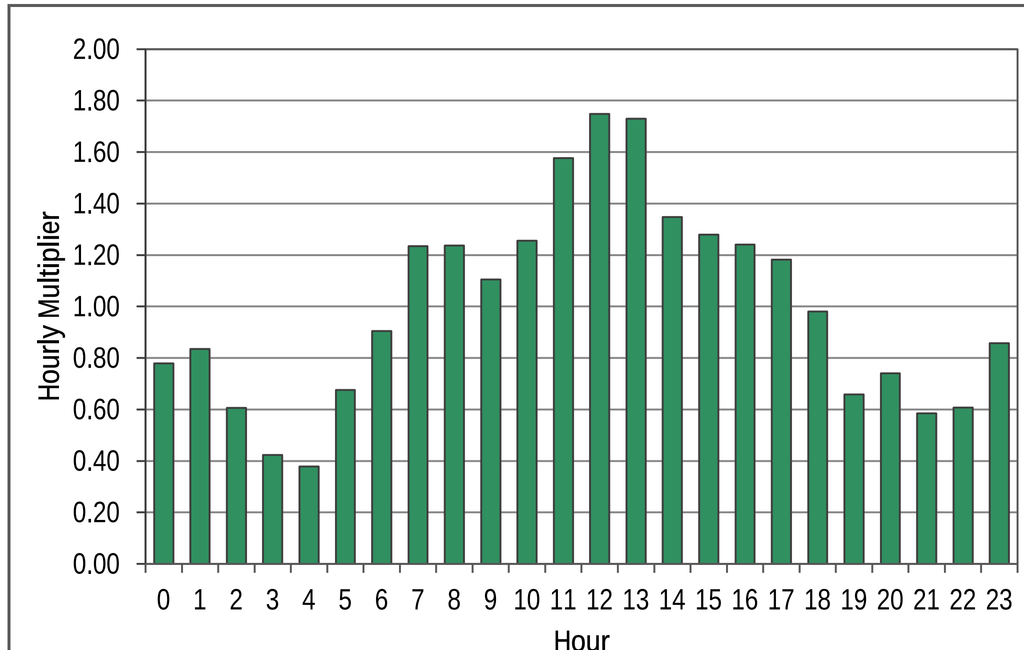
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

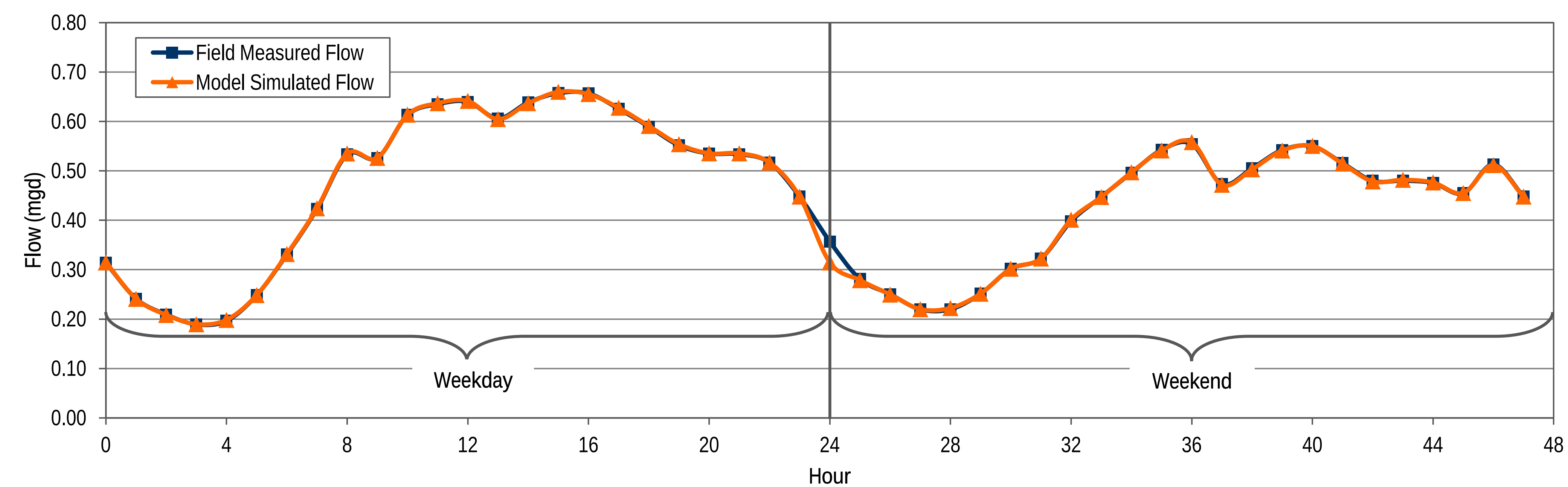
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-4 DRY WEATHER CALIBRATION

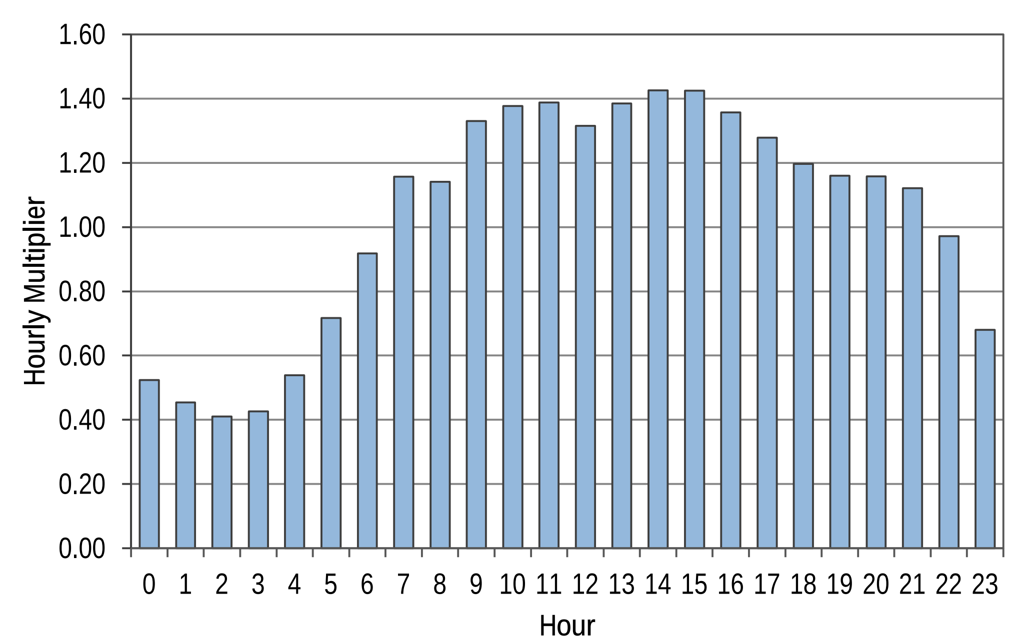
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.314	0.315	0.68	0.52	0.52
	1	0.241	0.241	0.52	0.45	0.45
	2	0.209	0.208	0.45	0.41	0.41
	3	0.189	0.190	0.41	0.43	0.43
	4	0.197	0.198	0.43	0.54	0.54
	5	0.249	0.249	0.54	0.72	0.72
	6	0.331	0.332	0.72	0.92	0.92
	7	0.423	0.424	0.92	1.16	1.16
	8	0.533	0.535	1.16	1.14	1.14
	9	0.526	0.526	1.14	1.33	1.33
	10	0.613	0.614	1.33	1.38	1.38
	11	0.635	0.637	1.38	1.39	1.39
	12	0.640	0.642	1.39	1.31	1.31
	13	0.606	0.605	1.31	1.38	1.38
	14	0.638	0.637	1.38	1.43	1.43
	15	0.657	0.660	1.43	1.42	1.42
	16	0.657	0.655	1.42	1.36	1.36
	17	0.626	0.628	1.36	1.28	1.28
	18	0.589	0.591	1.28	1.20	1.20
	19	0.552	0.554	1.20	1.16	1.16
	20	0.535	0.535	1.16	1.16	1.16
	21	0.534	0.535	1.16	1.12	1.12
	22	0.517	0.517	1.12	0.97	0.97
	23	0.448	0.448	0.97	0.68	0.68
Weekend	24	0.357	0.315	0.77	0.61	0.61
	25	0.281	0.279	0.61	0.54	0.54
	26	0.250	0.250	0.54	0.48	0.48
	27	0.220	0.220	0.48	0.48	0.48
	28	0.220	0.222	0.48	0.55	0.55
	29	0.251	0.251	0.55	0.65	0.65
	30	0.302	0.302	0.65	0.70	0.70
	31	0.323	0.323	0.70	0.86	0.86
	32	0.398	0.401	0.86	0.97	0.97
	33	0.447	0.447	0.97	1.08	1.08
	34	0.496	0.497	1.08	1.18	1.18
	35	0.542	0.541	1.18	1.20	1.20
	36	0.554	0.558	1.20	1.03	1.03
	37	0.473	0.472	1.03	1.10	1.10
	38	0.505	0.503	1.10	1.18	1.18
	39	0.542	0.541	1.18	1.19	1.19
	40	0.550	0.551	1.19	1.12	1.12
	41	0.516	0.515	1.12	1.04	1.04
	42	0.480	0.479	1.04	1.04	1.04
	43	0.480	0.482	1.04	1.03	1.03
	44	0.476	0.477	1.03	0.99	0.99
	45	0.455	0.455	0.99	1.11	1.11
	46	0.513	0.512	1.11	0.97	0.97
	47	0.448	0.448	0.97	0.77	0.77
Average						
	Weekday	0.477	0.478	1.04	1.04	1.04
	Weekend	0.420	0.418	0.91	0.91	0.91
	ADWF[1]	0.461	0.461	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.4%			

Notes:

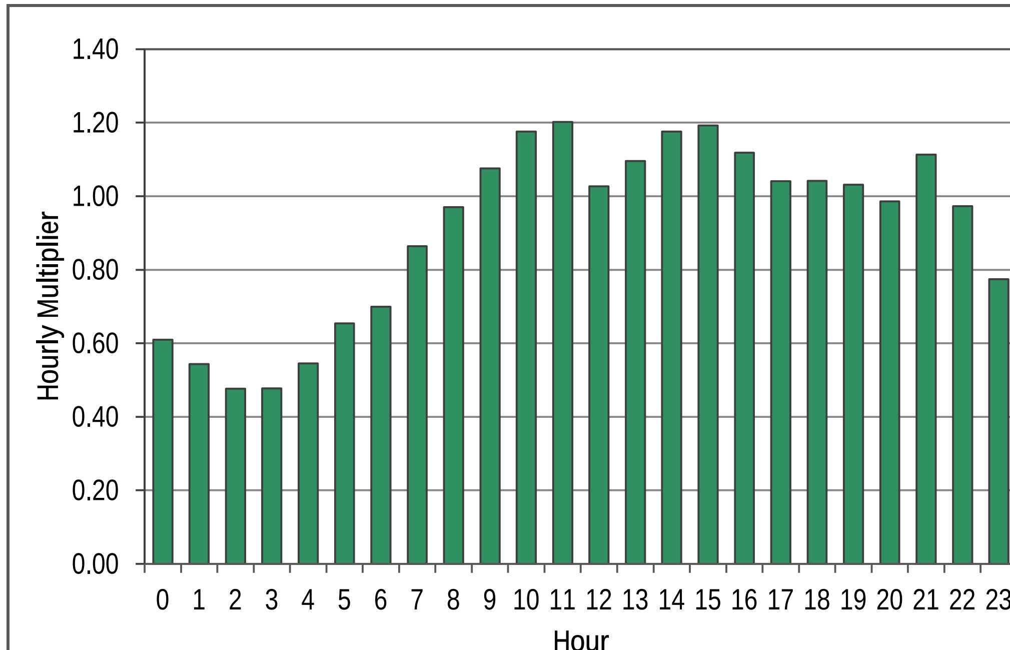
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_64.xlsx

City of Oakland

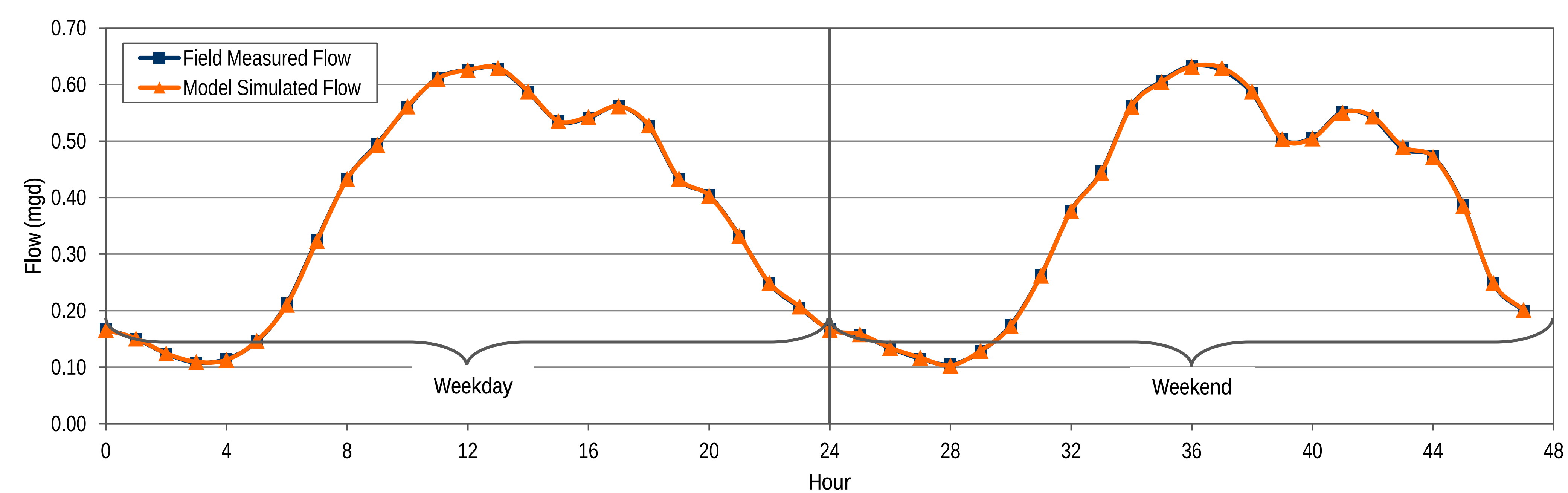
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-5 DRY WEATHER CALIBRATION

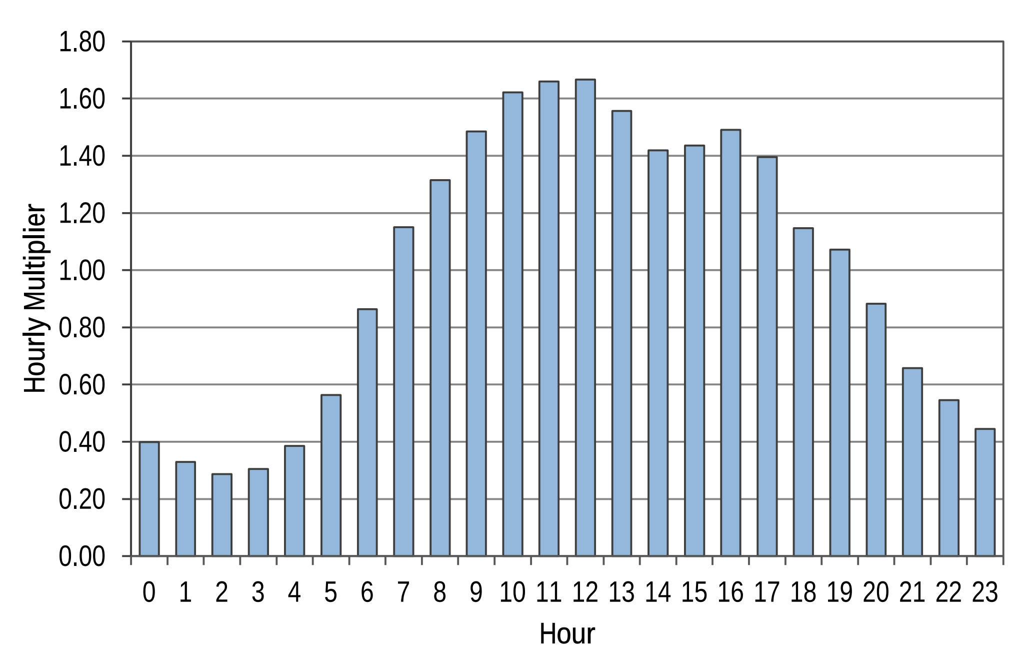
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.168	0.166	0.44	0.40	0.40
	1	0.150	0.151	0.40	0.33	0.33
	2	0.124	0.125	0.33	0.29	0.29
	3	0.108	0.109	0.29	0.30	0.30
	4	0.115	0.113	0.30	0.39	0.39
	5	0.145	0.147	0.39	0.56	0.56
	6	0.213	0.211	0.56	0.86	0.86
	7	0.326	0.323	0.86	1.15	1.15
	8	0.433	0.433	1.15	1.31	1.31
	9	0.496	0.493	1.31	1.49	1.49
	10	0.560	0.561	1.49	1.62	1.62
	11	0.612	0.610	1.62	1.66	1.66
	12	0.626	0.625	1.66	1.67	1.67
	13	0.628	0.629	1.67	1.56	1.56
	14	0.587	0.588	1.56	1.42	1.42
	15	0.535	0.535	1.42	1.44	1.44
	16	0.541	0.543	1.44	1.49	1.49
	17	0.562	0.561	1.49	1.40	1.40
	18	0.526	0.528	1.40	1.15	1.15
	19	0.432	0.434	1.15	1.07	1.07
	20	0.404	0.403	1.07	0.88	0.88
	21	0.333	0.332	0.88	0.66	0.66
	22	0.248	0.249	0.66	0.55	0.55
	23	0.206	0.207	0.55	0.44	0.44
Weekend	24	0.167	0.166	0.44	0.42	0.42
	25	0.157	0.158	0.42	0.36	0.36
	26	0.134	0.134	0.36	0.31	0.31
	27	0.115	0.117	0.31	0.28	0.28
	28	0.105	0.103	0.28	0.34	0.34
	29	0.128	0.129	0.34	0.46	0.46
	30	0.175	0.173	0.46	0.70	0.70
	31	0.263	0.262	0.70	1.00	1.00
	32	0.377	0.376	1.00	1.18	1.18
	33	0.446	0.444	1.18	1.49	1.49
	34	0.562	0.561	1.49	1.61	1.61
	35	0.606	0.604	1.61	1.68	1.68
	36	0.633	0.632	1.68	1.66	1.66
	37	0.625	0.629	1.66	1.55	1.55
	38	0.585	0.588	1.55	1.34	1.34
	39	0.504	0.503	1.34	1.34	1.34
	40	0.506	0.505	1.34	1.46	1.46
	41	0.552	0.550	1.46	1.44	1.44
	42	0.541	0.543	1.44	1.29	1.29
	43	0.487	0.490	1.29	1.25	1.25
	44	0.472	0.472	1.25	1.03	1.03
	45	0.387	0.385	1.03	0.66	0.66
	46	0.248	0.249	0.66	0.53	0.53
	47	0.200	0.201	0.53	0.44	0.44
Average						
	Weekday	0.378	0.378	1.00	1.00	1.00
	Weekend	0.374	0.374	0.99	0.99	0.99
	ADWF[(1)]	0.377	0.377	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

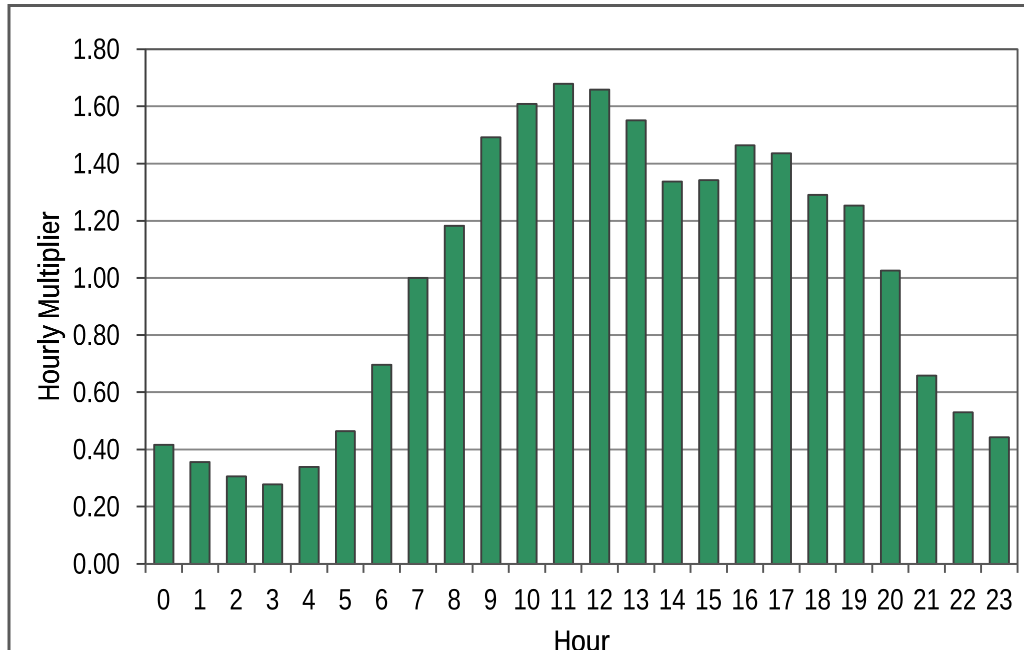
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

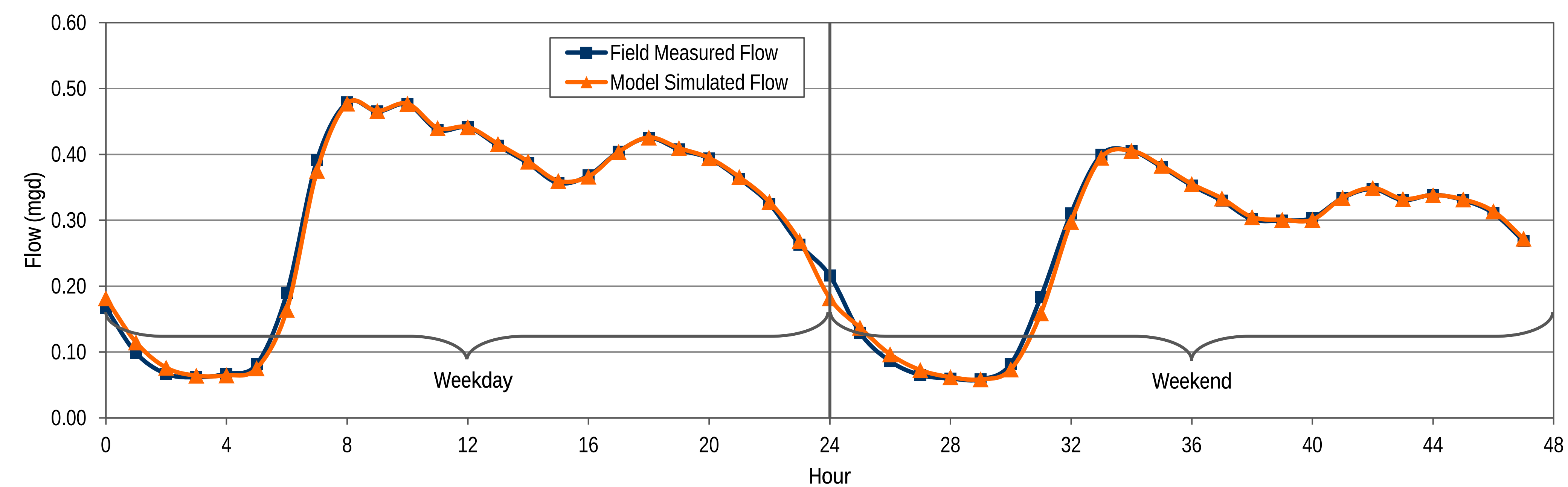
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_64.xlsx

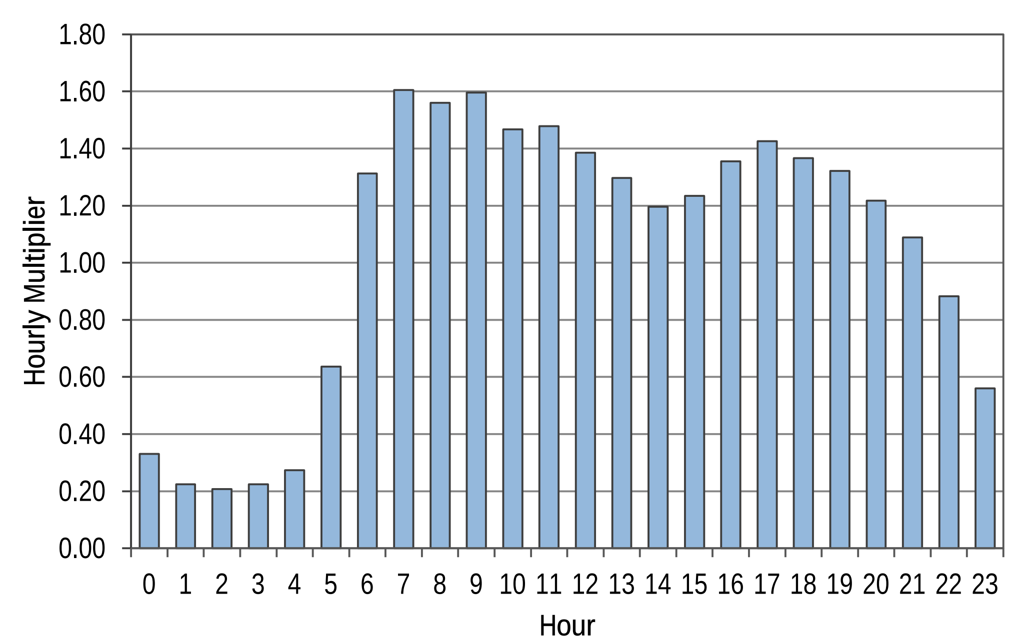
FLOW MONITORING SITE 64-6 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.167	0.182	0.56	0.33	0.33
	1	0.098	0.115	0.33	0.22	0.22
	2	0.067	0.076	0.22	0.21	0.21
	3	0.062	0.064	0.21	0.22	0.22
	4	0.067	0.065	0.22	0.27	0.27
	5	0.082	0.075	0.27	0.64	0.64
	6	0.190	0.164	0.64	1.31	1.31
	7	0.392	0.375	1.31	1.61	1.61
	8	0.479	0.477	1.61	1.56	1.56
	9	0.465	0.466	1.56	1.60	1.60
	10	0.476	0.477	1.60	1.47	1.47
	11	0.437	0.440	1.47	1.48	1.48
	12	0.441	0.441	1.48	1.39	1.39
	13	0.413	0.416	1.39	1.30	1.30
	14	0.387	0.389	1.30	1.20	1.20
	15	0.357	0.360	1.20	1.23	1.23
	16	0.368	0.366	1.23	1.36	1.36
	17	0.404	0.404	1.36	1.43	1.43
	18	0.425	0.426	1.43	1.37	1.37
	19	0.407	0.409	1.37	1.32	1.32
	20	0.394	0.394	1.32	1.22	1.22
	21	0.363	0.366	1.22	1.09	1.09
	22	0.325	0.328	1.09	0.88	0.88
	23	0.263	0.269	0.88	0.56	0.56
Weekend	24	0.216	0.182	0.72	0.43	0.43
	25	0.130	0.137	0.43	0.29	0.29
	26	0.086	0.097	0.29	0.22	0.22
	27	0.065	0.073	0.22	0.20	0.20
	28	0.060	0.062	0.20	0.20	0.20
	29	0.059	0.059	0.20	0.28	0.28
	30	0.082	0.074	0.28	0.62	0.62
	31	0.184	0.159	0.62	1.04	1.04
	32	0.311	0.298	1.04	1.34	1.34
	33	0.399	0.395	1.34	1.36	1.36
	34	0.405	0.405	1.36	1.28	1.28
	35	0.381	0.383	1.28	1.18	1.18
	36	0.353	0.355	1.18	1.11	1.11
	37	0.330	0.333	1.11	1.01	1.01
	38	0.302	0.305	1.01	1.01	1.01
	39	0.300	0.301	1.01	1.02	1.02
	40	0.303	0.301	1.02	1.12	1.12
	41	0.334	0.334	1.12	1.17	1.17
	42	0.347	0.349	1.17	1.11	1.11
	43	0.331	0.332	1.11	1.14	1.14
	44	0.339	0.338	1.14	1.11	1.11
	45	0.331	0.332	1.11	1.04	1.04
	46	0.311	0.314	1.04	0.90	0.90
	47	0.269	0.272	0.90	0.72	0.72
Average						
Weekday		0.314	0.314	1.05	1.05	1.05
Weekend		0.259	0.258	0.87	0.87	0.87
ADWF[(1)]		0.298	0.298	1.00	1.00	1.00
% Error						
Weekday			0.2%			
Weekend			-0.6%			

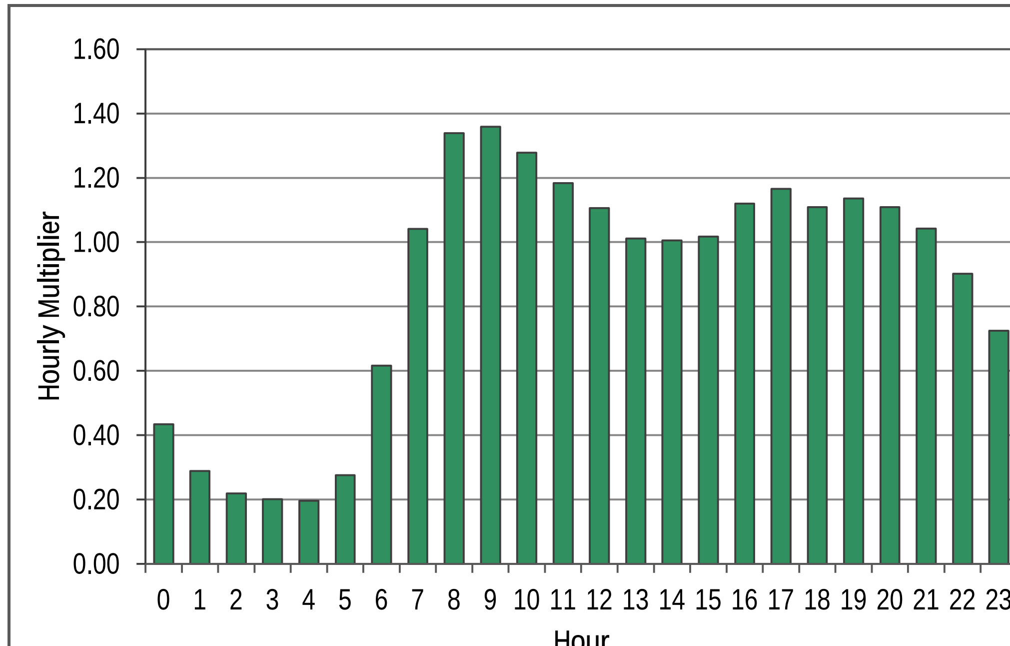
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

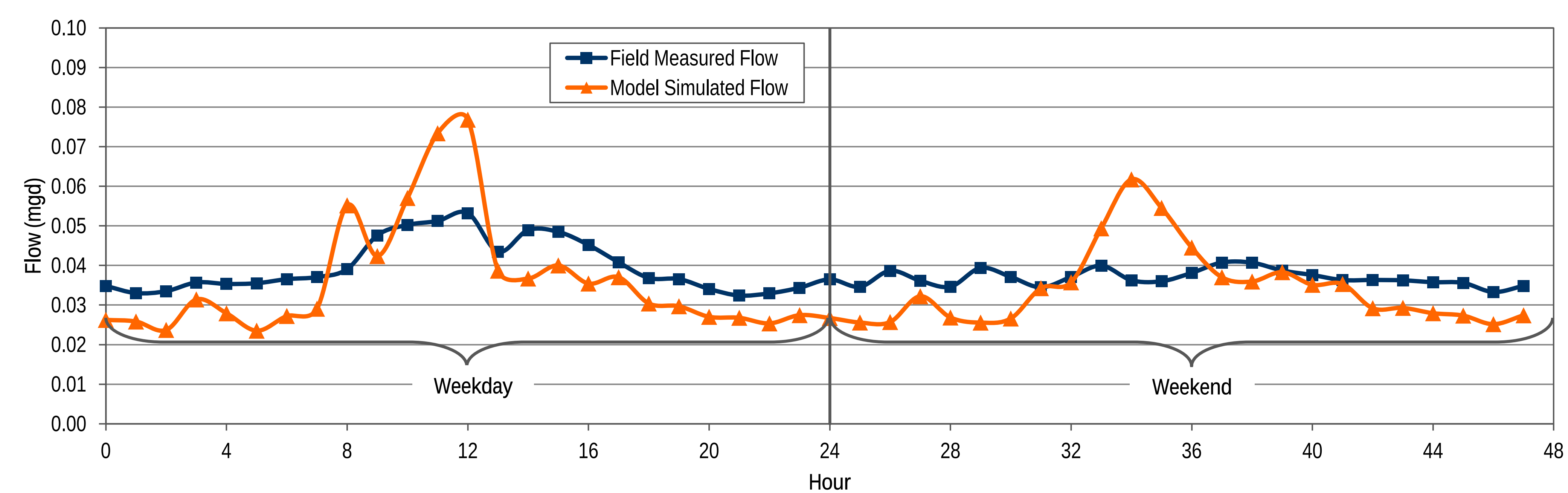
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-7 DRY WEATHER CALIBRATION

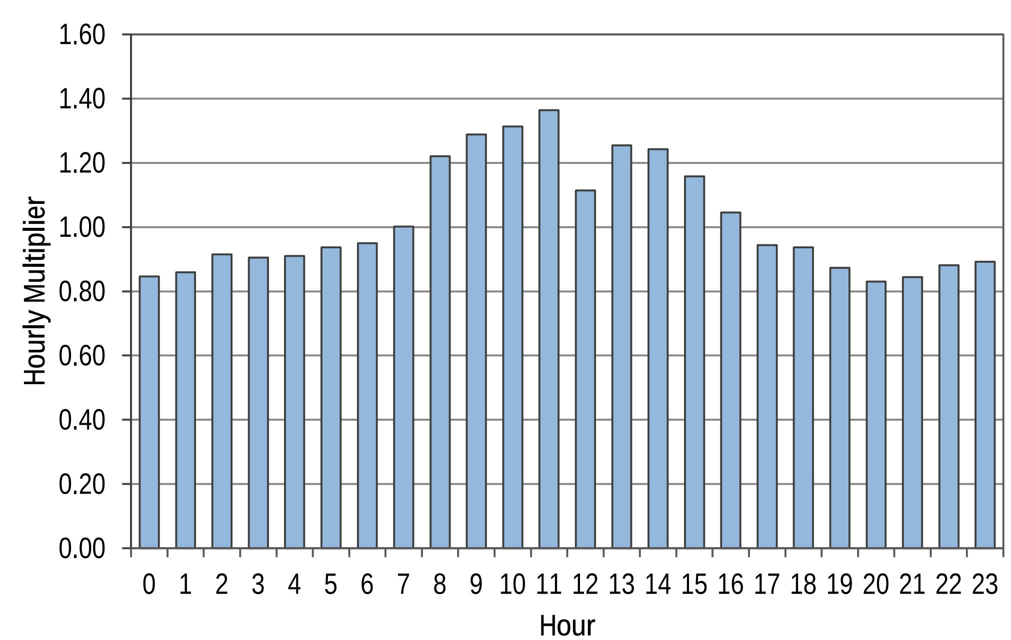
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.035	0.026	0.89	0.85	0.85
	1	0.033	0.026	0.85	0.86	0.86
	2	0.033	0.024	0.86	0.92	0.92
	3	0.036	0.031	0.92	0.91	0.91
	4	0.035	0.028	0.91	0.91	0.91
	5	0.035	0.024	0.91	0.94	0.94
	6	0.037	0.027	0.94	0.95	0.95
	7	0.037	0.029	0.95	1.00	1.00
	8	0.039	0.055	1.00	1.22	1.22
	9	0.048	0.042	1.22	1.29	1.29
	10	0.050	0.057	1.29	1.31	1.31
	11	0.051	0.073	1.31	1.36	1.36
	12	0.053	0.077	1.36	1.11	1.11
	13	0.043	0.039	1.11	1.25	1.25
	14	0.049	0.037	1.25	1.24	1.24
	15	0.048	0.040	1.24	1.16	1.16
	16	0.045	0.035	1.16	1.05	1.05
	17	0.041	0.037	1.05	0.94	0.94
	18	0.037	0.030	0.94	0.94	0.94
	19	0.037	0.030	0.94	0.87	0.87
	20	0.034	0.027	0.87	0.83	0.83
	21	0.032	0.027	0.83	0.84	0.84
	22	0.033	0.025	0.84	0.88	0.88
	23	0.034	0.027	0.88	0.89	0.89
Weekend	24	0.036	0.027	0.93	0.89	0.89
	25	0.035	0.026	0.89	0.99	0.99
	26	0.039	0.026	0.99	0.93	0.93
	27	0.036	0.032	0.93	0.89	0.89
	28	0.035	0.027	0.89	1.01	1.01
	29	0.039	0.026	1.01	0.95	0.95
	30	0.037	0.027	0.95	0.88	0.88
	31	0.034	0.034	0.88	0.95	0.95
	32	0.037	0.036	0.95	1.02	1.02
	33	0.040	0.049	1.02	0.93	0.93
	34	0.036	0.062	0.93	0.92	0.92
	35	0.036	0.055	0.92	0.98	0.98
	36	0.038	0.045	0.98	1.04	1.04
	37	0.041	0.037	1.04	1.04	1.04
	38	0.041	0.036	1.04	0.99	0.99
	39	0.039	0.038	0.99	0.96	0.96
	40	0.038	0.035	0.96	0.93	0.93
	41	0.036	0.035	0.93	0.93	0.93
	42	0.036	0.029	0.93	0.93	0.93
	43	0.036	0.029	0.93	0.92	0.92
	44	0.036	0.028	0.92	0.91	0.91
	45	0.036	0.027	0.91	0.85	0.85
	46	0.033	0.025	0.85	0.89	0.89
	47	0.035	0.027	0.89	0.93	0.93
Average						
Weekday		0.040	0.036	1.02	1.02	1.02
Weekend		0.037	0.034	0.95	0.95	0.95
ADWF[(1)]		0.039	0.036	1.00	1.00	1.00
% Error						
Weekday			-8.6%			
Weekend			-7.6%			

Notes:

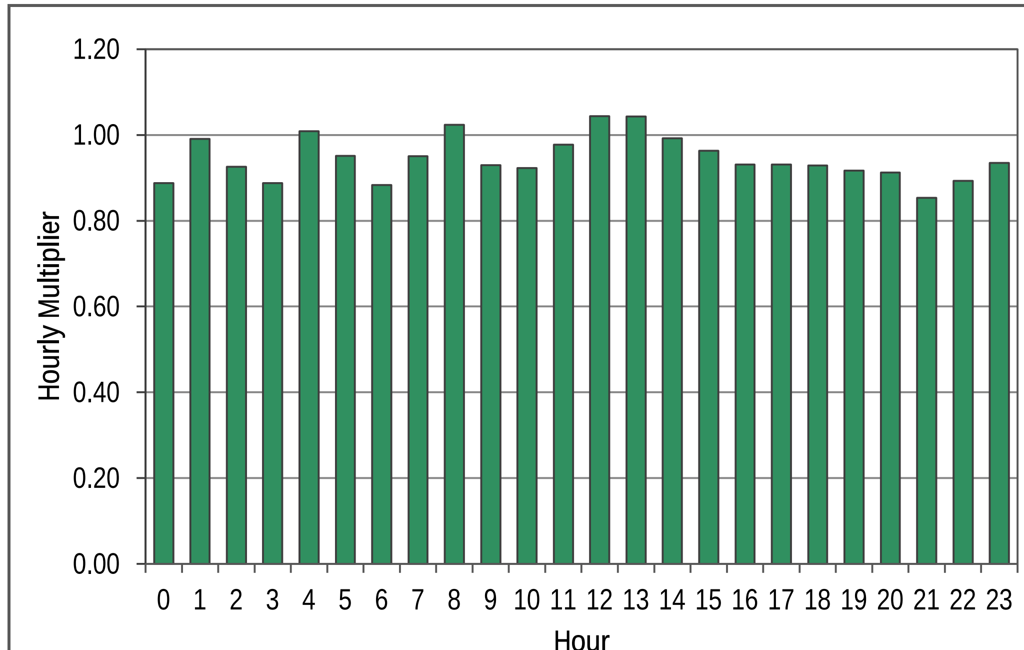
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

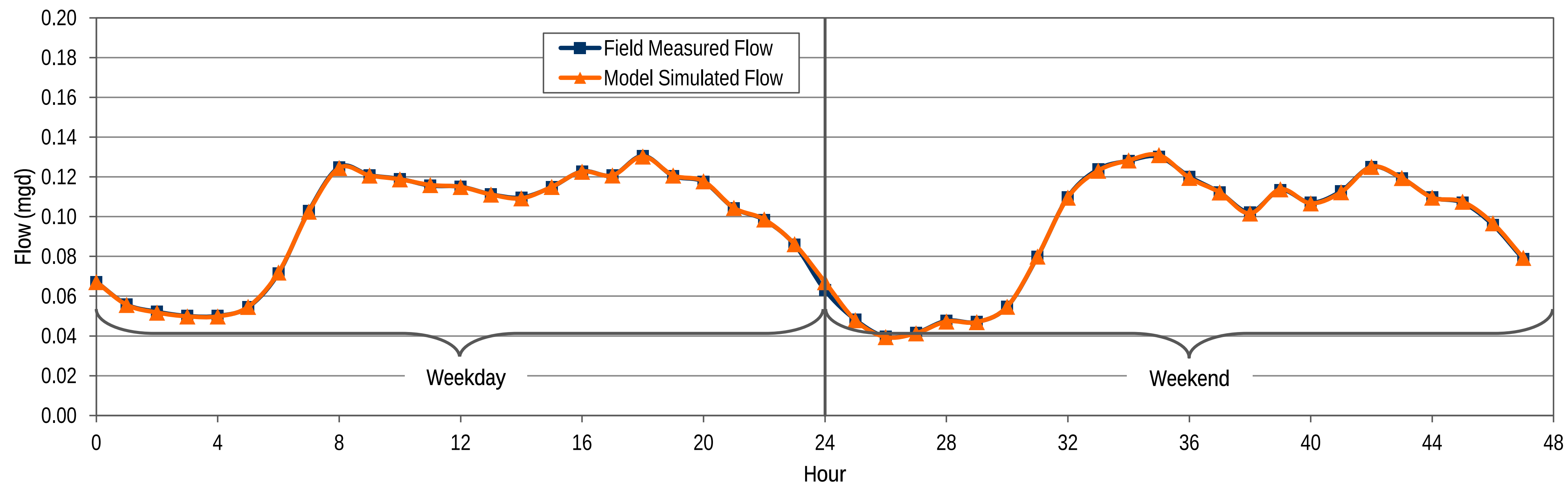
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-8 DRY WEATHER CALIBRATION

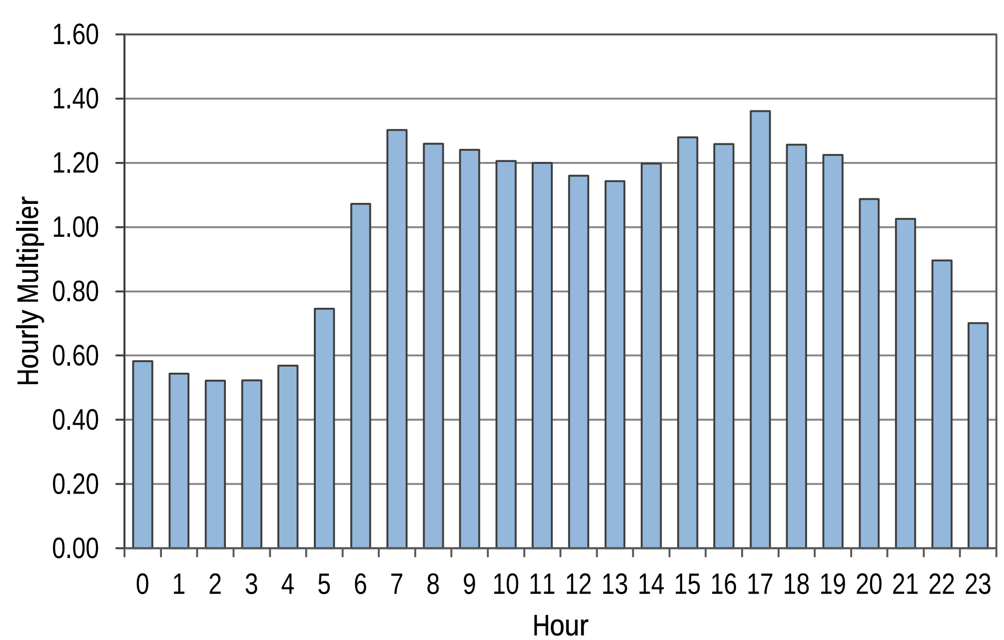
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.067	0.067	0.70	0.58	0.58
	1	0.056	0.056	0.58	0.54	0.54
	2	0.052	0.052	0.54	0.52	0.52
	3	0.050	0.050	0.52	0.52	0.52
	4	0.050	0.050	0.52	0.57	0.57
	5	0.055	0.055	0.57	0.75	0.75
	6	0.072	0.072	0.75	1.07	1.07
	7	0.103	0.103	1.07	1.30	1.30
	8	0.125	0.124	1.30	1.26	1.26
	9	0.121	0.121	1.26	1.24	1.24
	10	0.119	0.119	1.24	1.21	1.21
	11	0.116	0.116	1.21	1.20	1.20
	12	0.115	0.115	1.20	1.16	1.16
	13	0.111	0.111	1.16	1.14	1.14
	14	0.110	0.109	1.14	1.20	1.20
	15	0.115	0.115	1.20	1.28	1.28
	16	0.123	0.123	1.28	1.26	1.26
	17	0.121	0.121	1.26	1.36	1.36
	18	0.131	0.130	1.36	1.26	1.26
	19	0.120	0.121	1.26	1.23	1.23
	20	0.117	0.118	1.23	1.09	1.09
	21	0.104	0.104	1.09	1.03	1.03
	22	0.098	0.099	1.03	0.90	0.90
	23	0.086	0.086	0.90	0.70	0.70
Weekend	24	0.063	0.067	0.66	0.50	0.50
	25	0.048	0.048	0.50	0.41	0.41
	26	0.040	0.039	0.41	0.43	0.43
	27	0.042	0.041	0.43	0.50	0.50
	28	0.048	0.047	0.50	0.49	0.49
	29	0.047	0.047	0.49	0.57	0.57
	30	0.055	0.055	0.57	0.83	0.83
	31	0.080	0.080	0.83	1.14	1.14
	32	0.110	0.110	1.14	1.29	1.29
	33	0.124	0.123	1.29	1.34	1.34
	34	0.128	0.128	1.34	1.36	1.36
	35	0.130	0.131	1.36	1.25	1.25
	36	0.120	0.120	1.25	1.17	1.17
	37	0.112	0.112	1.17	1.07	1.07
	38	0.102	0.102	1.07	1.18	1.18
	39	0.113	0.114	1.18	1.12	1.12
	40	0.107	0.107	1.12	1.18	1.18
	41	0.113	0.112	1.18	1.30	1.30
	42	0.125	0.125	1.30	1.24	1.24
	43	0.119	0.119	1.24	1.14	1.14
	44	0.110	0.110	1.14	1.12	1.12
	45	0.107	0.108	1.12	1.00	1.00
	46	0.096	0.097	1.00	0.82	0.82
	47	0.079	0.079	0.82	0.66	0.66
Average						
	Weekday	0.097	0.097	1.01	1.01	1.01
	Weekend	0.092	0.093	0.96	0.96	0.96
	ADWF(1)	0.096	0.096	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		0.2%			

Notes:

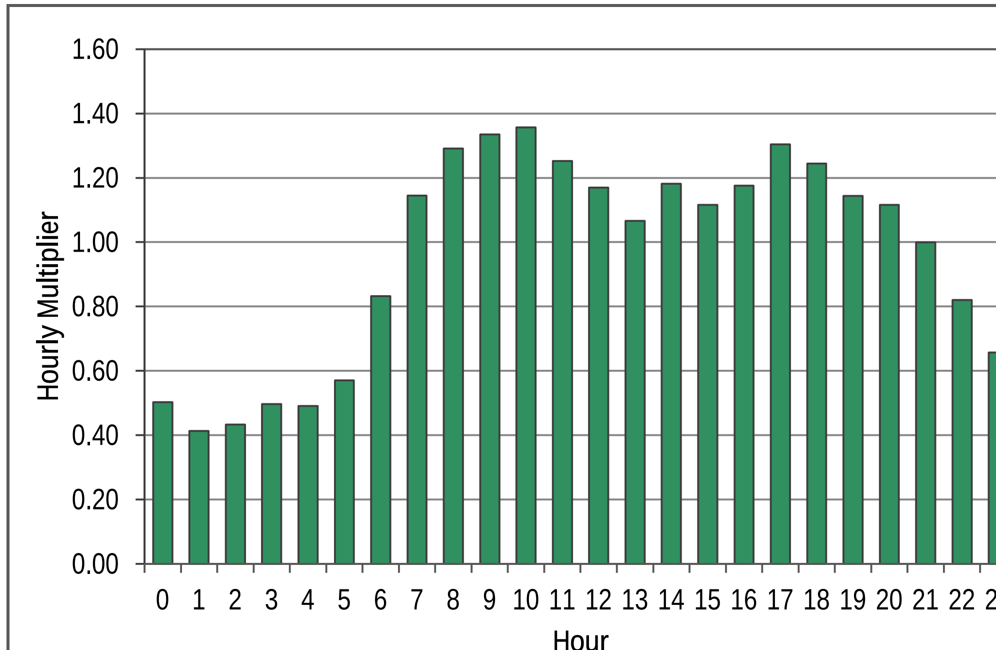
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_64.xlsx

City of Oakland

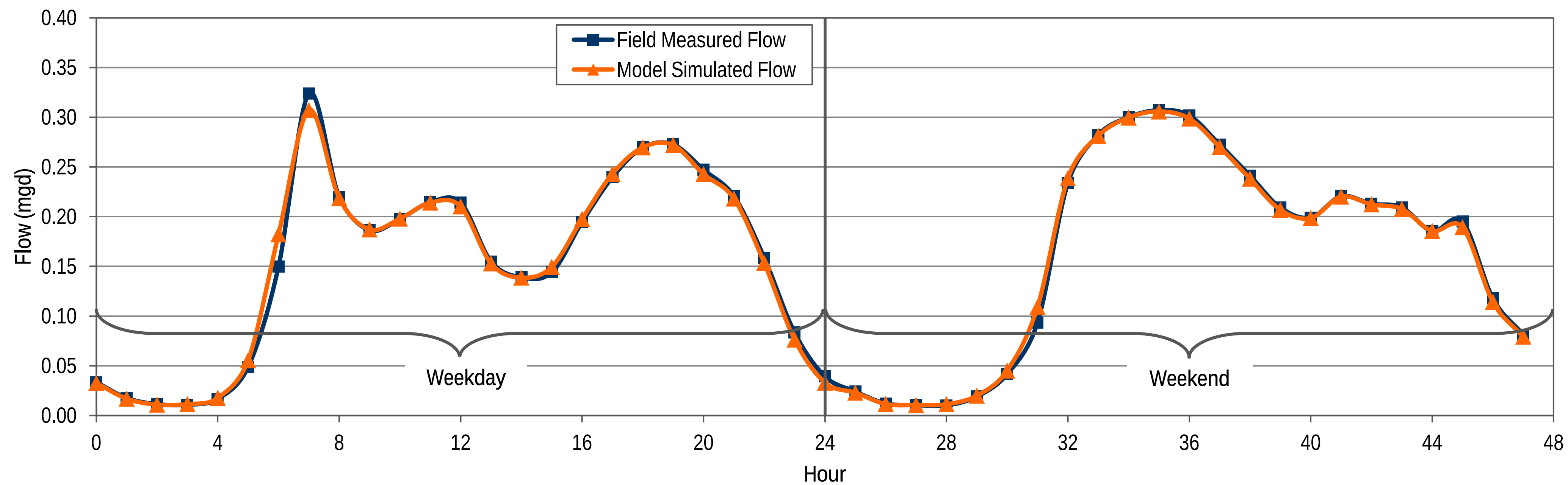
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80A DRY WEATHER CALIBRATION

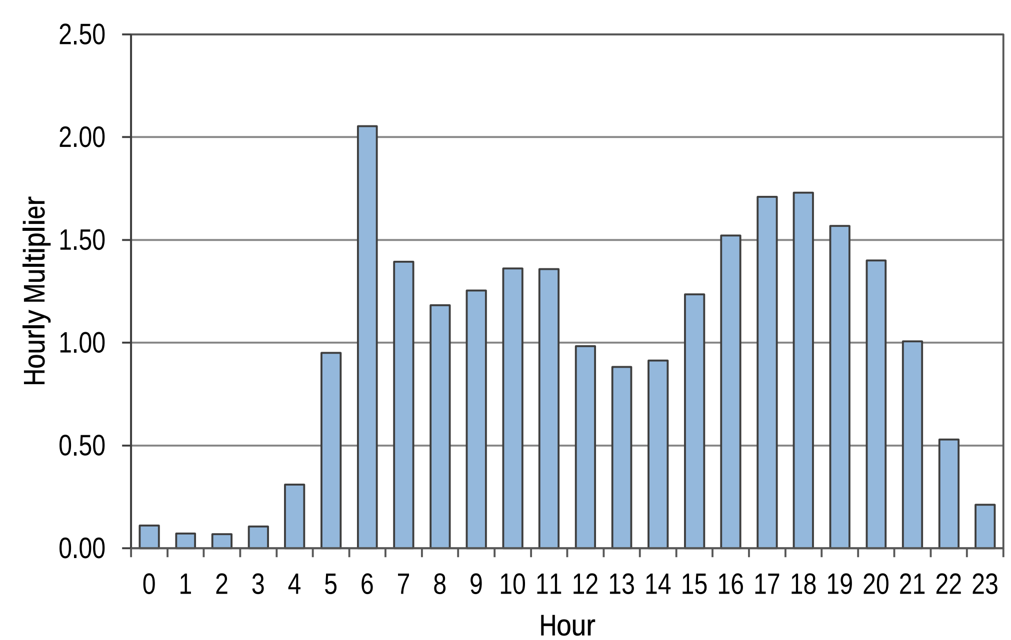
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.033	0.033	0.21	0.11	0.11
	1	0.018	0.017	0.11	0.07	0.07
	2	0.011	0.011	0.07	0.07	0.07
	3	0.011	0.012	0.07	0.11	0.11
	4	0.017	0.018	0.11	0.31	0.31
	5	0.049	0.056	0.31	0.95	0.95
	6	0.150	0.182	0.95	2.05	2.05
	7	0.324	0.307	2.05	1.39	1.39
	8	0.220	0.219	1.39	1.18	1.18
	9	0.186	0.187	1.18	1.25	1.25
	10	0.198	0.198	1.25	1.36	1.36
	11	0.215	0.214	1.36	1.36	1.36
	12	0.214	0.210	1.36	0.98	0.98
	13	0.155	0.153	0.98	0.88	0.88
	14	0.139	0.139	0.88	0.91	0.91
	15	0.144	0.150	0.91	1.23	1.23
	16	0.195	0.198	1.23	1.52	1.52
	17	0.240	0.243	1.52	1.71	1.71
	18	0.270	0.270	1.71	1.73	1.73
	19	0.273	0.272	1.73	1.57	1.57
	20	0.247	0.243	1.57	1.40	1.40
	21	0.221	0.218	1.40	1.01	1.01
	22	0.159	0.154	1.01	0.53	0.53
	23	0.083	0.076	0.53	0.21	0.21
Weekend	24	0.039	0.033	0.25	0.15	0.15
	25	0.024	0.023	0.15	0.08	0.08
	26	0.012	0.012	0.08	0.07	0.07
	27	0.010	0.011	0.07	0.06	0.06
	28	0.010	0.011	0.06	0.12	0.12
	29	0.019	0.020	0.12	0.26	0.26
	30	0.042	0.045	0.26	0.59	0.59
	31	0.093	0.109	0.59	1.48	1.48
	32	0.234	0.239	1.48	1.79	1.79
	33	0.282	0.281	1.79	1.90	1.90
	34	0.300	0.300	1.90	1.95	1.95
	35	0.307	0.306	1.95	1.91	1.91
	36	0.302	0.299	1.91	1.73	1.73
	37	0.273	0.270	1.73	1.53	1.53
	38	0.241	0.238	1.53	1.33	1.33
	39	0.209	0.207	1.33	1.26	1.26
	40	0.199	0.199	1.26	1.40	1.40
	41	0.221	0.220	1.40	1.35	1.35
	42	0.213	0.212	1.35	1.33	1.33
	43	0.209	0.208	1.33	1.18	1.18
	44	0.185	0.186	1.18	1.24	1.24
	45	0.195	0.189	1.24	0.75	0.75
	46	0.118	0.114	0.75	0.52	0.52
	47	0.081	0.079	0.52	0.25	0.25
Average						
	Weekday	0.157	0.157	1.00	1.00	1.00
	Weekend	0.159	0.159	1.01	1.01	1.01
	ADWF(1)	0.158	0.158	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		-0.2%			

Notes:

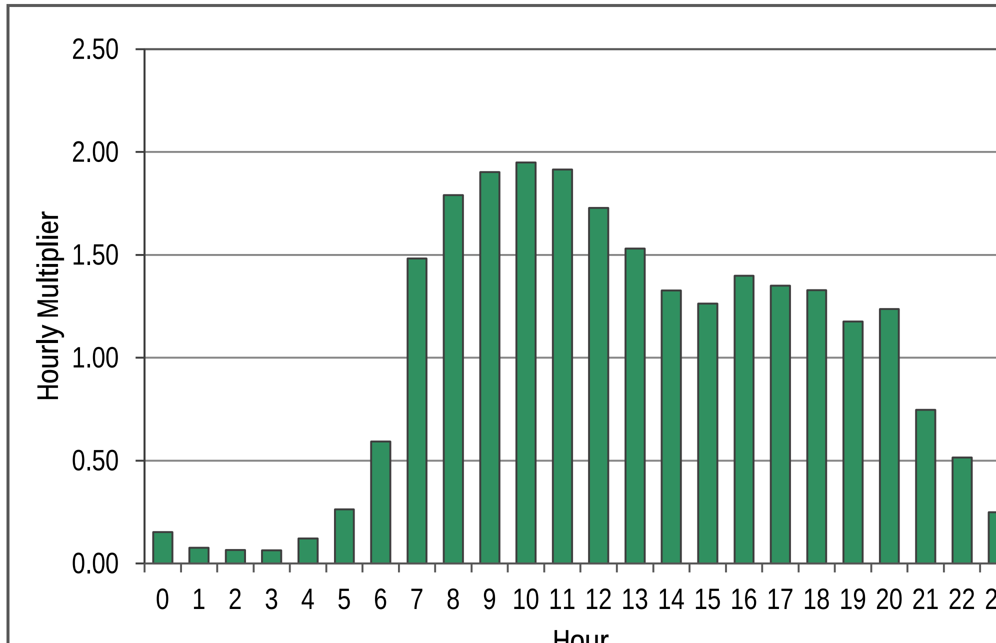
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_80.xlsx

City of Oakland

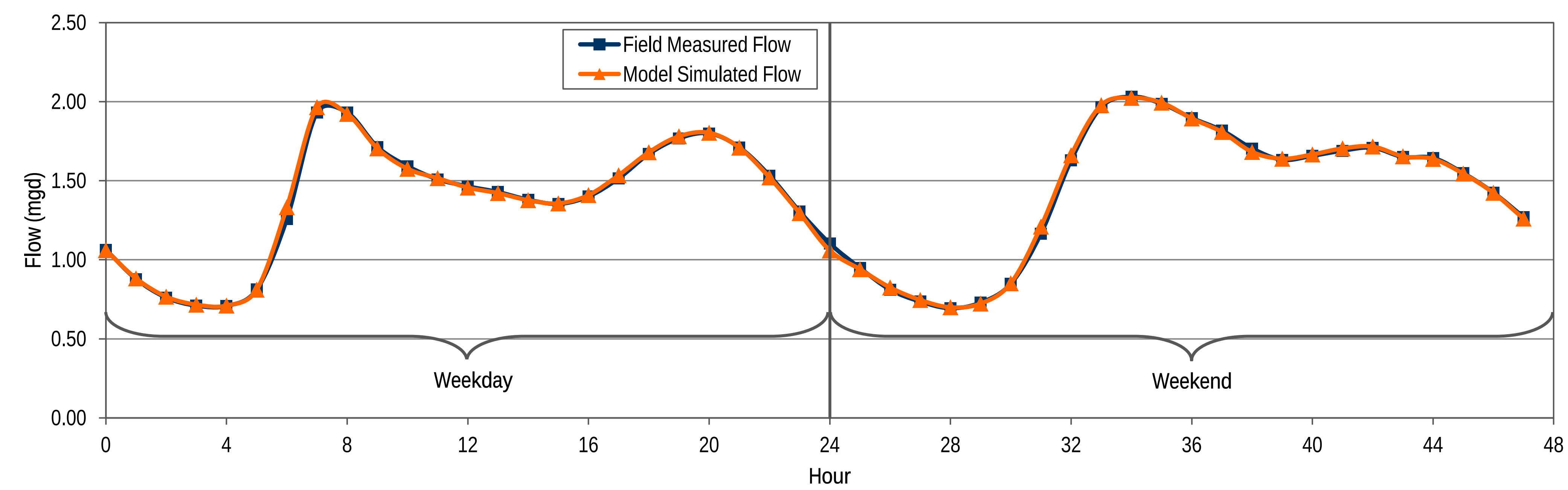
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80B DRY WEATHER CALIBRATION

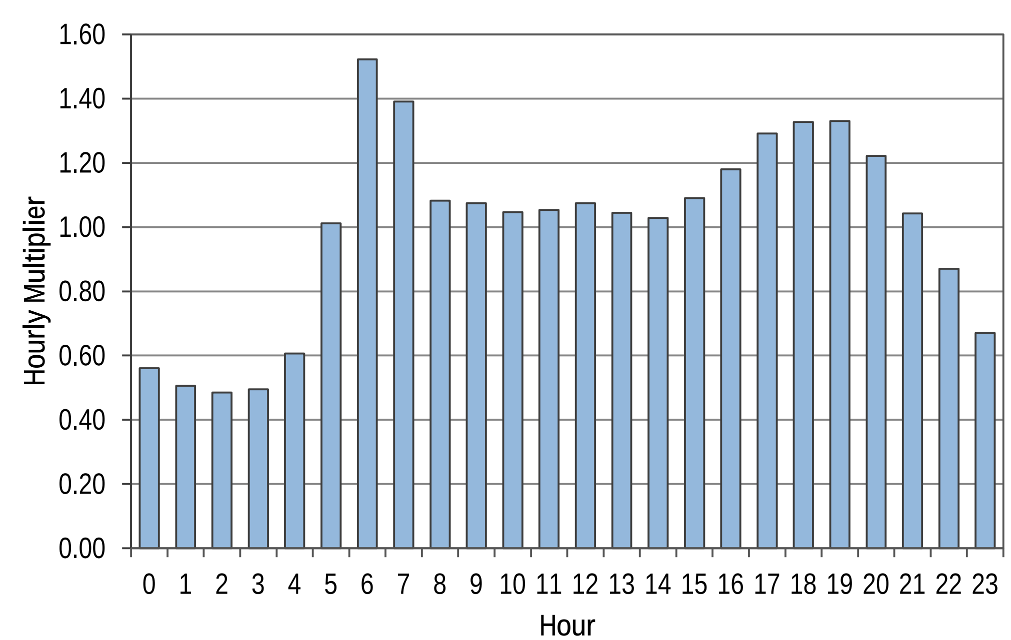
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.063	1.061	0.76	0.63	0.56
	1	0.878	0.882	0.63	0.55	0.51
	2	0.761	0.767	0.55	0.51	0.49
	3	0.710	0.716	0.51	0.51	0.49
	4	0.708	0.711	0.51	0.58	0.61
	5	0.812	0.811	0.58	0.90	1.01
	6	1.258	1.333	0.90	1.38	1.52
	7	1.931	1.965	1.38	1.38	1.39
	8	1.930	1.923	1.38	1.23	1.08
	9	1.713	1.705	1.23	1.14	1.07
	10	1.591	1.575	1.14	1.08	1.05
	11	1.509	1.516	1.08	1.05	1.05
	12	1.463	1.457	1.05	1.02	1.07
	13	1.428	1.422	1.02	0.99	1.04
	14	1.379	1.377	0.99	0.97	1.03
	15	1.353	1.357	0.97	1.00	1.09
	16	1.400	1.409	1.00	1.09	1.18
	17	1.515	1.535	1.09	1.20	1.29
	18	1.669	1.680	1.20	1.27	1.33
	19	1.768	1.781	1.27	1.29	1.33
	20	1.799	1.803	1.29	1.23	1.22
	21	1.711	1.709	1.23	1.10	1.04
	22	1.532	1.521	1.10	0.93	0.87
	23	1.305	1.295	0.93	0.76	0.67
Weekend	24	1.102	1.059	0.79	0.68	0.66
	25	0.948	0.940	0.68	0.58	0.55
	26	0.811	0.825	0.58	0.53	0.50
	27	0.736	0.746	0.53	0.50	0.45
	28	0.693	0.700	0.50	0.52	0.52
	29	0.728	0.723	0.52	0.61	0.64
	30	0.848	0.852	0.61	0.83	0.89
	31	1.165	1.210	0.83	1.17	1.19
	32	1.628	1.661	1.17	1.41	1.41
	33	1.965	1.978	1.41	1.45	1.39
	34	2.031	2.024	1.45	1.42	1.31
	35	1.987	1.994	1.42	1.36	1.27
	36	1.896	1.894	1.36	1.30	1.23
	37	1.818	1.809	1.30	1.22	1.23
	38	1.703	1.682	1.22	1.17	1.21
	39	1.632	1.639	1.17	1.19	1.26
	40	1.657	1.666	1.19	1.21	1.25
	41	1.689	1.704	1.21	1.22	1.23
	42	1.708	1.716	1.22	1.18	1.09
	43	1.650	1.654	1.18	1.18	1.11
	44	1.644	1.638	1.18	1.11	1.04
	45	1.548	1.545	1.11	1.02	0.98
	46	1.425	1.424	1.02	0.91	0.87
	47	1.270	1.261	0.91	0.79	0.74
Average						
	Weekday	1.383	1.388	0.99	0.99	1.00
	Weekend	1.428	1.431	1.02	1.02	1.00
	ADWF[(1)]	1.396	1.400	1.00	1.00	1.00
% Error						
	Weekday		0.4%			
	Weekend		0.2%			

Notes:

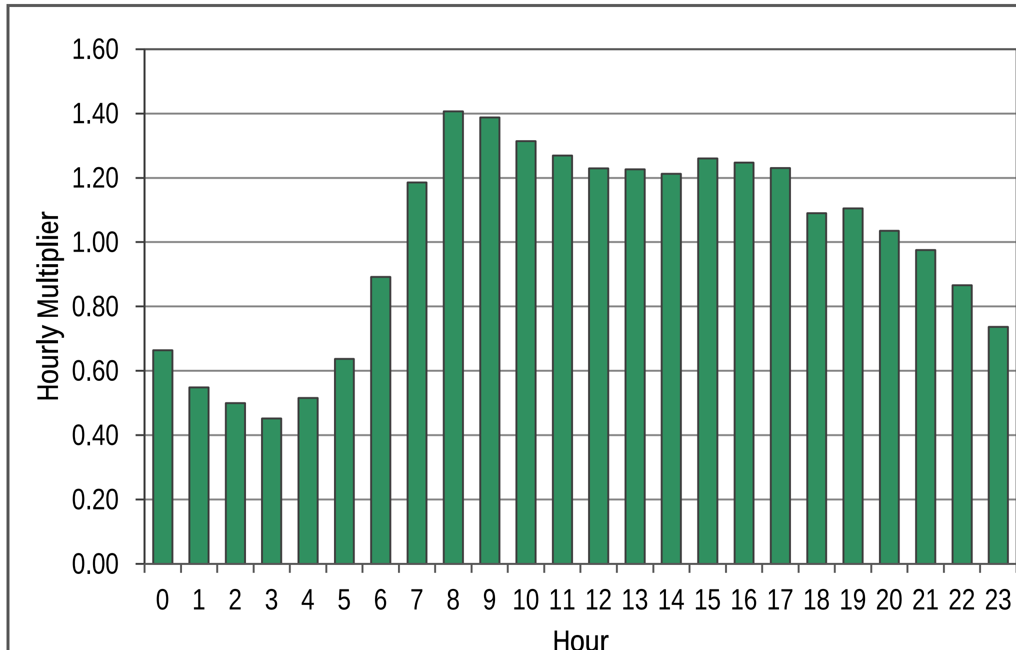
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

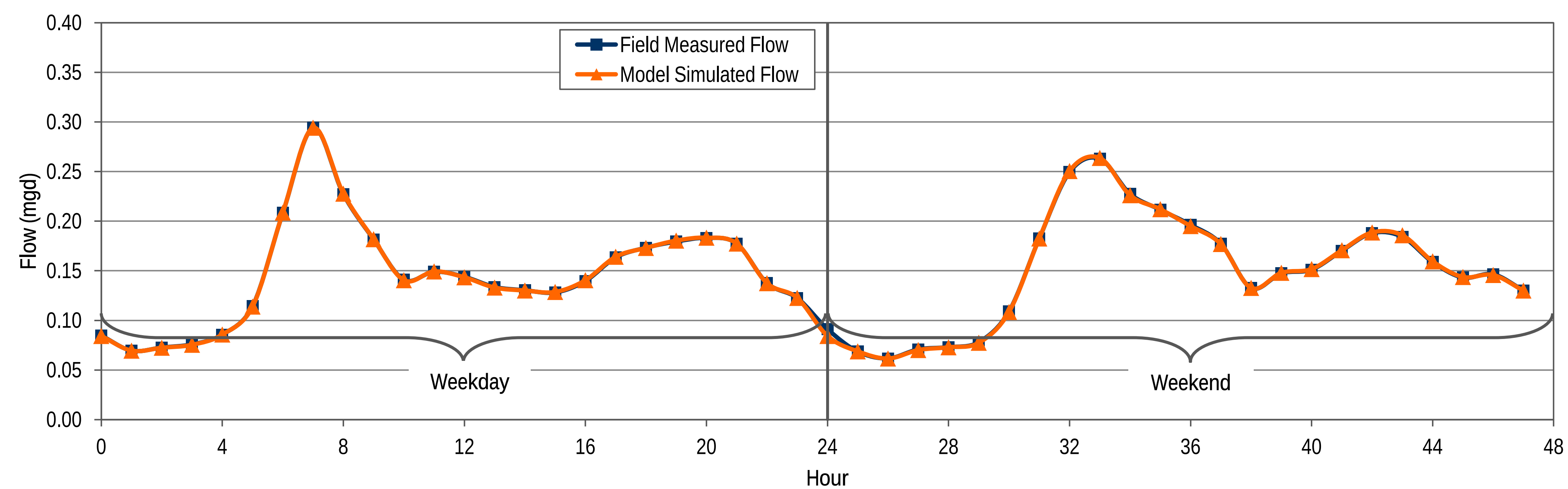
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80C DRY WEATHER CALIBRATION

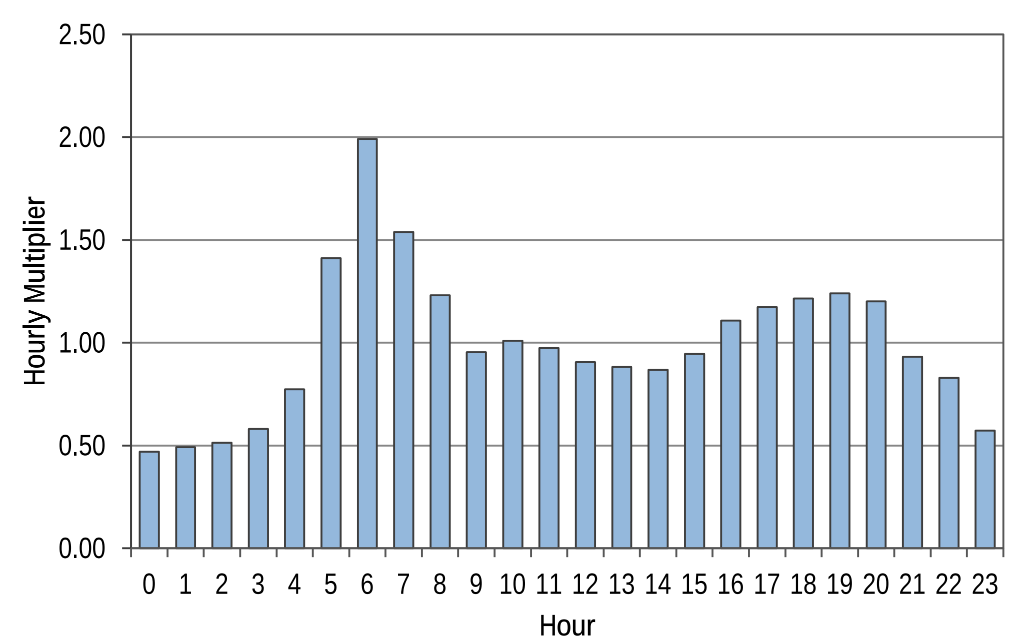
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.085	0.084	0.57	0.47	0.47
	1	0.069	0.070	0.47	0.49	0.49
	2	0.073	0.072	0.49	0.51	0.51
	3	0.076	0.075	0.51	0.58	0.58
	4	0.086	0.086	0.58	0.77	0.77
	5	0.114	0.114	0.77	1.41	1.41
	6	0.208	0.209	1.41	1.99	1.99
	7	0.294	0.294	1.99	1.54	1.54
	8	0.227	0.228	1.54	1.23	1.23
	9	0.182	0.182	1.23	0.95	0.95
	10	0.141	0.140	0.95	1.01	1.01
	11	0.149	0.149	1.01	0.97	0.97
	12	0.144	0.143	0.97	0.90	0.90
	13	0.134	0.133	0.90	0.88	0.88
	14	0.130	0.130	0.88	0.87	0.87
	15	0.128	0.129	0.87	0.95	0.95
	16	0.140	0.141	0.95	1.11	1.11
	17	0.164	0.164	1.11	1.17	1.17
	18	0.173	0.173	1.17	1.22	1.22
	19	0.180	0.180	1.22	1.24	1.24
	20	0.183	0.183	1.24	1.20	1.20
	21	0.177	0.177	1.20	0.93	0.93
	22	0.138	0.138	0.93	0.83	0.83
	23	0.123	0.123	0.83	0.57	0.57
Weekend	24	0.091	0.084	0.62	0.46	0.46
	25	0.069	0.069	0.46	0.42	0.42
	26	0.062	0.062	0.42	0.48	0.48
	27	0.071	0.070	0.48	0.49	0.49
	28	0.073	0.073	0.49	0.53	0.53
	29	0.078	0.077	0.53	0.74	0.74
	30	0.109	0.108	0.74	1.24	1.24
	31	0.183	0.183	1.24	1.69	1.69
	32	0.249	0.251	1.69	1.78	1.78
	33	0.263	0.264	1.78	1.54	1.54
	34	0.228	0.226	1.54	1.43	1.43
	35	0.212	0.212	1.43	1.33	1.33
	36	0.196	0.195	1.33	1.20	1.20
	37	0.177	0.177	1.20	0.90	0.90
	38	0.133	0.133	0.90	1.00	1.00
	39	0.147	0.148	1.00	1.02	1.02
	40	0.151	0.152	1.02	1.15	1.15
	41	0.170	0.171	1.15	1.27	1.27
	42	0.188	0.189	1.27	1.25	1.25
	43	0.184	0.186	1.25	1.08	1.08
	44	0.159	0.160	1.08	0.97	0.97
	45	0.143	0.144	0.97	0.99	0.99
	46	0.146	0.146	0.99	0.88	0.88
	47	0.130	0.130	0.88	0.62	0.62
Average						
Weekday		0.147	0.147	0.99	0.99	0.99
Weekend		0.150	0.150	1.02	1.02	1.02
ADWF[(1)]		0.148	0.148	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			-0.1%			

Notes:

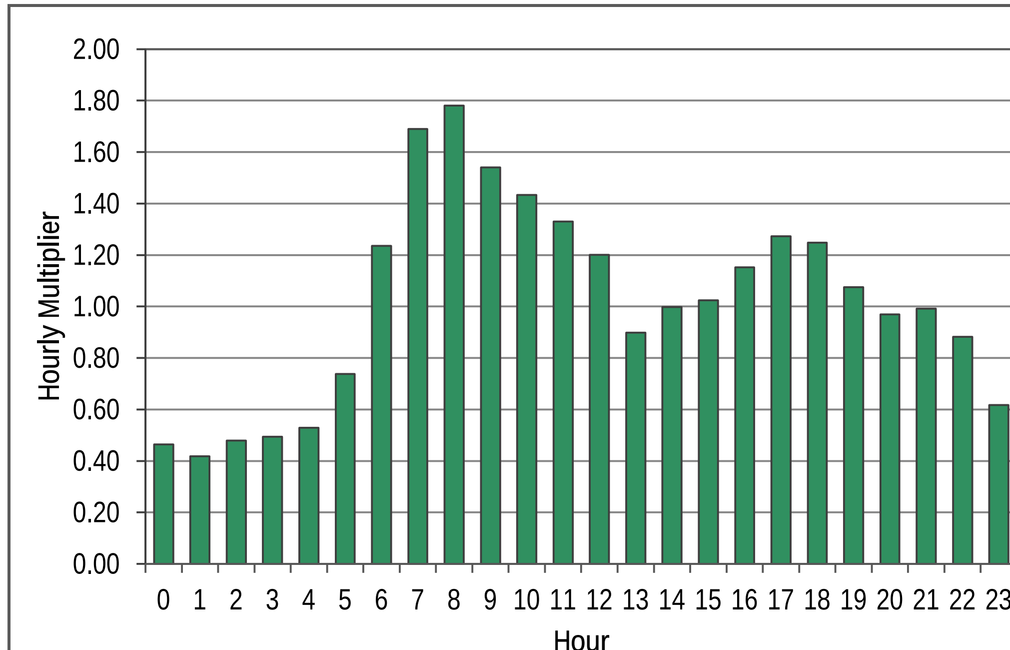
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

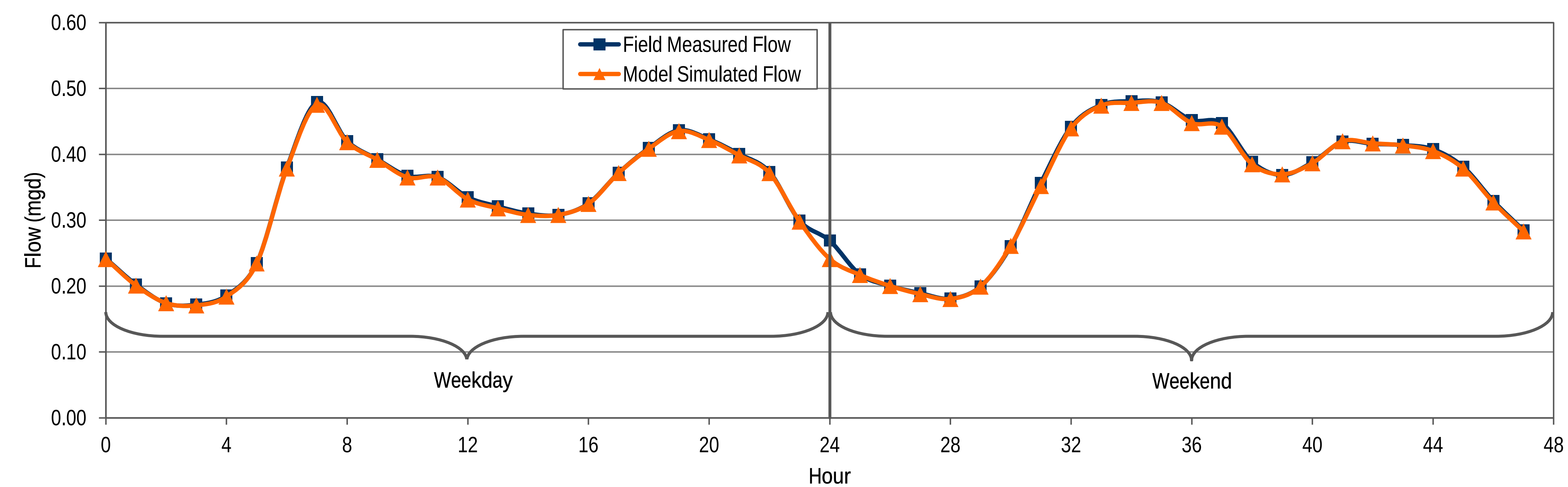
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80D DRY WEATHER CALIBRATION

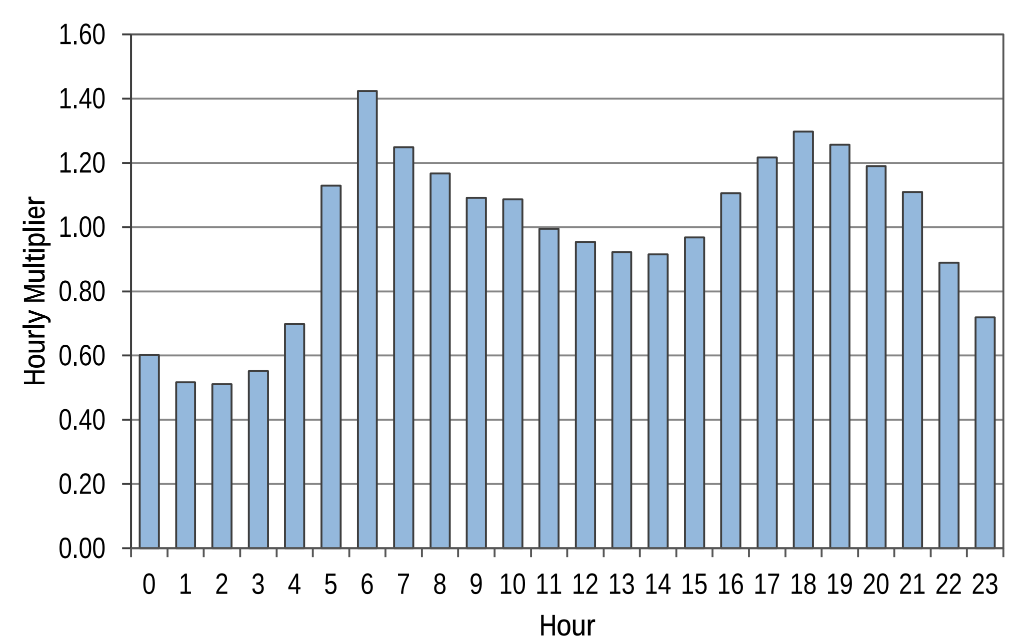
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.242	0.241	0.72	0.60	0.60
	1	0.203	0.201	0.60	0.52	0.52
	2	0.174	0.174	0.52	0.51	0.51
	3	0.172	0.171	0.51	0.55	0.55
	4	0.186	0.184	0.55	0.70	0.70
	5	0.235	0.234	0.70	1.13	1.13
	6	0.380	0.378	1.13	1.42	1.42
	7	0.479	0.475	1.42	1.25	1.25
	8	0.420	0.419	1.25	1.17	1.17
	9	0.393	0.392	1.17	1.09	1.09
	10	0.367	0.365	1.09	1.09	1.09
	11	0.366	0.365	1.09	0.99	0.99
	12	0.335	0.331	0.99	0.95	0.95
	13	0.321	0.318	0.95	0.92	0.92
	14	0.310	0.308	0.92	0.92	0.92
	15	0.308	0.308	0.92	0.97	0.97
	16	0.326	0.325	0.97	1.11	1.11
	17	0.372	0.372	1.11	1.22	1.22
	18	0.410	0.408	1.22	1.30	1.30
	19	0.437	0.435	1.30	1.26	1.26
	20	0.423	0.422	1.26	1.19	1.19
	21	0.401	0.398	1.19	1.11	1.11
	22	0.373	0.372	1.11	0.89	0.89
	23	0.299	0.298	0.89	0.72	0.72
Weekend	24	0.269	0.241	0.80	0.65	0.65
	25	0.218	0.217	0.65	0.60	0.60
	26	0.201	0.200	0.60	0.56	0.56
	27	0.190	0.188	0.56	0.54	0.54
	28	0.181	0.180	0.54	0.59	0.59
	29	0.200	0.199	0.59	0.77	0.77
	30	0.261	0.261	0.77	1.06	1.06
	31	0.357	0.352	1.06	1.31	1.31
	32	0.442	0.439	1.31	1.41	1.41
	33	0.475	0.474	1.41	1.43	1.43
	34	0.481	0.478	1.43	1.42	1.42
	35	0.479	0.478	1.42	1.34	1.34
	36	0.452	0.447	1.34	1.33	1.33
	37	0.448	0.442	1.33	1.15	1.15
	38	0.389	0.385	1.15	1.10	1.10
	39	0.369	0.370	1.10	1.15	1.15
	40	0.388	0.386	1.15	1.25	1.25
	41	0.419	0.420	1.25	1.24	1.24
	42	0.416	0.417	1.24	1.23	1.23
	43	0.414	0.413	1.23	1.21	1.21
	44	0.408	0.405	1.21	1.13	1.13
	45	0.381	0.378	1.13	0.98	0.98
	46	0.329	0.327	0.98	0.85	0.85
	47	0.285	0.283	0.85	0.80	0.80
Average						
Weekday		0.331	0.329	0.98	0.98	0.98
Weekend		0.352	0.349	1.05	1.05	1.05
ADWF[1]		0.337	0.335	1.00	1.00	1.00
% Error						
Weekday			-0.5%			
Weekend			-0.8%			

Notes:

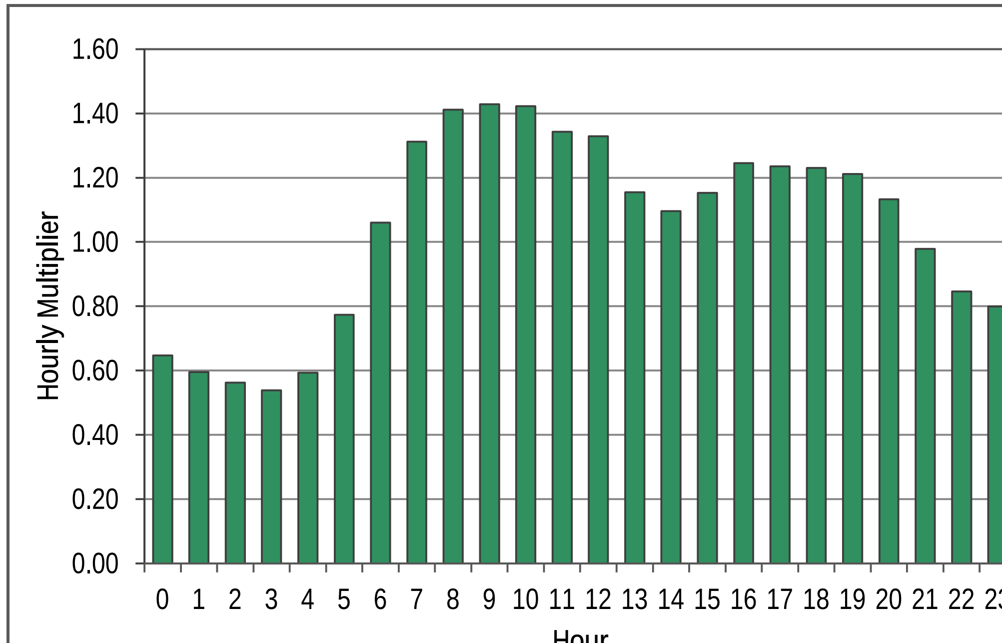
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

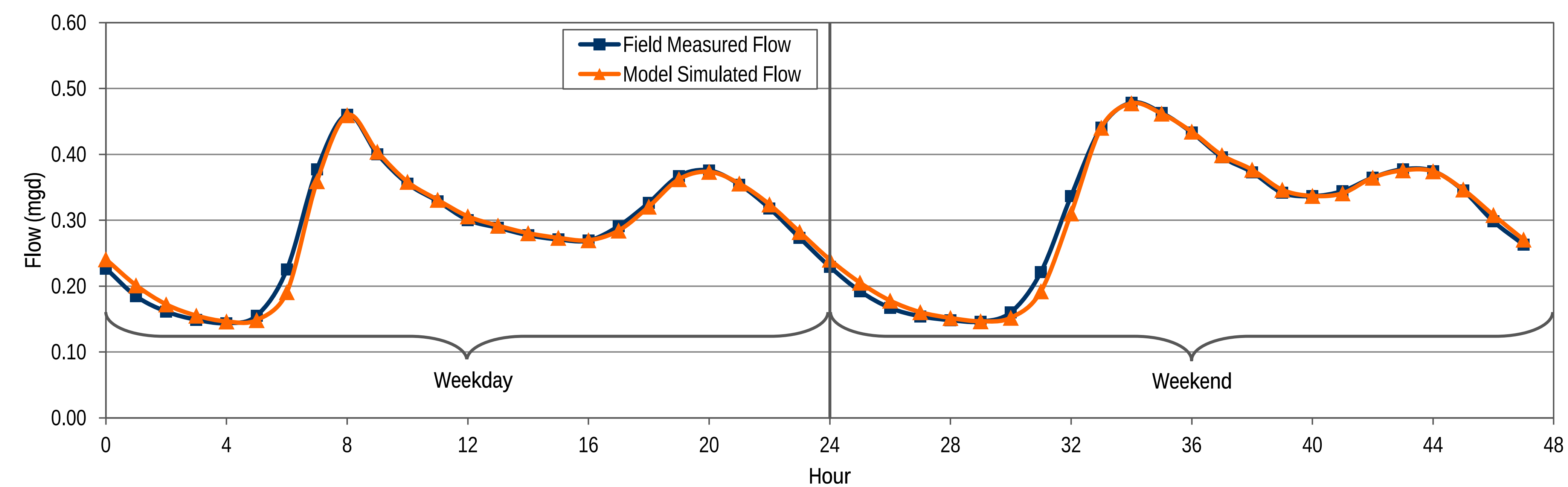
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80E DRY WEATHER CALIBRATION

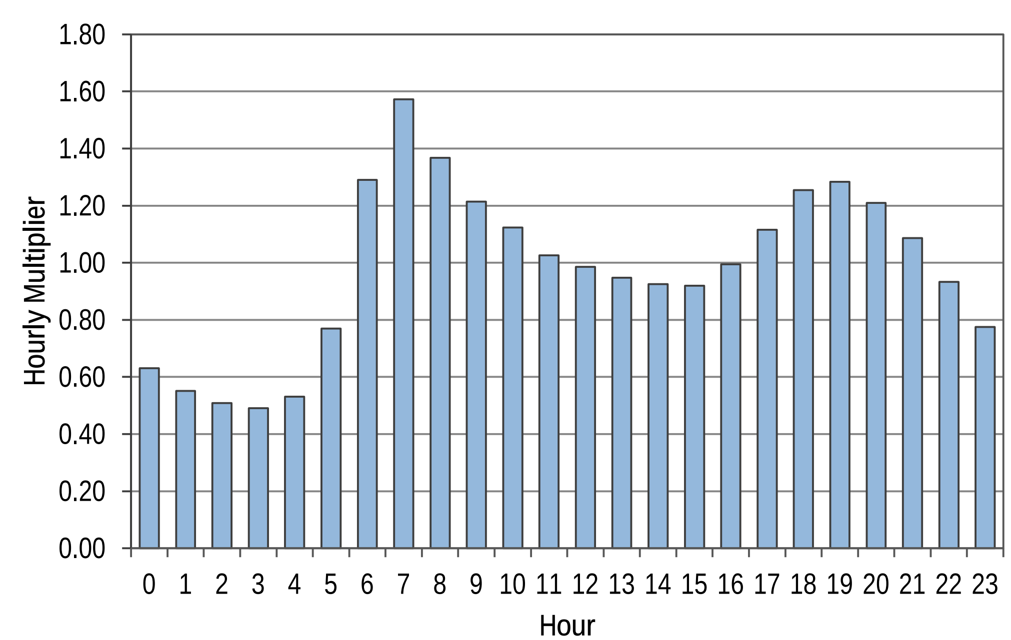
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.227	0.241	0.77	0.63	0.63
	1	0.185	0.201	0.63	0.55	0.55
	2	0.161	0.172	0.55	0.51	0.51
	3	0.149	0.155	0.51	0.49	0.49
	4	0.144	0.146	0.49	0.53	0.53
	5	0.155	0.148	0.53	0.77	0.77
	6	0.225	0.191	0.77	1.29	1.29
	7	0.377	0.359	1.29	1.57	1.57
	8	0.460	0.459	1.57	1.37	1.37
	9	0.400	0.404	1.37	1.21	1.21
	10	0.355	0.358	1.21	1.12	1.12
	11	0.329	0.331	1.12	1.03	1.03
	12	0.300	0.306	1.03	0.99	0.99
	13	0.289	0.292	0.99	0.95	0.95
	14	0.277	0.280	0.95	0.93	0.93
	15	0.271	0.273	0.93	0.92	0.92
	16	0.269	0.270	0.92	0.99	0.99
	17	0.291	0.284	0.99	1.12	1.12
	18	0.327	0.321	1.12	1.25	1.25
	19	0.367	0.362	1.25	1.28	1.28
	20	0.375	0.374	1.28	1.21	1.21
	21	0.354	0.356	1.21	1.09	1.09
	22	0.318	0.324	1.09	0.93	0.93
	23	0.273	0.282	0.93	0.77	0.77
Weekend	24	0.229	0.240	0.78	0.66	0.66
	25	0.192	0.205	0.66	0.57	0.57
	26	0.167	0.178	0.57	0.53	0.53
	27	0.154	0.161	0.53	0.51	0.51
	28	0.148	0.152	0.51	0.50	0.50
	29	0.146	0.147	0.50	0.55	0.55
	30	0.160	0.152	0.55	0.76	0.76
	31	0.221	0.192	0.76	1.15	1.15
	32	0.337	0.310	1.15	1.51	1.51
	33	0.441	0.440	1.51	1.63	1.63
	34	0.478	0.478	1.63	1.58	1.58
	35	0.463	0.462	1.58	1.48	1.48
	36	0.433	0.435	1.48	1.35	1.35
	37	0.396	0.399	1.35	1.27	1.27
	38	0.373	0.377	1.27	1.17	1.17
	39	0.342	0.346	1.17	1.15	1.15
	40	0.337	0.337	1.15	1.18	1.18
	41	0.344	0.341	1.18	1.25	1.25
	42	0.365	0.365	1.25	1.29	1.29
	43	0.377	0.376	1.29	1.28	1.28
	44	0.375	0.374	1.28	1.18	1.18
	45	0.345	0.347	1.18	1.02	1.02
	46	0.298	0.308	1.02	0.90	0.90
	47	0.263	0.271	0.90	0.78	0.78
Average						
	Weekday	0.287	0.287	0.98	0.98	0.98
	Weekend	0.308	0.308	1.05	1.05	1.05
	ADWF(1)	0.293	0.293	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		0.1%			

Notes:

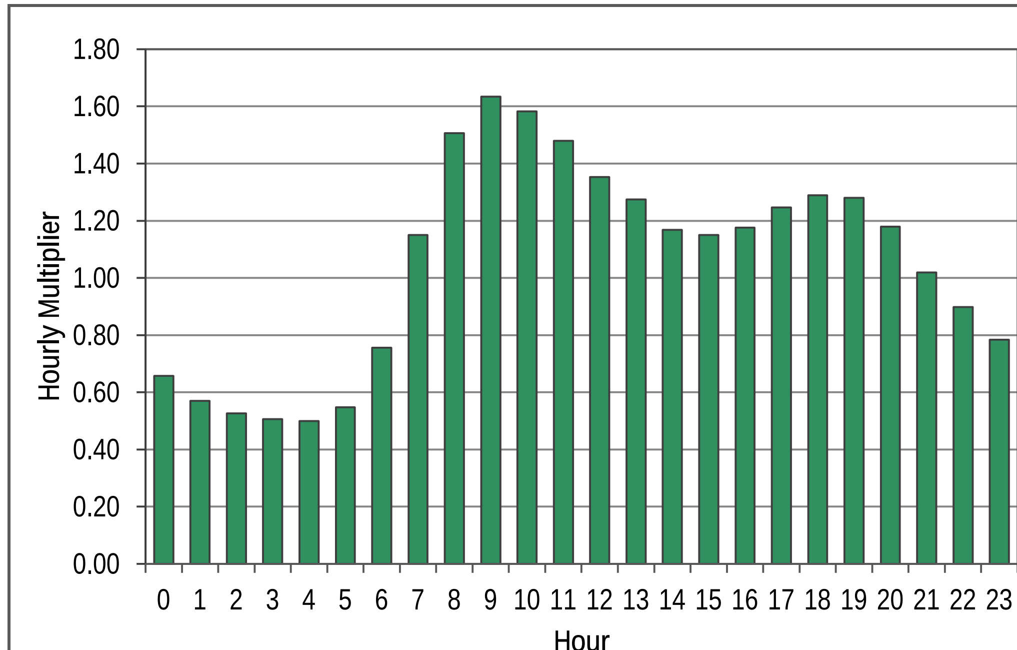
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

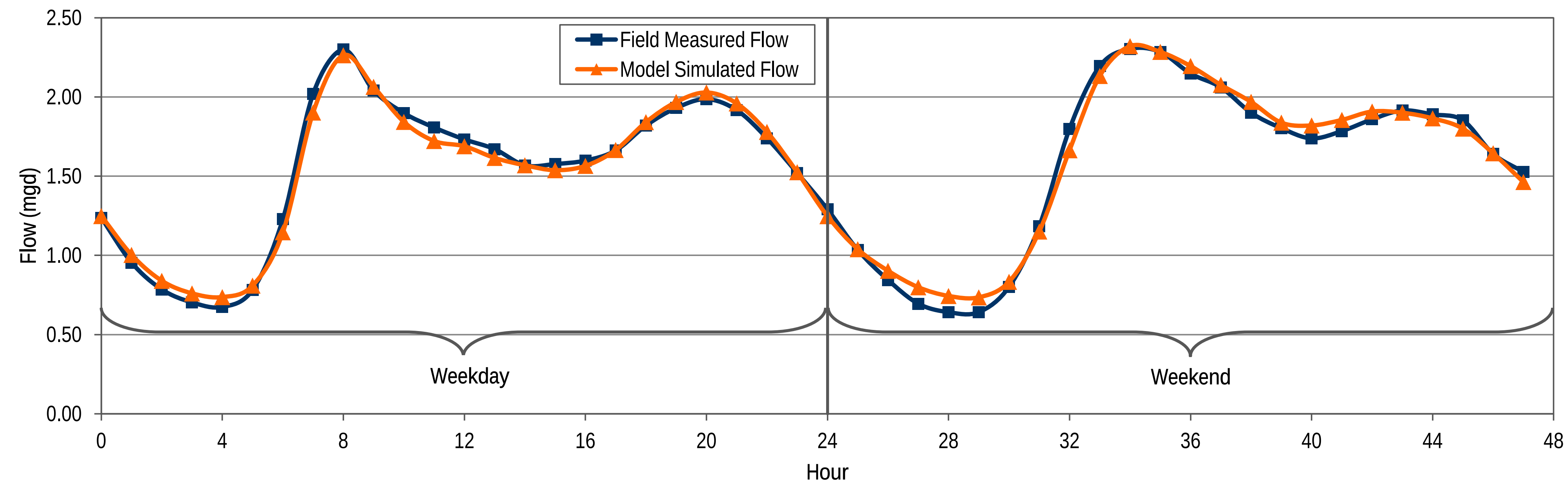
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80-1 DRY WEATHER CALIBRATION

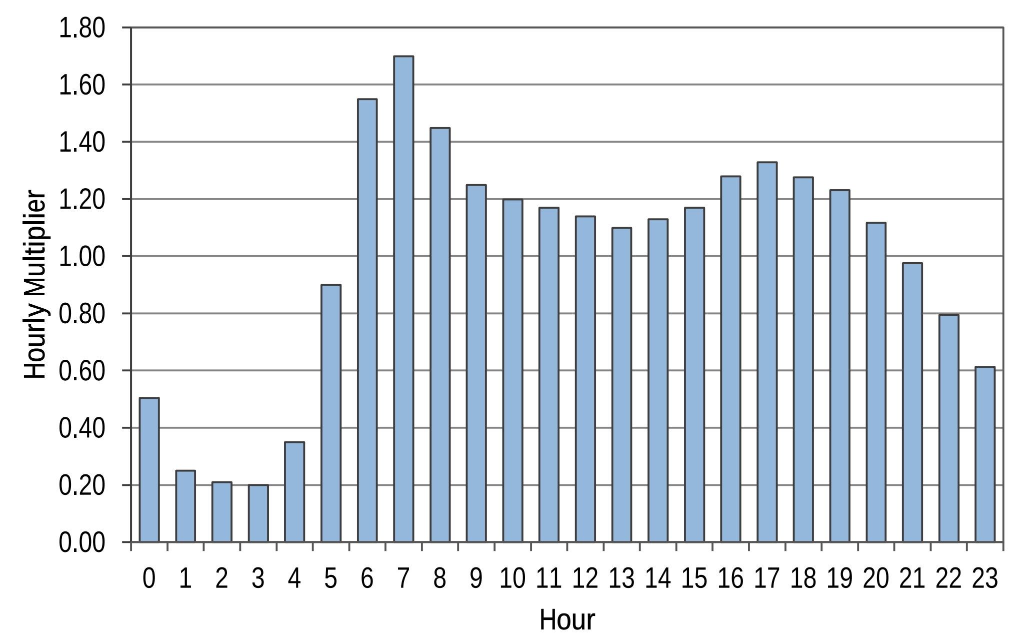
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.236	1.248	0.79	0.61	0.50
	1	0.954	1.003	0.61	0.50	0.25
	2	0.784	0.839	0.50	0.45	0.21
	3	0.702	0.760	0.45	0.43	0.20
	4	0.674	0.736	0.43	0.50	0.35
	5	0.782	0.809	0.50	0.79	0.90
	6	1.228	1.146	0.79	1.30	1.55
	7	2.020	1.902	1.30	1.48	1.70
	8	2.299	2.263	1.48	1.31	1.45
	9	2.041	2.064	1.31	1.22	1.25
	10	1.898	1.842	1.22	1.16	1.20
	11	1.807	1.722	1.16	1.11	1.17
	12	1.732	1.689	1.11	1.07	1.14
	13	1.671	1.615	1.07	1.01	1.10
	14	1.568	1.569	1.01	1.01	1.13
	15	1.577	1.538	1.01	1.03	1.17
	16	1.598	1.565	1.03	1.07	1.28
	17	1.662	1.665	1.07	1.17	1.33
	18	1.819	1.841	1.17	1.24	1.28
	19	1.930	1.968	1.24	1.28	1.23
	20	1.986	2.028	1.28	1.23	1.12
	21	1.917	1.959	1.23	1.12	0.98
	22	1.740	1.779	1.12	0.98	0.79
	23	1.520	1.525	0.98	0.79	0.61
Weekend	24	1.290	1.247	0.83	0.66	0.54
	25	1.034	1.039	0.66	0.54	0.24
	26	0.844	0.902	0.54	0.45	0.22
	27	0.695	0.799	0.45	0.41	0.20
	28	0.641	0.743	0.41	0.41	0.22
	29	0.641	0.735	0.41	0.51	0.33
	30	0.801	0.833	0.51	0.76	1.16
	31	1.183	1.150	0.76	1.16	1.71
	32	1.798	1.663	1.16	1.41	1.68
	33	2.194	2.132	1.41	1.48	1.61
	34	2.303	2.320	1.48	1.47	1.45
	35	2.284	2.284	1.47	1.38	1.33
	36	2.148	2.195	1.38	1.32	1.23
	37	2.061	2.076	1.32	1.22	1.12
	38	1.901	1.969	1.22	1.16	1.04
	39	1.803	1.838	1.16	1.12	1.00
	40	1.738	1.820	1.12	1.15	1.08
	41	1.784	1.855	1.15	1.19	1.23
	42	1.859	1.908	1.19	1.23	1.37
	43	1.915	1.900	1.23	1.21	1.40
	44	1.890	1.865	1.21	1.19	1.35
	45	1.853	1.800	1.19	1.05	1.15
	46	1.641	1.644	1.05	0.98	0.95
	47	1.527	1.463	0.98	0.83	0.67
Average						
	Weekday	1.548	1.545	0.99	0.99	0.99
	Weekend	1.576	1.591	1.01	1.01	1.01
	ADWF[(1)]	1.556	1.558	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		0.9%			

Notes:

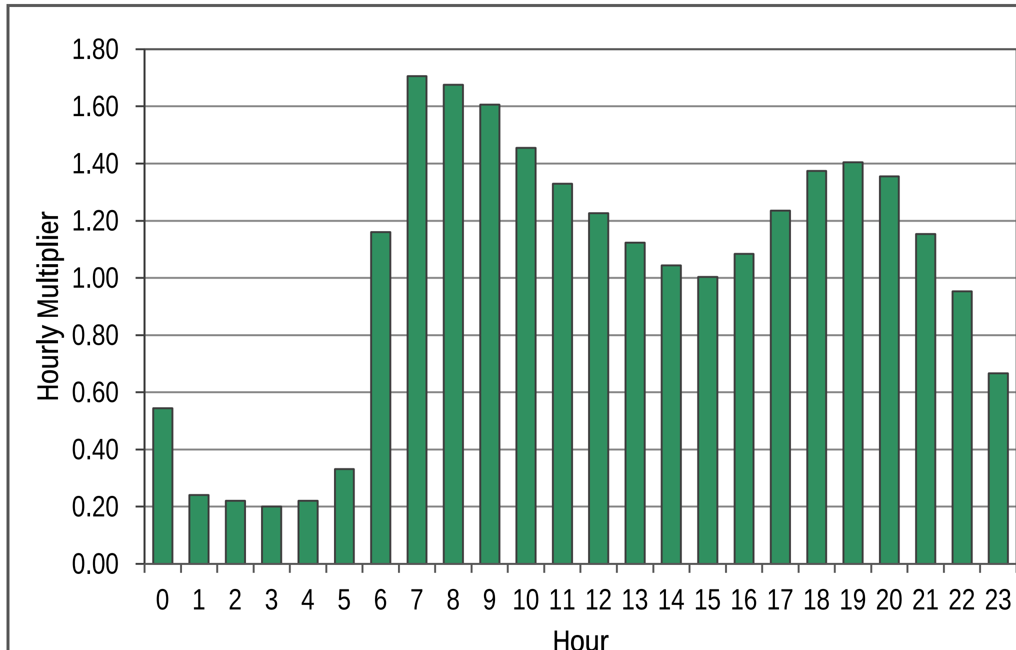
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

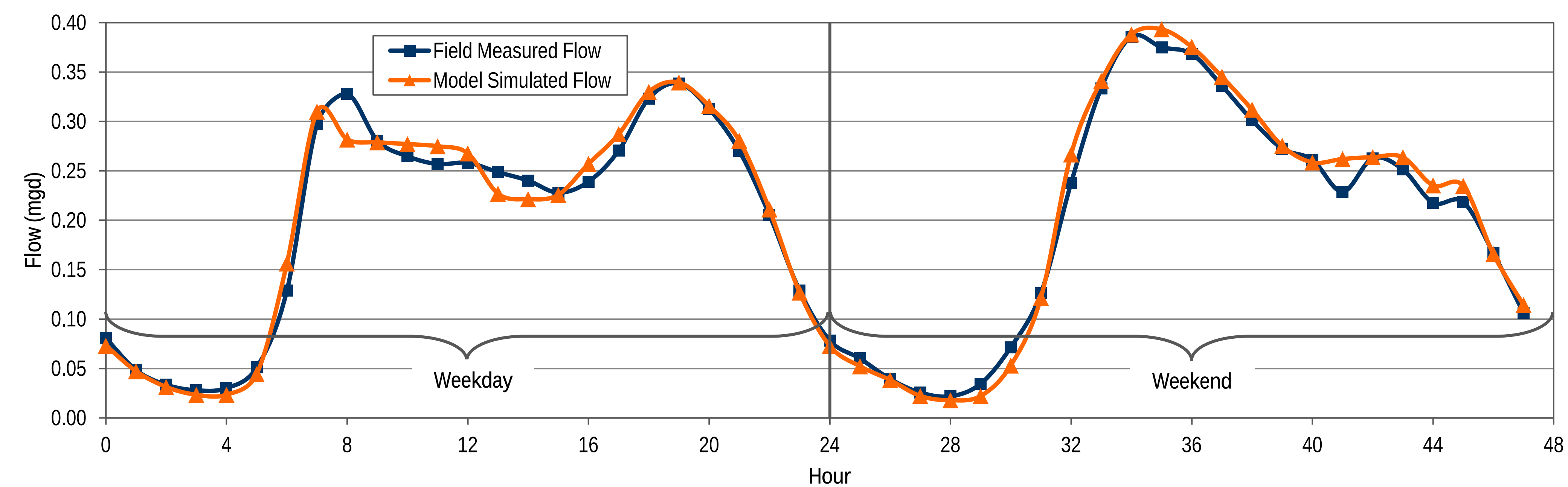
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80-2 DRY WEATHER CALIBRATION

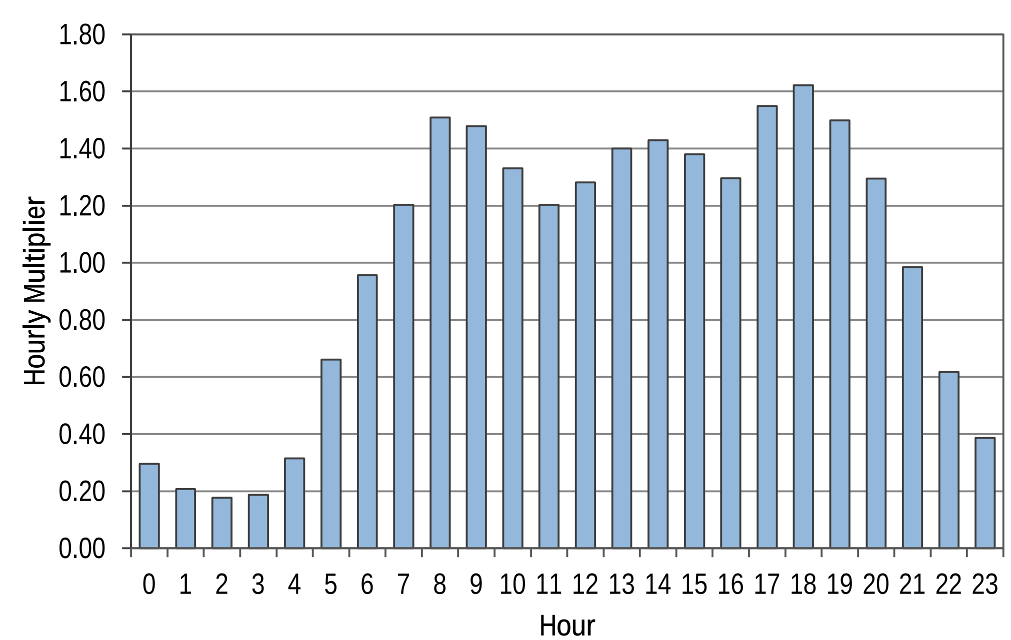
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.081	0.073	0.40	0.24	0.30
	1	0.048	0.047	0.24	0.17	0.21
	2	0.034	0.031	0.17	0.14	0.18
	3	0.028	0.023	0.14	0.15	0.19
	4	0.030	0.023	0.15	0.25	0.32
	5	0.051	0.044	0.25	0.64	0.66
	6	0.129	0.156	0.64	1.47	0.96
	7	0.297	0.310	1.47	1.62	1.20
	8	0.328	0.282	1.62	1.39	1.51
	9	0.281	0.279	1.39	1.31	1.48
	10	0.265	0.277	1.31	1.27	1.33
	11	0.257	0.275	1.27	1.27	1.20
	12	0.258	0.268	1.27	1.23	1.28
	13	0.249	0.227	1.23	1.19	1.40
	14	0.240	0.221	1.19	1.13	1.43
	15	0.228	0.226	1.13	1.18	1.38
	16	0.239	0.257	1.18	1.34	1.30
	17	0.270	0.287	1.34	1.60	1.55
	18	0.323	0.330	1.60	1.67	1.62
	19	0.338	0.339	1.67	1.54	1.50
	20	0.313	0.316	1.54	1.33	1.29
	21	0.270	0.280	1.33	1.01	0.98
	22	0.205	0.211	1.01	0.64	0.62
	23	0.129	0.127	0.64	0.40	0.39
Weekend	24	0.078	0.073	0.39	0.30	0.35
	25	0.060	0.052	0.30	0.19	0.28
	26	0.039	0.038	0.19	0.13	0.13
	27	0.026	0.022	0.13	0.11	0.12
	28	0.022	0.018	0.11	0.17	0.20
	29	0.035	0.022	0.17	0.35	0.44
	30	0.071	0.053	0.35	0.62	0.75
	31	0.126	0.121	0.62	1.17	1.16
	32	0.238	0.267	1.17	1.65	1.48
	33	0.334	0.341	1.65	1.90	1.84
	34	0.386	0.388	1.90	1.85	1.87
	35	0.375	0.393	1.85	1.82	1.71
	36	0.368	0.375	1.82	1.66	1.61
	37	0.336	0.345	1.66	1.49	1.48
	38	0.301	0.312	1.49	1.35	1.34
	39	0.273	0.275	1.35	1.29	1.31
	40	0.261	0.259	1.29	1.13	1.21
	41	0.229	0.262	1.13	1.30	1.15
	42	0.263	0.264	1.30	1.24	1.23
	43	0.251	0.264	1.24	1.08	1.07
	44	0.218	0.235	1.08	1.08	0.94
	45	0.219	0.235	1.08	0.82	0.76
	46	0.167	0.166	0.82	0.52	0.52
	47	0.106	0.114	0.52	0.39	0.38
Average						
	Weekday	0.204	0.205	1.01	1.01	1.01
	Weekend	0.199	0.204	0.98	0.98	0.97
	ADWF(1)	0.202	0.204	1.00	1.00	1.00
% Error						
	Weekday		0.4%			
	Weekend		2.4%			

Notes:

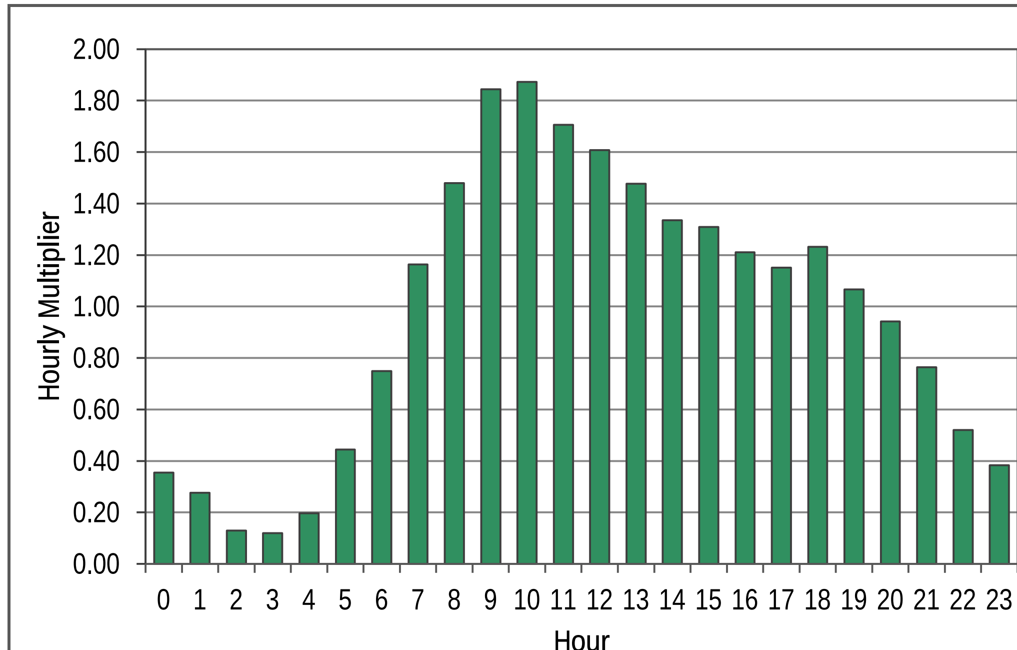
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_80.xlsx

City of Oakland

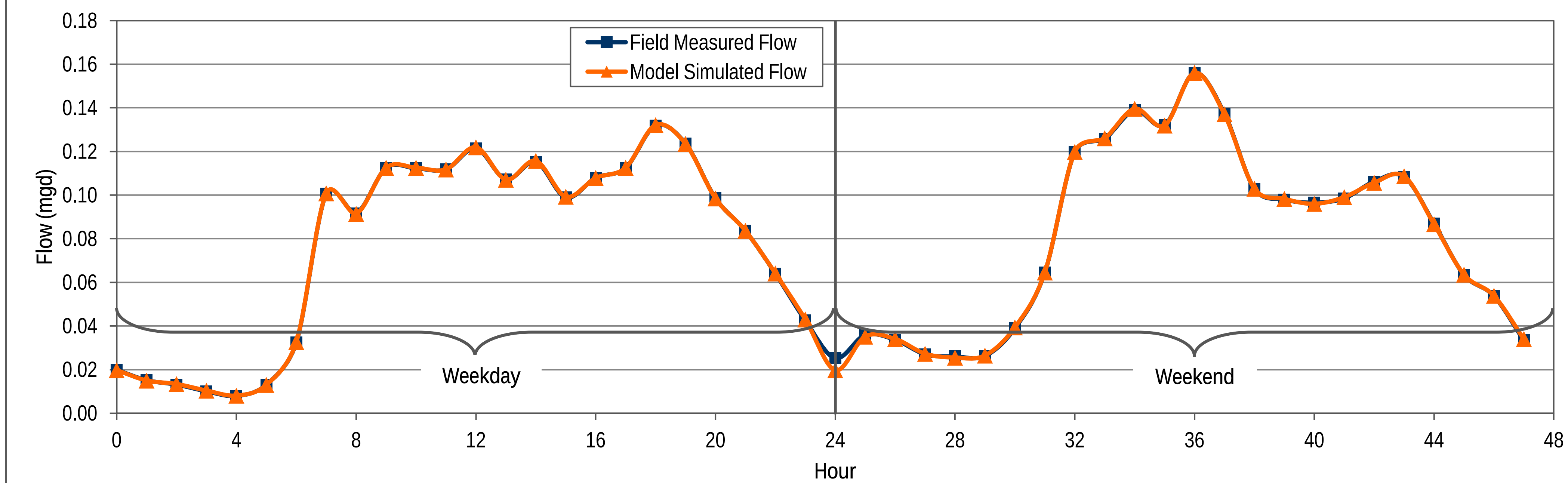
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81A DRY WEATHER CALIBRATION

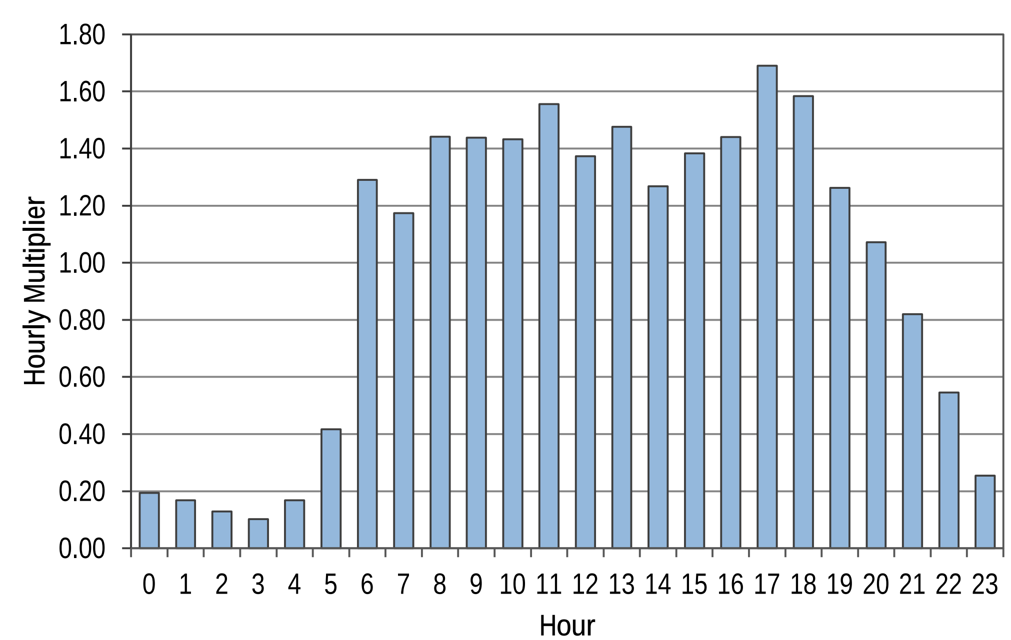
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.020	0.020	0.25	0.19	0.19
	1	0.015	0.015	0.19	0.17	0.17
	2	0.013	0.013	0.17	0.13	0.13
	3	0.010	0.010	0.13	0.10	0.10
	4	0.008	0.008	0.10	0.17	0.17
	5	0.013	0.013	0.17	0.42	0.42
	6	0.033	0.033	0.42	1.29	1.29
	7	0.101	0.101	1.29	1.17	1.17
	8	0.092	0.091	1.17	1.44	1.44
	9	0.112	0.113	1.44	1.44	1.44
	10	0.112	0.113	1.44	1.43	1.43
	11	0.112	0.112	1.43	1.56	1.56
	12	0.121	0.122	1.56	1.37	1.37
	13	0.107	0.107	1.37	1.48	1.48
	14	0.115	0.116	1.48	1.27	1.27
	15	0.099	0.099	1.27	1.38	1.38
	16	0.108	0.108	1.38	1.44	1.44
	17	0.112	0.113	1.44	1.69	1.69
	18	0.132	0.132	1.69	1.58	1.58
	19	0.124	0.123	1.58	1.26	1.26
	20	0.099	0.098	1.26	1.07	1.07
	21	0.084	0.084	1.07	0.82	0.82
	22	0.064	0.064	0.82	0.55	0.55
	23	0.043	0.043	0.55	0.25	0.25
Weekend	24	0.025	0.020	0.32	0.46	0.46
	25	0.036	0.035	0.46	0.43	0.43
	26	0.034	0.034	0.43	0.35	0.35
	27	0.027	0.027	0.35	0.33	0.33
	28	0.026	0.025	0.33	0.34	0.34
	29	0.026	0.026	0.34	0.50	0.50
	30	0.039	0.039	0.50	0.83	0.83
	31	0.064	0.065	0.83	1.53	1.53
	32	0.120	0.120	1.53	1.61	1.61
	33	0.126	0.126	1.61	1.78	1.78
	34	0.139	0.140	1.78	1.69	1.69
	35	0.132	0.132	1.69	2.00	2.00
	36	0.156	0.156	2.00	1.76	1.76
	37	0.137	0.137	1.76	1.32	1.32
	38	0.103	0.103	1.32	1.25	1.25
	39	0.098	0.098	1.25	1.24	1.24
	40	0.097	0.096	1.24	1.26	1.26
	41	0.099	0.099	1.26	1.36	1.36
	42	0.106	0.106	1.36	1.39	1.39
	43	0.108	0.109	1.39	1.11	1.11
	44	0.087	0.087	1.11	0.81	0.81
	45	0.063	0.064	0.81	0.69	0.69
	46	0.054	0.054	0.69	0.43	0.43
	47	0.033	0.034	0.43	0.32	0.32
Average						
	Weekday	0.077	0.077	0.99	0.99	0.99
	Weekend	0.081	0.080	1.03	1.03	1.03
	ADWF[(1)]	0.078	0.078	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.2%			

Notes:

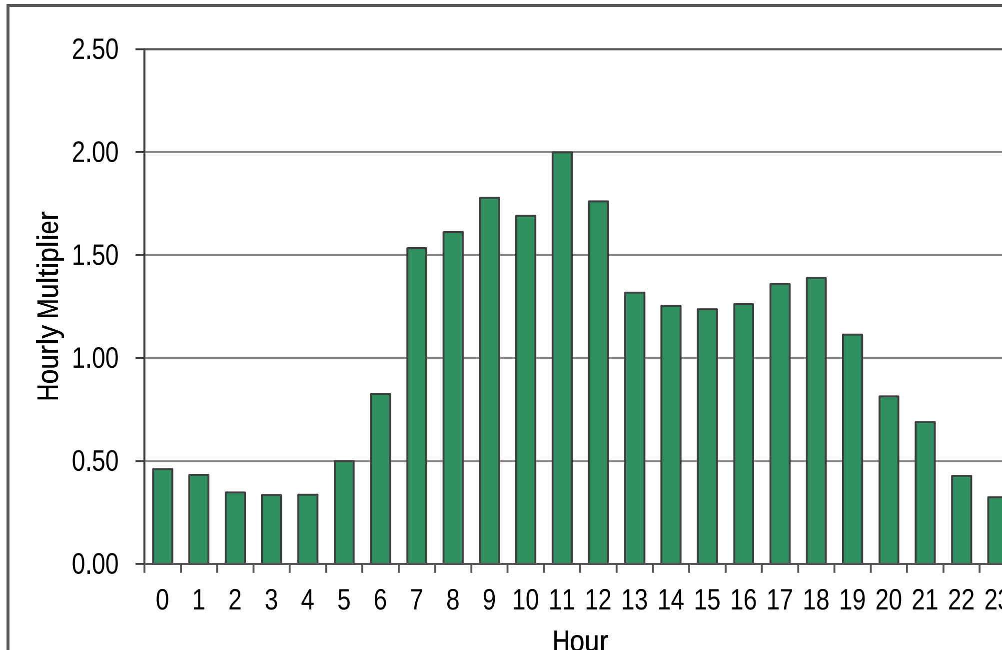
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

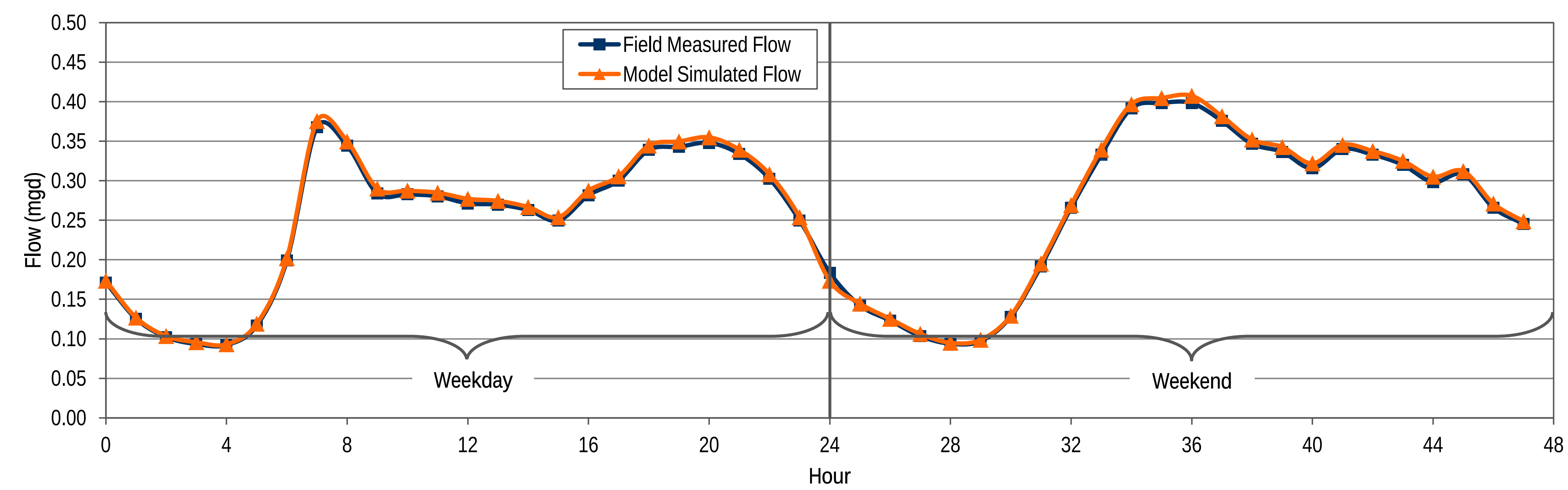
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81A.1 DRY WEATHER CALIBRATION

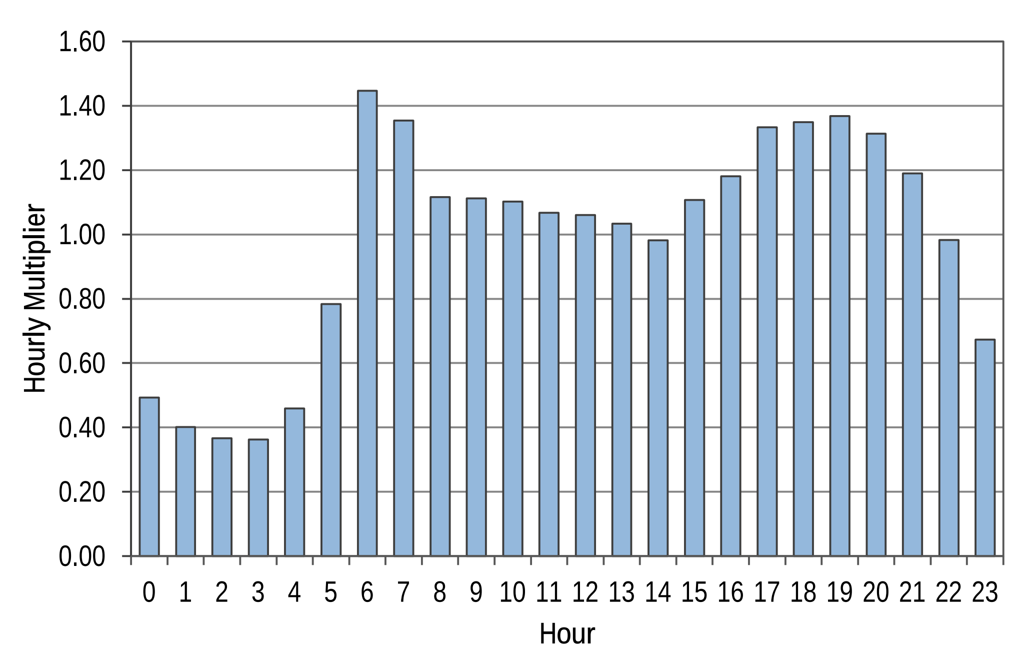
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.171	0.174	0.67	0.49	0.49
	1	0.125	0.127	0.49	0.40	0.40
	2	0.102	0.104	0.40	0.37	0.37
	3	0.093	0.096	0.37	0.36	0.36
	4	0.092	0.093	0.36	0.46	0.46
	5	0.117	0.119	0.46	0.78	0.78
	6	0.199	0.202	0.78	1.45	1.45
	7	0.368	0.376	1.45	1.35	1.35
	8	0.344	0.350	1.35	1.12	1.12
	9	0.284	0.290	1.12	1.11	1.11
	10	0.283	0.287	1.11	1.10	1.10
	11	0.280	0.285	1.10	1.07	1.07
	12	0.271	0.277	1.07	1.06	1.06
	13	0.270	0.275	1.06	1.03	1.03
	14	0.263	0.267	1.03	0.98	0.98
	15	0.249	0.254	0.98	1.11	1.11
	16	0.282	0.287	1.11	1.18	1.18
	17	0.300	0.306	1.18	1.33	1.33
	18	0.339	0.344	1.33	1.35	1.35
	19	0.343	0.350	1.35	1.37	1.37
	20	0.348	0.355	1.37	1.31	1.31
	21	0.334	0.339	1.31	1.19	1.19
	22	0.303	0.308	1.19	0.98	0.98
	23	0.250	0.254	0.98	0.67	0.67
Weekend	24	0.184	0.174	0.72	0.56	0.56
	25	0.142	0.145	0.56	0.48	0.48
	26	0.123	0.125	0.48	0.41	0.41
	27	0.103	0.106	0.41	0.37	0.37
	28	0.094	0.095	0.37	0.38	0.38
	29	0.097	0.099	0.38	0.50	0.50
	30	0.128	0.129	0.50	0.75	0.75
	31	0.192	0.195	0.75	1.05	1.05
	32	0.266	0.269	1.05	1.31	1.31
	33	0.333	0.339	1.31	1.54	1.54
	34	0.391	0.397	1.54	1.57	1.57
	35	0.398	0.405	1.57	1.57	1.57
	36	0.398	0.407	1.57	1.48	1.48
	37	0.376	0.382	1.48	1.36	1.36
	38	0.347	0.352	1.36	1.32	1.32
	39	0.336	0.343	1.32	1.24	1.24
	40	0.316	0.322	1.24	1.34	1.34
	41	0.340	0.345	1.34	1.31	1.31
	42	0.333	0.338	1.31	1.26	1.26
	43	0.320	0.325	1.26	1.17	1.17
	44	0.298	0.305	1.17	1.21	1.21
	45	0.308	0.312	1.21	1.05	1.05
	46	0.266	0.271	1.05	0.96	0.96
	47	0.245	0.249	0.96	0.72	0.72
Average						
	Weekday	0.250	0.255	0.98	0.98	0.98
	Weekend	0.264	0.268	1.04	1.04	1.04
	ADWF[(1)]	0.254	0.259	1.00	1.00	1.00
% Error						
	Weekday		1.8%			
	Weekend		1.5%			

Notes:

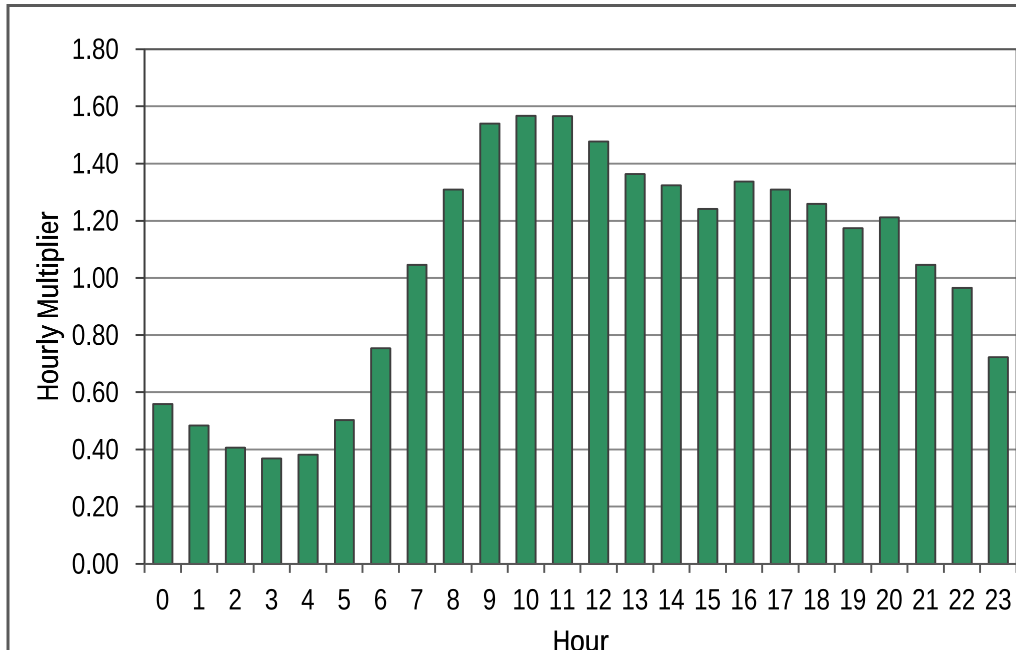
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

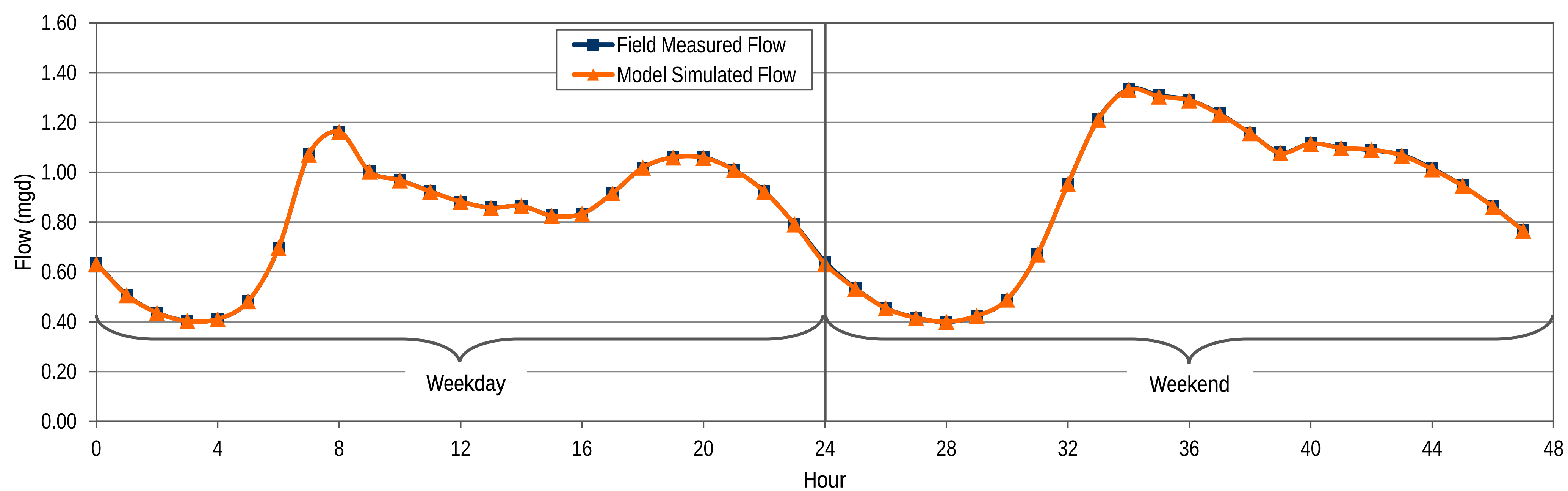
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_81.xlsx

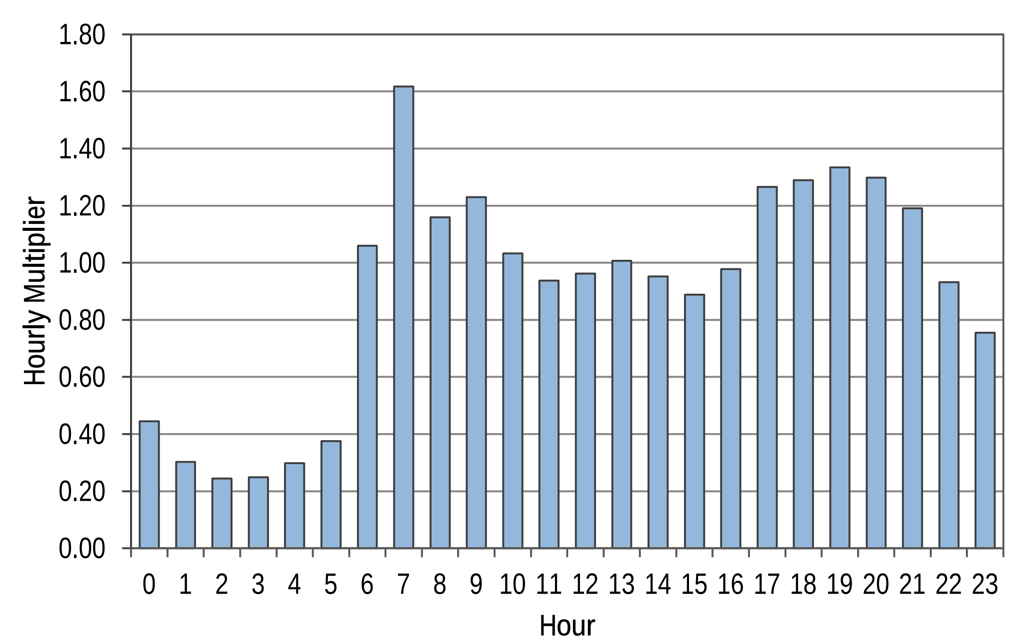
FLOW MONITORING SITE 81B DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.635	0.633	0.75	0.60	0.44
	1	0.508	0.506	0.60	0.52	0.30
	2	0.436	0.435	0.52	0.48	0.24
	3	0.403	0.402	0.48	0.49	0.25
	4	0.411	0.411	0.49	0.57	0.30
	5	0.482	0.482	0.57	0.82	0.38
	6	0.696	0.696	0.82	1.27	1.06
	7	1.072	1.071	1.27	1.38	1.62
	8	1.162	1.162	1.38	1.19	1.16
	9	1.003	1.002	1.19	1.15	1.23
	10	0.969	0.967	1.15	1.09	1.03
	11	0.924	0.922	1.09	1.04	0.94
	12	0.881	0.881	1.04	1.02	0.96
	13	0.859	0.857	1.02	1.02	1.01
	14	0.864	0.864	1.02	0.98	0.95
	15	0.827	0.825	0.98	0.99	0.89
	16	0.834	0.833	0.99	1.08	0.98
	17	0.915	0.915	1.08	1.21	1.27
	18	1.019	1.019	1.21	1.26	1.29
	19	1.060	1.059	1.26	1.26	1.33
	20	1.060	1.058	1.26	1.20	1.30
	21	1.010	1.009	1.20	1.09	1.19
	22	0.923	0.922	1.09	0.94	0.93
	23	0.792	0.791	0.94	0.75	0.75
Weekend	24	0.641	0.633	0.76	0.63	0.44
	25	0.535	0.533	0.63	0.54	0.33
	26	0.455	0.454	0.54	0.49	0.27
	27	0.416	0.415	0.49	0.47	0.14
	28	0.399	0.400	0.47	0.50	0.20
	29	0.423	0.423	0.50	0.58	0.13
	30	0.489	0.489	0.58	0.80	0.44
	31	0.671	0.670	0.80	1.13	1.04
	32	0.953	0.952	1.13	1.44	1.97
	33	1.213	1.211	1.44	1.58	2.55
	34	1.334	1.331	1.58	1.55	2.45
	35	1.309	1.304	1.55	1.53	2.30
	36	1.290	1.289	1.53	1.46	2.16
	37	1.235	1.232	1.46	1.37	1.93
	38	1.157	1.157	1.37	1.28	1.69
	39	1.080	1.077	1.28	1.32	1.79
	40	1.115	1.115	1.32	1.30	1.79
	41	1.099	1.097	1.30	1.29	1.56
	42	1.089	1.090	1.29	1.27	1.55
	43	1.070	1.067	1.27	1.20	1.30
	44	1.016	1.012	1.20	1.12	1.05
	45	0.946	0.946	1.12	1.02	0.91
	46	0.862	0.861	1.02	0.91	0.72
	47	0.766	0.766	0.91	0.76	0.78
Average						
	Weekday	0.823	0.822	0.97	0.97	0.91
	Weekend	0.898	0.897	1.06	1.06	1.23
	ADWF[(1)]	0.844	0.843	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.2%			

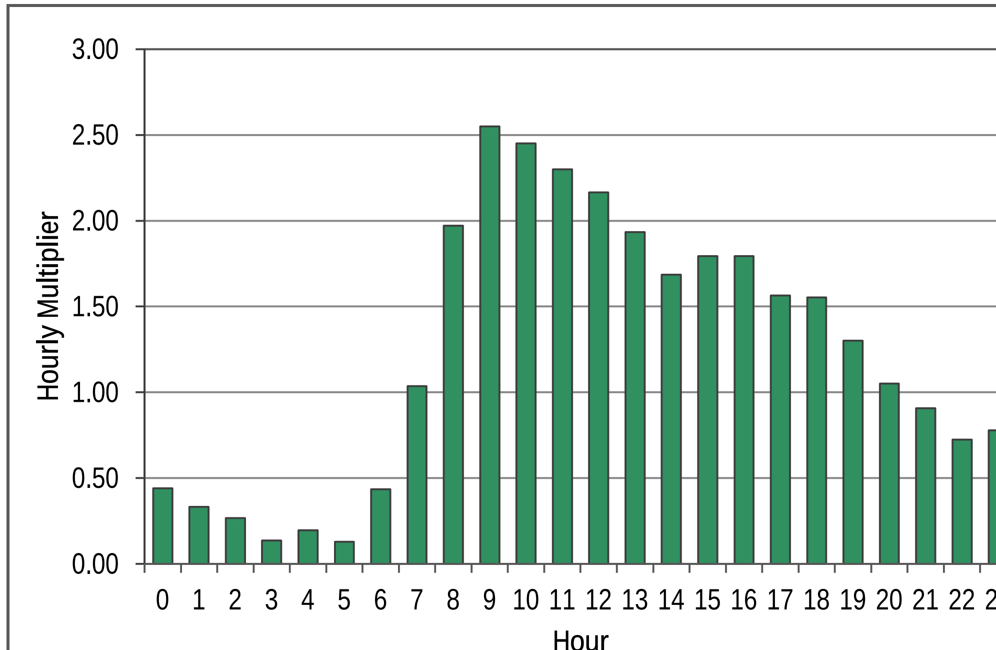
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

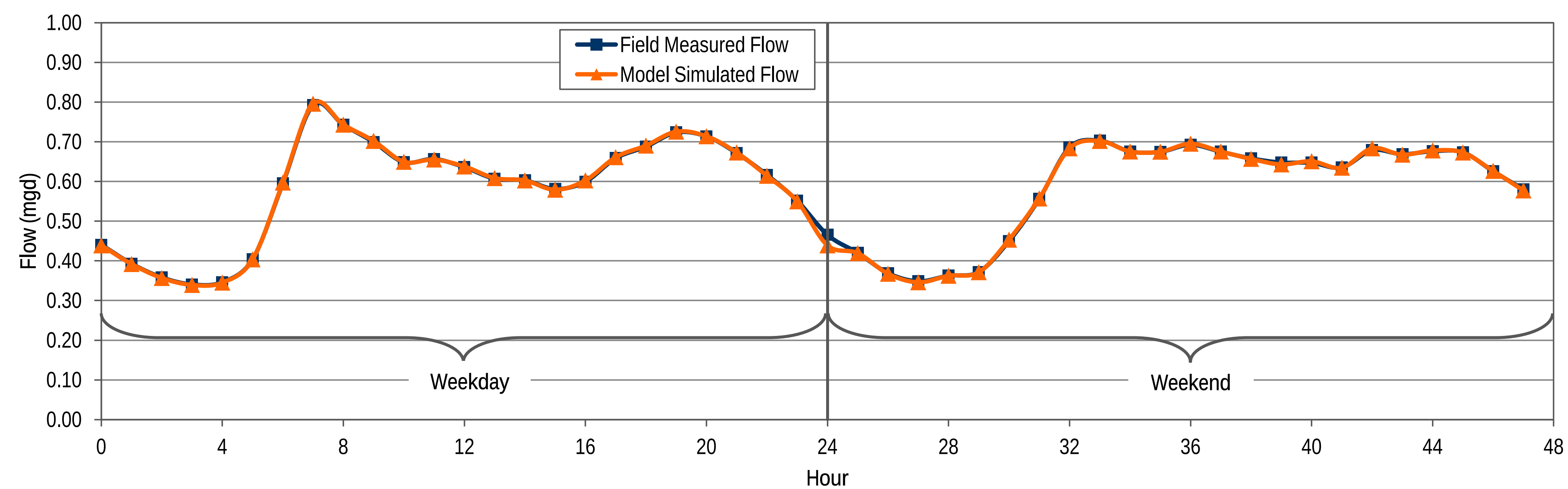
City of Oakland
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81C DRY WEATHER CALIBRATION

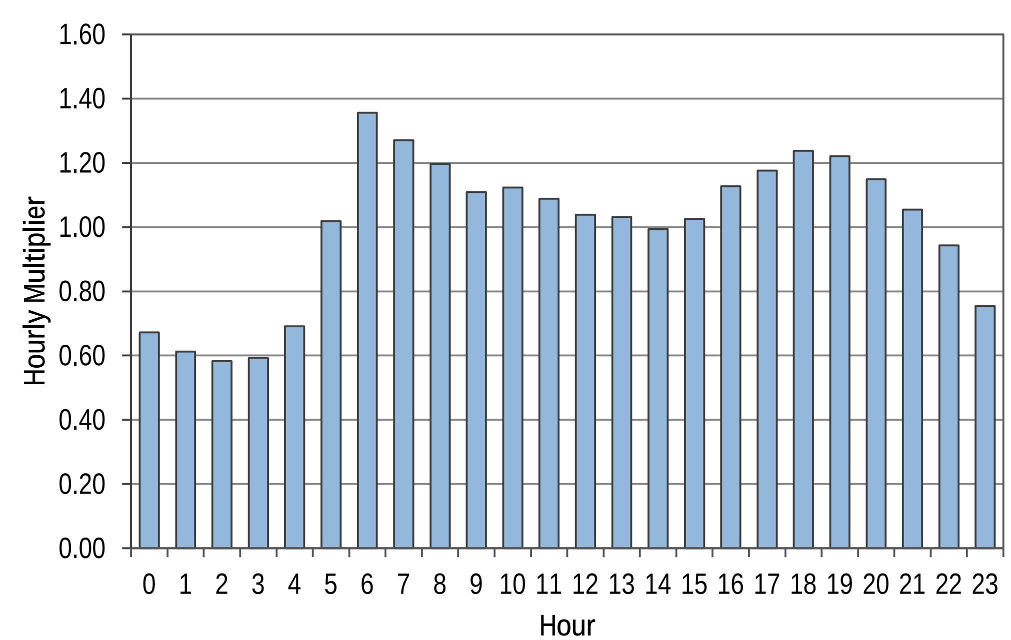
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.440	0.439	0.75	0.67	0.67
	1	0.393	0.392	0.67	0.61	0.61
	2	0.358	0.357	0.61	0.58	0.58
	3	0.341	0.339	0.58	0.59	0.59
	4	0.346	0.345	0.59	0.69	0.69
	5	0.404	0.404	0.69	1.02	1.02
	6	0.595	0.597	1.02	1.36	1.36
	7	0.793	0.796	1.36	1.27	1.27
	8	0.743	0.743	1.27	1.20	1.20
	9	0.700	0.702	1.20	1.11	1.11
	10	0.649	0.650	1.11	1.12	1.12
	11	0.657	0.655	1.12	1.09	1.09
	12	0.636	0.638	1.09	1.04	1.04
	13	0.607	0.609	1.04	1.03	1.03
	14	0.603	0.603	1.03	0.99	0.99
	15	0.581	0.579	0.99	1.03	1.03
	16	0.600	0.603	1.03	1.13	1.13
	17	0.659	0.661	1.13	1.18	1.18
	18	0.688	0.691	1.18	1.24	1.24
	19	0.724	0.726	1.24	1.22	1.22
	20	0.714	0.714	1.22	1.15	1.15
	21	0.672	0.673	1.15	1.05	1.05
	22	0.617	0.614	1.05	0.94	0.94
	23	0.552	0.550	0.94	0.75	0.75
Weekend	24	0.466	0.439	0.80	0.72	0.72
	25	0.420	0.420	0.72	0.63	0.63
	26	0.369	0.368	0.63	0.60	0.60
	27	0.349	0.346	0.60	0.62	0.62
	28	0.363	0.363	0.62	0.64	0.64
	29	0.372	0.372	0.64	0.77	0.77
	30	0.450	0.453	0.77	0.95	0.95
	31	0.556	0.557	0.95	1.17	1.17
	32	0.686	0.684	1.17	1.20	1.20
	33	0.703	0.702	1.20	1.16	1.16
	34	0.676	0.676	1.16	1.15	1.15
	35	0.675	0.675	1.15	1.18	1.18
	36	0.693	0.695	1.18	1.15	1.15
	37	0.675	0.676	1.15	1.13	1.13
	38	0.658	0.657	1.13	1.11	1.11
	39	0.648	0.643	1.11	1.11	1.11
	40	0.647	0.651	1.11	1.09	1.09
	41	0.635	0.635	1.09	1.16	1.16
	42	0.679	0.684	1.16	1.14	1.14
	43	0.669	0.668	1.14	1.16	1.16
	44	0.676	0.678	1.16	1.15	1.15
	45	0.674	0.673	1.15	1.07	1.07
	46	0.626	0.627	1.07	0.99	0.99
	47	0.580	0.578	0.99	0.80	0.80
Average						
	Weekday	0.586	0.587	1.00	1.00	1.00
	Weekend	0.581	0.580	0.99	0.99	0.99
	ADWF[(1)]	0.585	0.585	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.2%			

Notes:

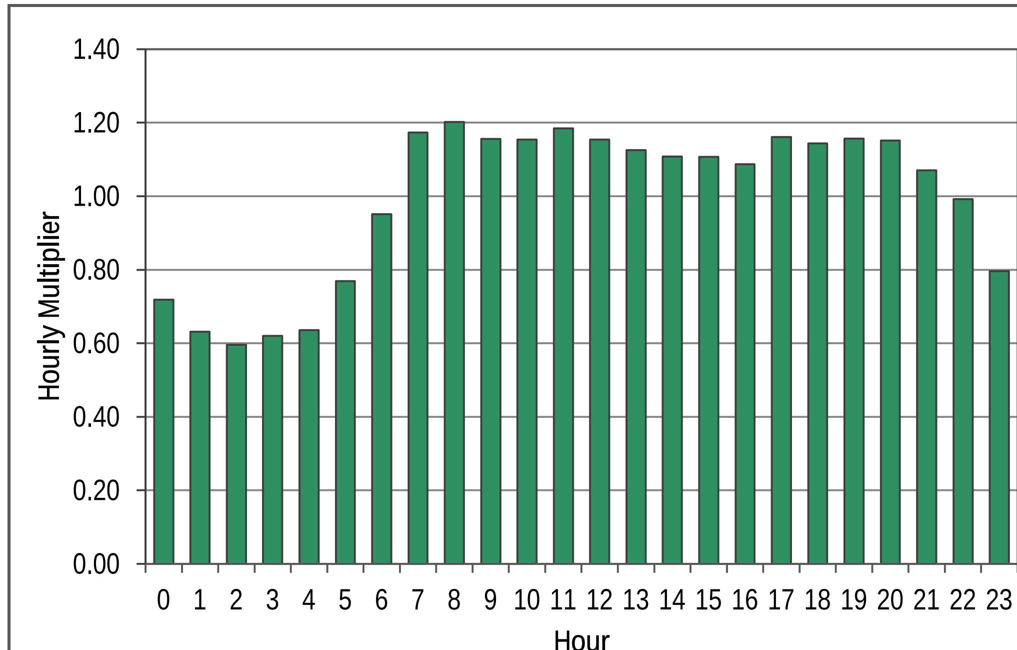
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_81.xlsx

City of Oakland

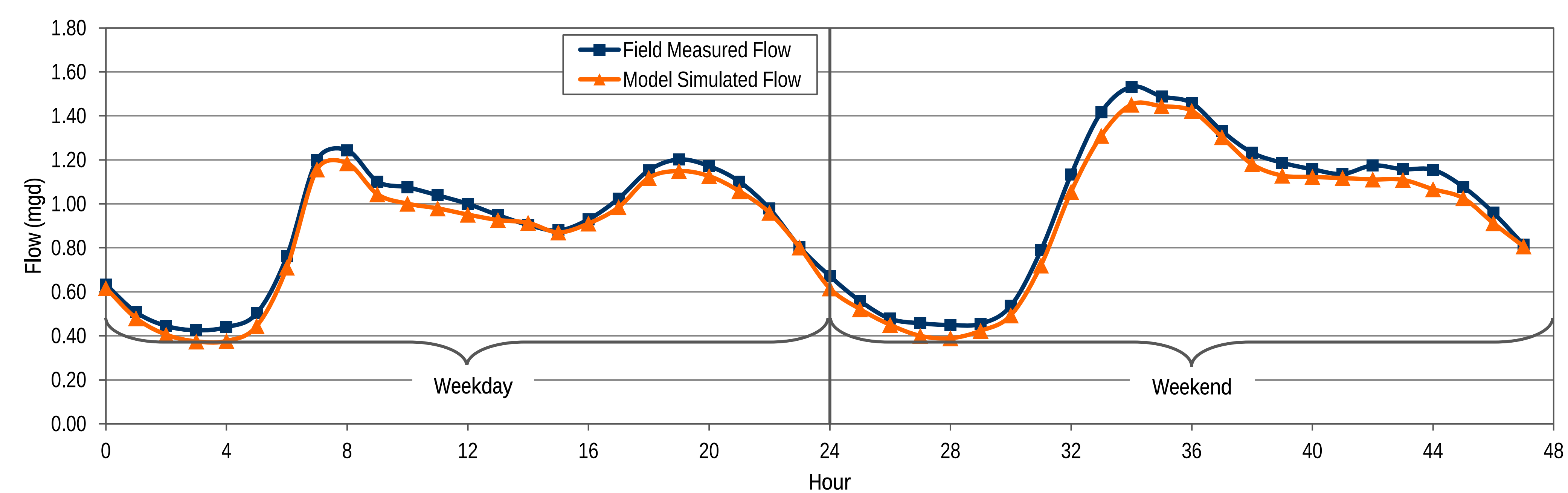
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-1 DRY WEATHER CALIBRATION

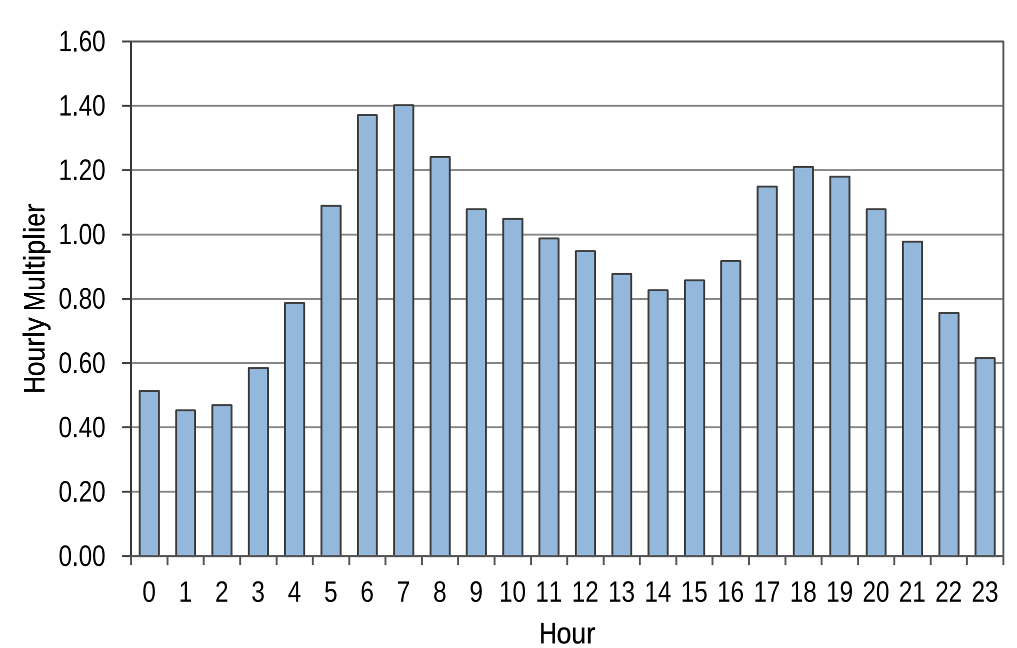
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.634	0.617	0.69	0.55	0.51
	1	0.507	0.480	0.55	0.48	0.45
	2	0.445	0.405	0.48	0.46	0.47
	3	0.426	0.374	0.46	0.48	0.58
	4	0.440	0.377	0.48	0.55	0.79
	5	0.503	0.444	0.55	0.83	1.09
	6	0.762	0.711	0.83	1.30	1.37
	7	1.201	1.157	1.30	1.35	1.40
	8	1.244	1.185	1.35	1.19	1.24
	9	1.102	1.044	1.19	1.17	1.08
	10	1.075	1.001	1.17	1.13	1.05
	11	1.039	0.980	1.13	1.08	0.99
	12	1.000	0.951	1.08	1.03	0.95
	13	0.949	0.927	1.03	0.98	0.88
	14	0.904	0.914	0.98	0.95	0.83
	15	0.879	0.870	0.95	1.01	0.86
	16	0.930	0.911	1.01	1.11	0.92
	17	1.024	0.985	1.11	1.25	1.15
	18	1.152	1.118	1.25	1.30	1.21
	19	1.202	1.149	1.30	1.27	1.18
	20	1.172	1.126	1.27	1.19	1.08
	21	1.101	1.058	1.19	1.06	0.98
	22	0.978	0.960	1.06	0.87	0.76
	23	0.804	0.802	0.87	0.69	0.61
Weekend	24	0.672	0.616	0.73	0.61	0.58
	25	0.559	0.521	0.61	0.52	0.48
	26	0.478	0.450	0.52	0.50	0.45
	27	0.457	0.400	0.50	0.49	0.58
	28	0.450	0.389	0.49	0.49	0.76
	29	0.455	0.423	0.49	0.58	0.91
	30	0.537	0.493	0.58	0.85	1.13
	31	0.789	0.720	0.85	1.23	1.49
	32	1.133	1.055	1.23	1.54	1.85
	33	1.416	1.310	1.54	1.66	1.97
	34	1.532	1.452	1.66	1.61	1.89
	35	1.488	1.444	1.61	1.58	1.78
	36	1.458	1.423	1.58	1.44	1.43
	37	1.331	1.303	1.44	1.34	1.30
	38	1.233	1.180	1.34	1.29	1.26
	39	1.187	1.129	1.29	1.25	1.27
	40	1.157	1.122	1.25	1.23	1.21
	41	1.136	1.117	1.23	1.27	1.18
	42	1.175	1.111	1.27	1.25	1.27
	43	1.157	1.109	1.25	1.25	1.27
	44	1.155	1.067	1.25	1.17	1.26
	45	1.078	1.026	1.17	1.04	1.06
	46	0.960	0.912	1.04	0.88	0.90
	47	0.814	0.807	0.88	0.73	0.67
Average						
	Weekday	0.895	0.856	0.97	0.97	0.93
	Weekend	0.992	0.941	1.08	1.08	1.16
	ADWF[(1)]	0.922	0.880	1.00	1.00	1.00
% Error						
	Weekday		-4.3%			
	Weekend		-5.1%			

Notes:

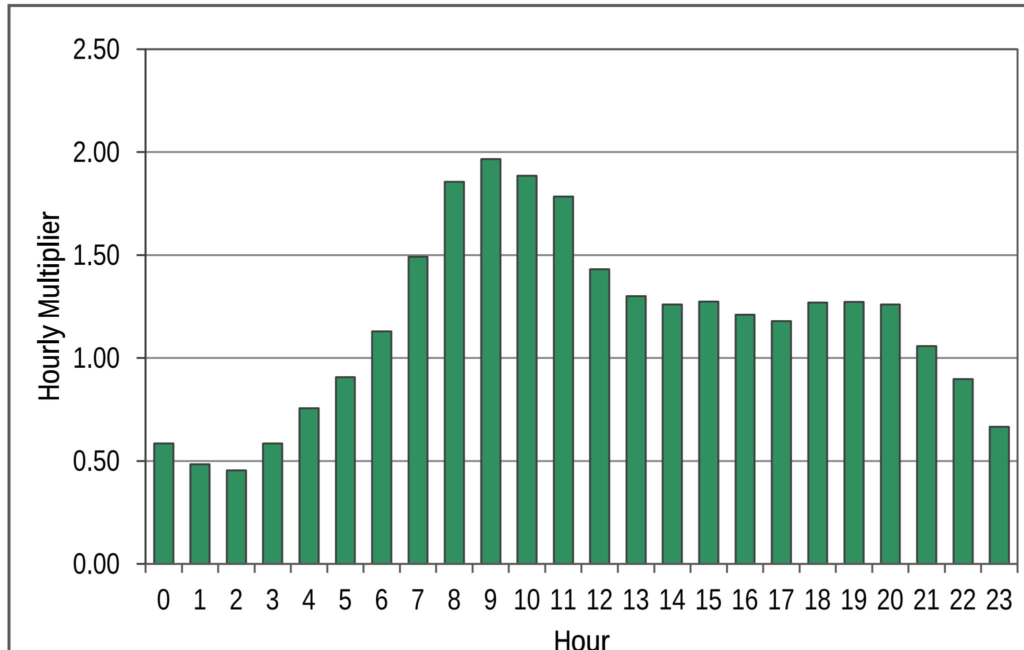
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_81.xlsx

City of Oakland

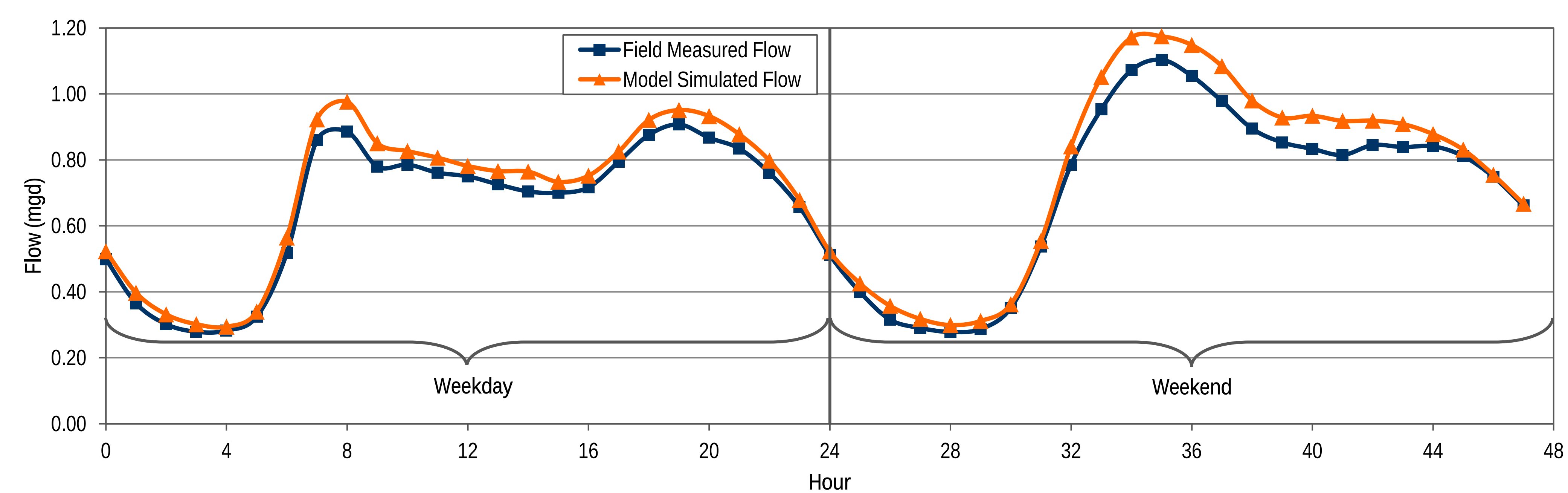
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-2 DRY WEATHER CALIBRATION

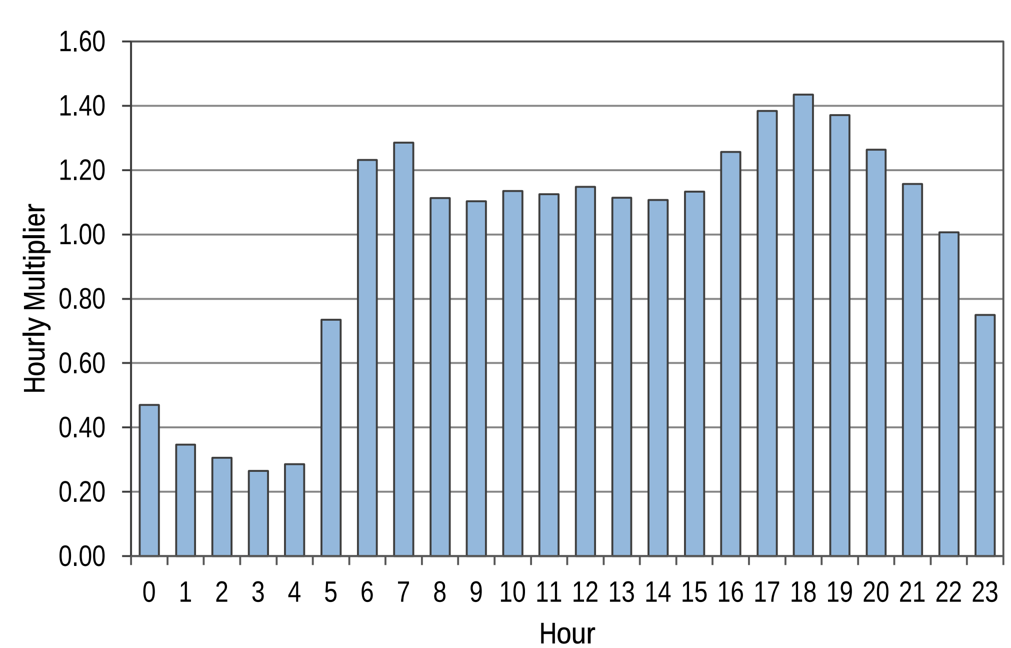
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.499	0.523	0.74	0.54	0.47
	1	0.365	0.397	0.54	0.45	0.35
	2	0.302	0.332	0.45	0.41	0.31
	3	0.279	0.302	0.41	0.42	0.27
	4	0.283	0.295	0.42	0.48	0.29
	5	0.325	0.340	0.48	0.76	0.74
	6	0.518	0.565	0.76	1.27	1.23
	7	0.860	0.923	1.27	1.31	1.29
	8	0.886	0.977	1.31	1.15	1.11
	9	0.780	0.851	1.15	1.16	1.10
	10	0.786	0.827	1.16	1.12	1.14
	11	0.761	0.807	1.12	1.11	1.12
	12	0.750	0.782	1.11	1.07	1.15
	13	0.726	0.766	1.07	1.04	1.11
	14	0.705	0.765	1.04	1.03	1.11
	15	0.700	0.734	1.03	1.06	1.13
	16	0.717	0.752	1.06	1.17	1.26
	17	0.795	0.825	1.17	1.29	1.38
	18	0.876	0.921	1.29	1.34	1.43
	19	0.907	0.951	1.34	1.28	1.37
	20	0.867	0.933	1.28	1.23	1.26
	21	0.834	0.878	1.23	1.12	1.16
	22	0.760	0.798	1.12	0.97	1.01
	23	0.657	0.678	0.97	0.74	0.75
Weekend	24	0.512	0.523	0.76	0.59	0.50
	25	0.400	0.426	0.59	0.47	0.37
	26	0.316	0.358	0.47	0.43	0.31
	27	0.291	0.318	0.43	0.41	0.28
	28	0.279	0.299	0.41	0.42	0.29
	29	0.288	0.312	0.42	0.52	0.31
	30	0.351	0.362	0.52	0.79	0.72
	31	0.537	0.554	0.79	1.16	1.24
	32	0.786	0.841	1.16	1.41	1.51
	33	0.953	1.051	1.41	1.58	1.69
	34	1.072	1.171	1.58	1.63	1.81
	35	1.103	1.175	1.63	1.56	1.67
	36	1.055	1.148	1.56	1.44	1.55
	37	0.978	1.084	1.44	1.32	1.30
	38	0.895	0.980	1.32	1.26	1.28
	39	0.853	0.929	1.26	1.23	1.22
	40	0.834	0.934	1.23	1.20	1.14
	41	0.815	0.918	1.20	1.25	1.17
	42	0.845	0.919	1.25	1.24	1.21
	43	0.839	0.909	1.24	1.24	1.28
	44	0.841	0.878	1.24	1.20	1.28
	45	0.812	0.831	1.20	1.11	1.18
	46	0.749	0.755	1.11	0.98	1.05
	47	0.662	0.667	0.98	0.76	0.81
Average						
	Weekday	0.664	0.705	0.98	0.98	0.98
	Weekend	0.711	0.764	1.05	1.05	1.05
	ADWF[1]	0.678	0.722	1.00	1.00	1.00
% Error						
	Weekday		6.1%			
	Weekend		7.5%			

Notes:

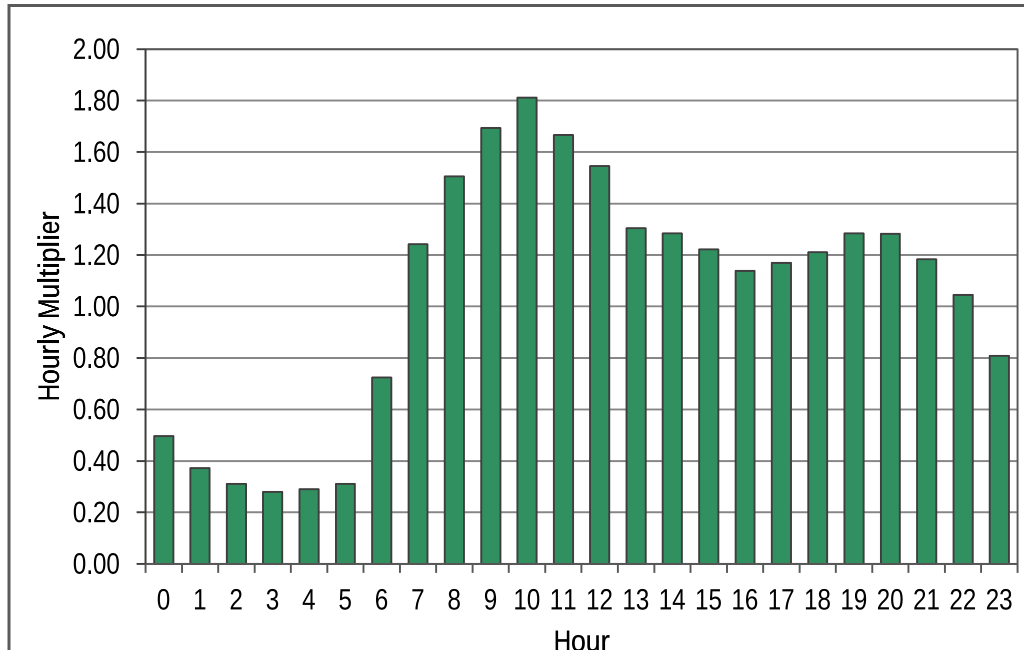
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

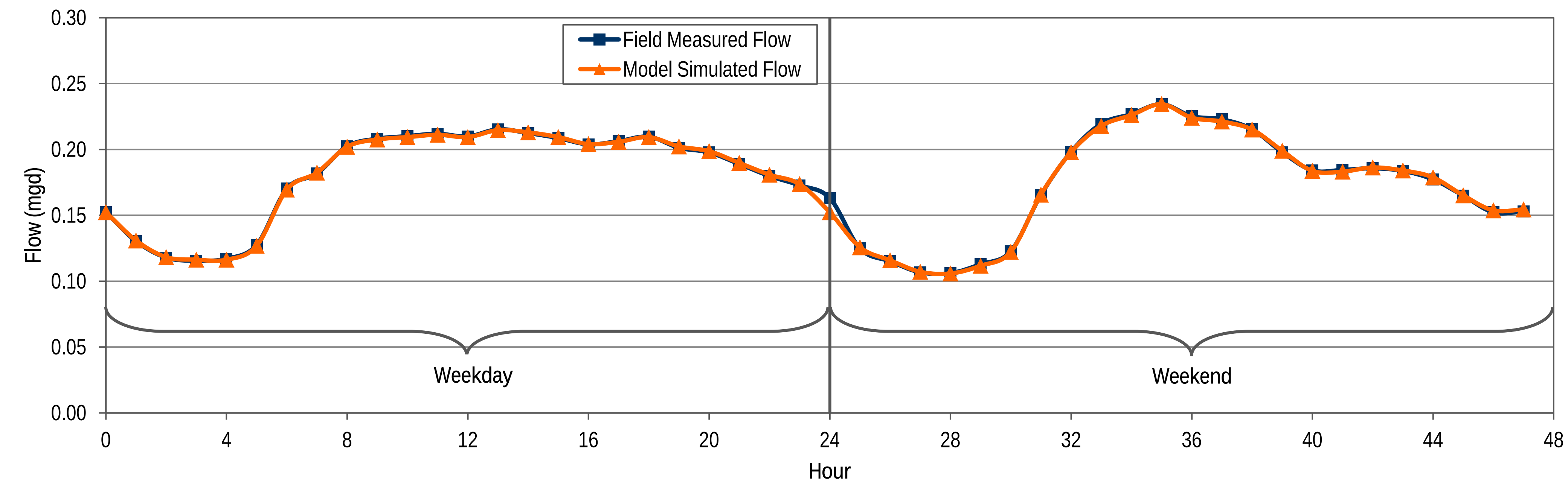
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-3 DRY WEATHER CALIBRATION

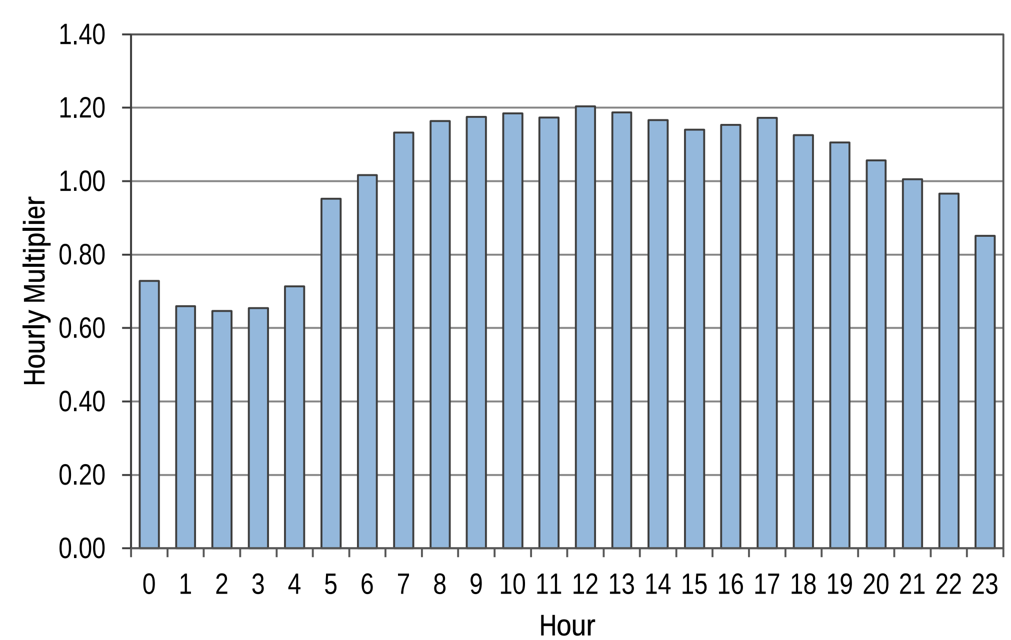
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.152	0.152	0.85	0.73	0.73
	1	0.130	0.131	0.73	0.66	0.66
	2	0.118	0.118	0.66	0.65	0.65
	3	0.116	0.116	0.65	0.65	0.65
	4	0.117	0.116	0.65	0.71	0.71
	5	0.128	0.127	0.71	0.95	0.95
	6	0.170	0.170	0.95	1.02	1.02
	7	0.182	0.182	1.02	1.13	1.13
	8	0.202	0.202	1.13	1.16	1.16
	9	0.208	0.208	1.16	1.17	1.17
	10	0.210	0.209	1.17	1.18	1.18
	11	0.212	0.211	1.18	1.17	1.17
	12	0.210	0.209	1.17	1.20	1.20
	13	0.215	0.215	1.20	1.19	1.19
	14	0.212	0.213	1.19	1.17	1.17
	15	0.209	0.209	1.17	1.14	1.14
	16	0.204	0.204	1.14	1.15	1.15
	17	0.206	0.206	1.15	1.17	1.17
	18	0.210	0.209	1.17	1.13	1.13
	19	0.201	0.202	1.13	1.11	1.11
	20	0.198	0.199	1.11	1.06	1.06
	21	0.189	0.190	1.06	1.01	1.01
	22	0.180	0.181	1.01	0.97	0.97
	23	0.173	0.174	0.97	0.85	0.85
Weekend	24	0.163	0.152	0.91	0.70	0.70
	25	0.125	0.126	0.70	0.64	0.64
	26	0.115	0.116	0.64	0.60	0.60
	27	0.107	0.107	0.60	0.59	0.59
	28	0.106	0.106	0.59	0.63	0.63
	29	0.113	0.112	0.63	0.69	0.69
	30	0.123	0.122	0.69	0.93	0.93
	31	0.165	0.166	0.93	1.11	1.11
	32	0.198	0.198	1.11	1.23	1.23
	33	0.219	0.218	1.23	1.27	1.27
	34	0.227	0.226	1.27	1.31	1.31
	35	0.234	0.234	1.31	1.26	1.26
	36	0.225	0.224	1.26	1.25	1.25
	37	0.223	0.221	1.25	1.20	1.20
	38	0.215	0.215	1.20	1.11	1.11
	39	0.198	0.199	1.11	1.03	1.03
	40	0.184	0.184	1.03	1.03	1.03
	41	0.184	0.183	1.03	1.04	1.04
	42	0.186	0.186	1.04	1.03	1.03
	43	0.184	0.184	1.03	0.99	0.99
	44	0.177	0.179	0.99	0.92	0.92
	45	0.165	0.165	0.92	0.85	0.85
	46	0.152	0.154	0.85	0.86	0.86
	47	0.153	0.155	0.86	0.91	0.91
Average						
Weekday		0.181	0.181	1.01	1.01	1.01
Weekend		0.173	0.172	0.97	0.97	0.97
ADWF[(1)]		0.179	0.179	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			-0.2%			

Notes:

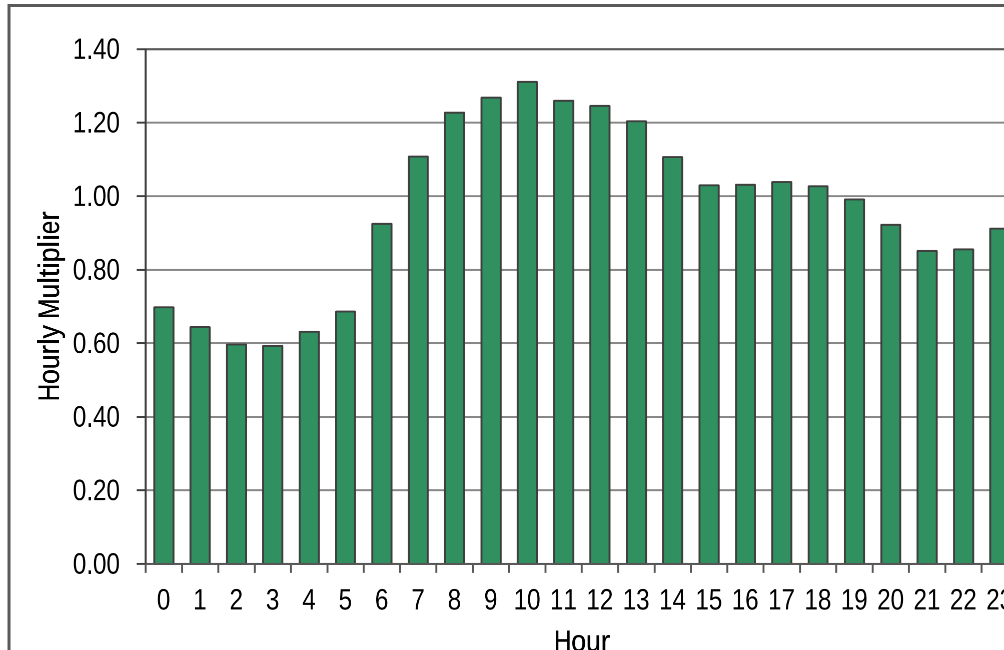
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

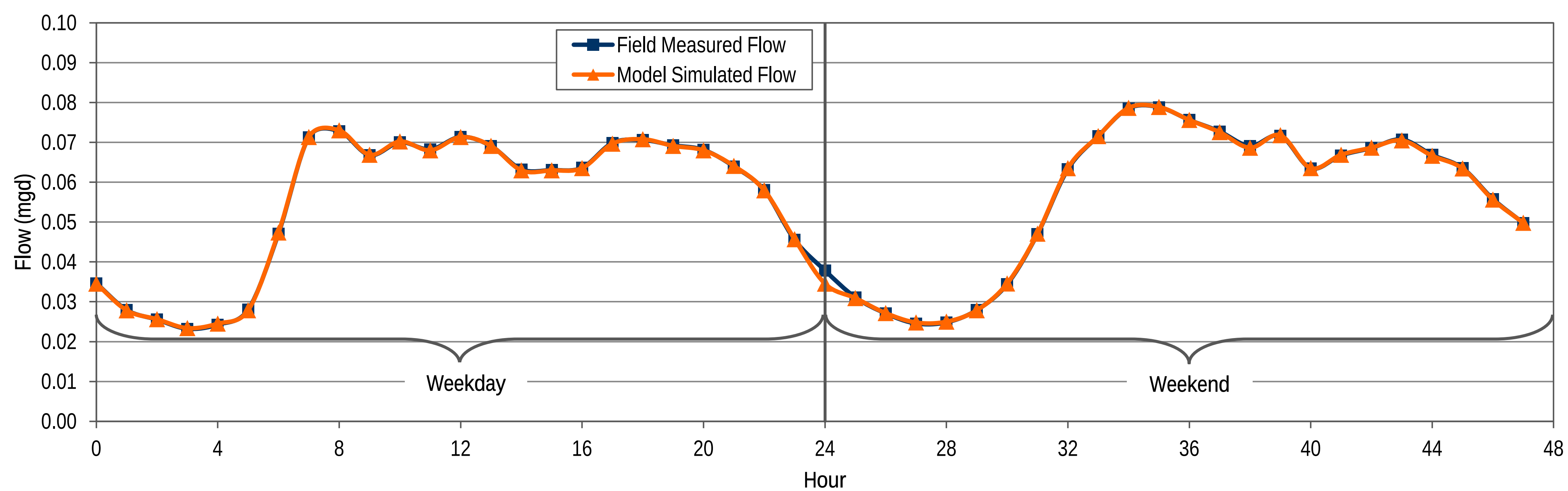
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82A DRY WEATHER CALIBRATION

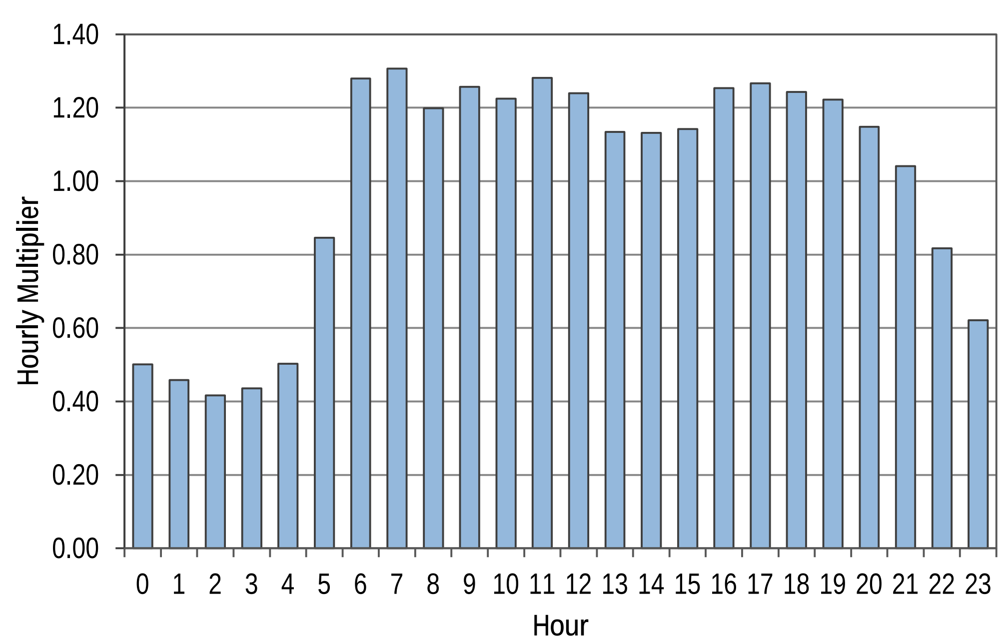
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.035	0.035	0.62	0.50	0.50
	1	0.028	0.028	0.50	0.46	0.46
	2	0.026	0.026	0.46	0.42	0.42
	3	0.023	0.023	0.42	0.44	0.44
	4	0.024	0.025	0.44	0.50	0.50
	5	0.028	0.028	0.50	0.85	0.85
	6	0.047	0.047	0.85	1.28	1.28
	7	0.071	0.071	1.28	1.31	1.31
	8	0.073	0.073	1.31	1.20	1.20
	9	0.067	0.067	1.20	1.26	1.26
	10	0.070	0.070	1.26	1.22	1.22
	11	0.068	0.068	1.22	1.28	1.28
	12	0.071	0.071	1.28	1.24	1.24
	13	0.069	0.069	1.24	1.13	1.13
	14	0.063	0.063	1.13	1.13	1.13
	15	0.063	0.063	1.13	1.14	1.14
	16	0.064	0.064	1.14	1.25	1.25
	17	0.070	0.070	1.25	1.27	1.27
	18	0.071	0.071	1.27	1.24	1.24
	19	0.069	0.069	1.24	1.22	1.22
	20	0.068	0.068	1.22	1.15	1.15
	21	0.064	0.064	1.15	1.04	1.04
	22	0.058	0.058	1.04	0.82	0.82
	23	0.046	0.046	0.82	0.62	0.62
Weekend	24	0.038	0.035	0.68	0.56	0.56
	25	0.031	0.031	0.56	0.49	0.49
	26	0.027	0.027	0.49	0.44	0.44
	27	0.025	0.025	0.44	0.45	0.45
	28	0.025	0.025	0.45	0.50	0.50
	29	0.028	0.028	0.50	0.62	0.62
	30	0.034	0.035	0.62	0.84	0.84
	31	0.047	0.047	0.84	1.13	1.13
	32	0.063	0.064	1.13	1.28	1.28
	33	0.072	0.072	1.28	1.41	1.41
	34	0.079	0.079	1.41	1.41	1.41
	35	0.079	0.079	1.41	1.36	1.36
	36	0.076	0.076	1.36	1.31	1.31
	37	0.073	0.073	1.31	1.24	1.24
	38	0.069	0.069	1.24	1.29	1.29
	39	0.072	0.072	1.29	1.14	1.14
	40	0.063	0.064	1.14	1.20	1.20
	41	0.067	0.067	1.20	1.23	1.23
	42	0.069	0.069	1.23	1.27	1.27
	43	0.071	0.071	1.27	1.20	1.20
	44	0.067	0.067	1.20	1.14	1.14
	45	0.064	0.063	1.14	1.00	1.00
	46	0.056	0.056	1.00	0.89	0.89
	47	0.050	0.050	0.89	0.68	0.68
Average						
	Weekday	0.056	0.056	1.00	1.00	1.00
	Weekend	0.056	0.056	1.00	1.00	1.00
	ADWF[1]	0.056	0.056	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.2%			

Notes:

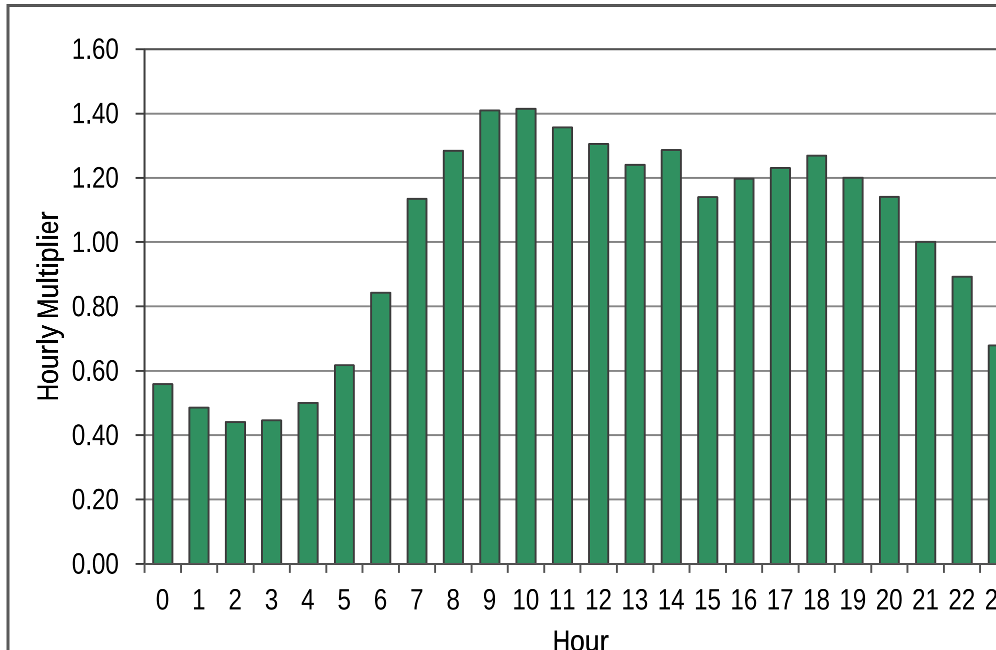
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_82.xlsx

City of Oakland

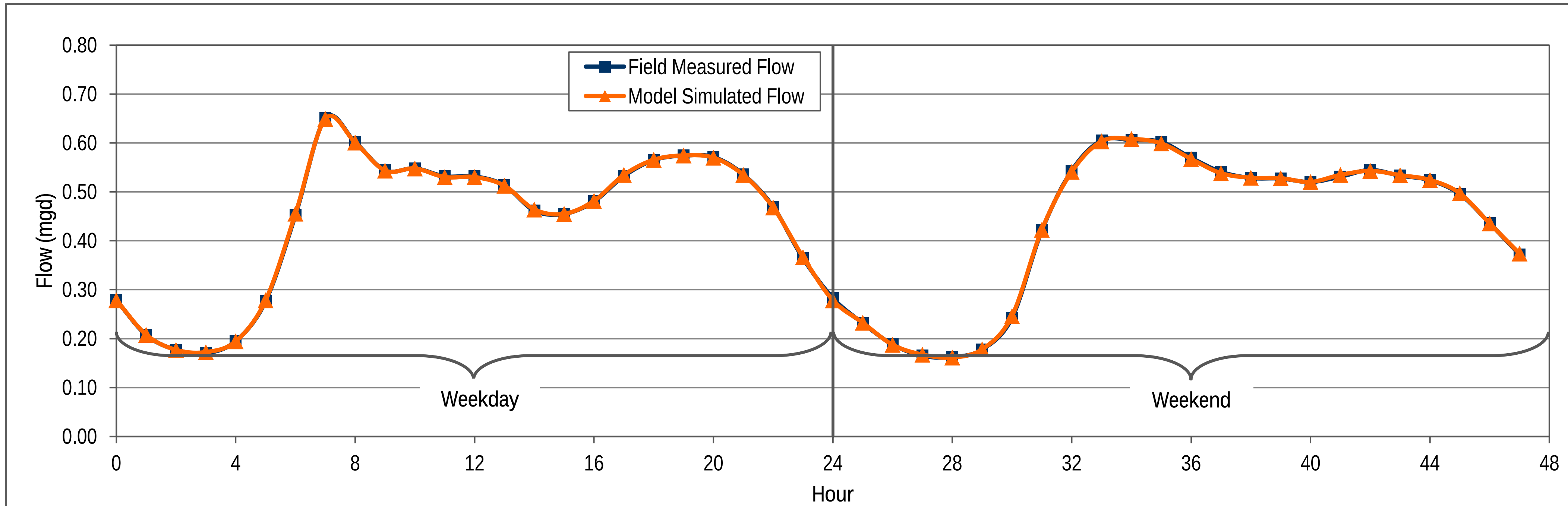
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82B DRY WEATHER CALIBRATION

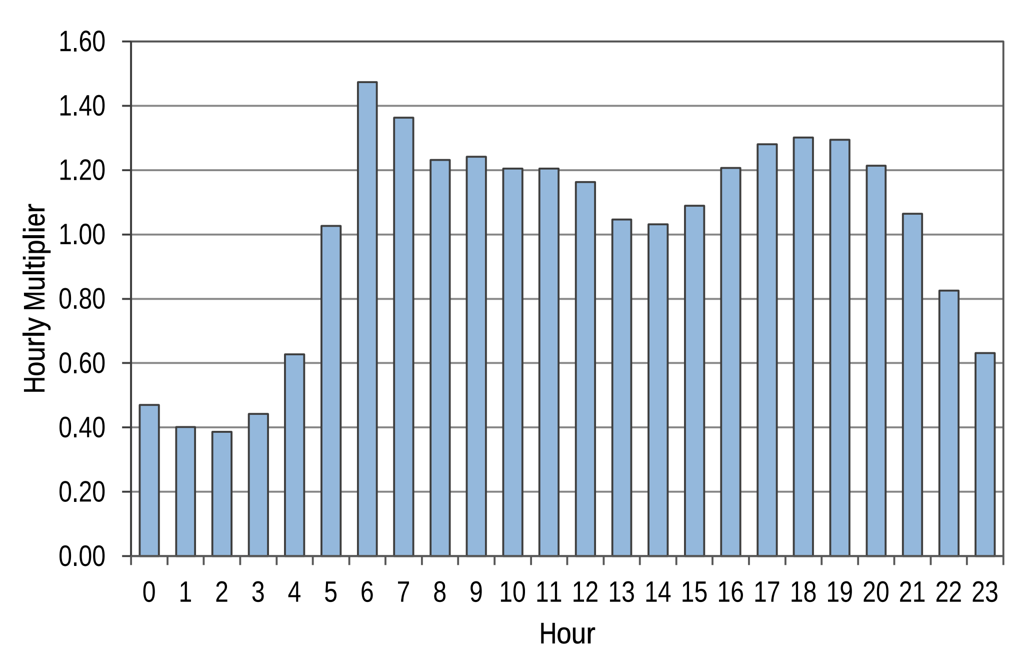
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.279	0.278	0.63	0.47	0.47
	1	0.208	0.208	0.47	0.40	0.40
	2	0.177	0.177	0.40	0.39	0.39
	3	0.171	0.172	0.39	0.44	0.44
	4	0.195	0.195	0.44	0.63	0.63
	5	0.277	0.278	0.63	1.03	1.03
	6	0.453	0.456	1.03	1.47	1.47
	7	0.650	0.649	1.47	1.36	1.36
	8	0.602	0.601	1.36	1.23	1.23
	9	0.544	0.544	1.23	1.24	1.24
	10	0.548	0.548	1.24	1.20	1.20
	11	0.532	0.530	1.20	1.20	1.20
	12	0.532	0.530	1.20	1.16	1.16
	13	0.513	0.513	1.16	1.05	1.05
	14	0.462	0.464	1.05	1.03	1.03
	15	0.455	0.455	1.03	1.09	1.09
	16	0.481	0.482	1.09	1.21	1.21
	17	0.533	0.535	1.21	1.28	1.28
	18	0.565	0.566	1.28	1.30	1.30
	19	0.574	0.574	1.30	1.29	1.29
	20	0.571	0.570	1.29	1.21	1.21
	21	0.536	0.535	1.21	1.06	1.06
	22	0.470	0.468	1.06	0.83	0.83
	23	0.364	0.367	0.83	0.63	0.63
Weekend	24	0.283	0.278	0.64	0.53	0.53
	25	0.232	0.232	0.53	0.43	0.43
	26	0.188	0.187	0.43	0.37	0.37
	27	0.165	0.167	0.37	0.37	0.37
	28	0.163	0.161	0.37	0.40	0.40
	29	0.178	0.178	0.40	0.55	0.55
	30	0.243	0.246	0.55	0.95	0.95
	31	0.421	0.423	0.95	1.23	1.23
	32	0.543	0.541	1.23	1.37	1.37
	33	0.605	0.603	1.37	1.37	1.37
	34	0.606	0.608	1.37	1.36	1.36
	35	0.602	0.599	1.36	1.29	1.29
	36	0.570	0.567	1.29	1.23	1.23
	37	0.541	0.538	1.23	1.20	1.20
	38	0.529	0.529	1.20	1.19	1.19
	39	0.527	0.528	1.19	1.18	1.18
	40	0.520	0.520	1.18	1.20	1.20
	41	0.531	0.535	1.20	1.23	1.23
	42	0.545	0.543	1.23	1.21	1.21
	43	0.533	0.534	1.21	1.19	1.19
	44	0.524	0.524	1.19	1.12	1.12
	45	0.496	0.497	1.12	0.99	0.99
	46	0.436	0.435	0.99	0.84	0.84
	47	0.372	0.374	0.84	0.64	0.64
Average						
	Weekday	0.445	0.446	1.01	1.01	1.01
	Weekend	0.431	0.431	0.98	0.98	0.98
	ADWF[(1)]	0.441	0.441	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

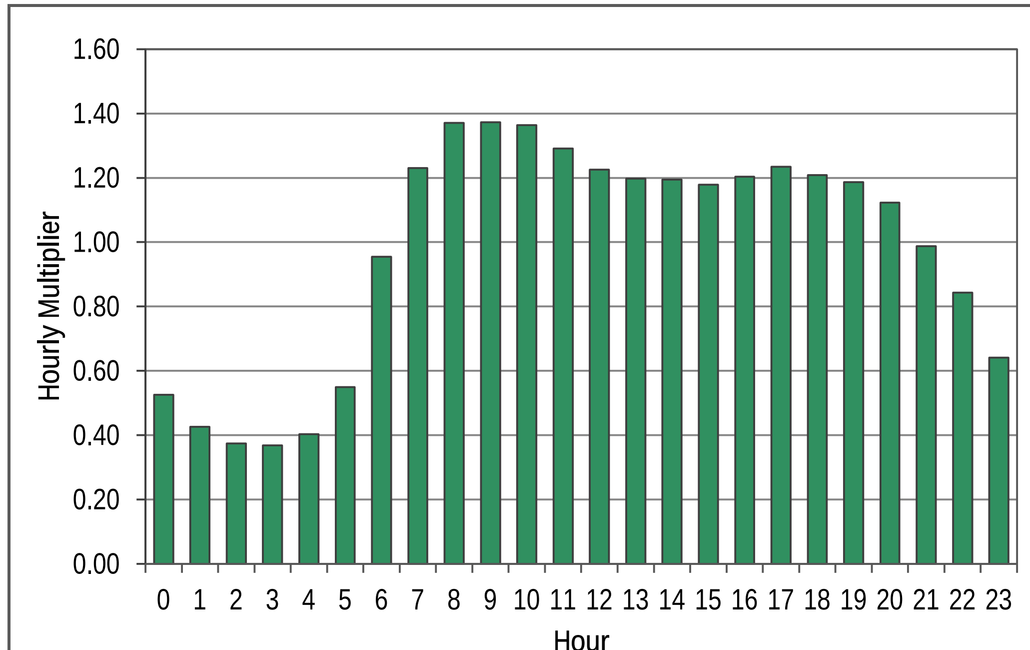
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

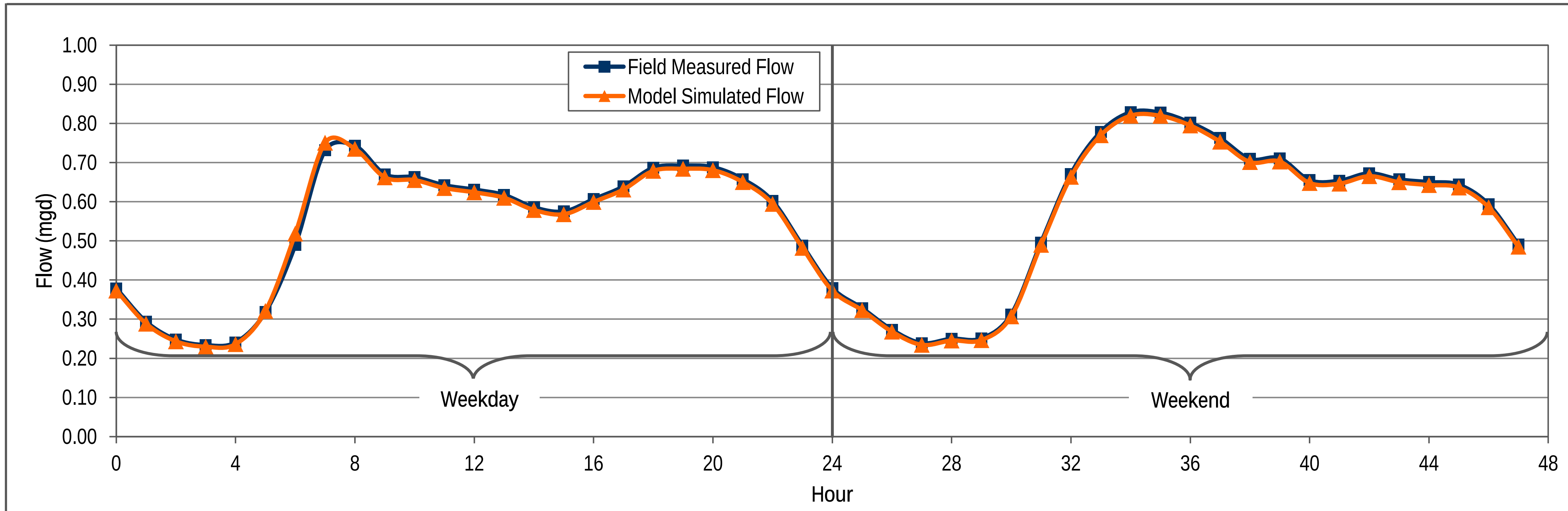
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82U-1 DRY WEATHER CALIBRATION

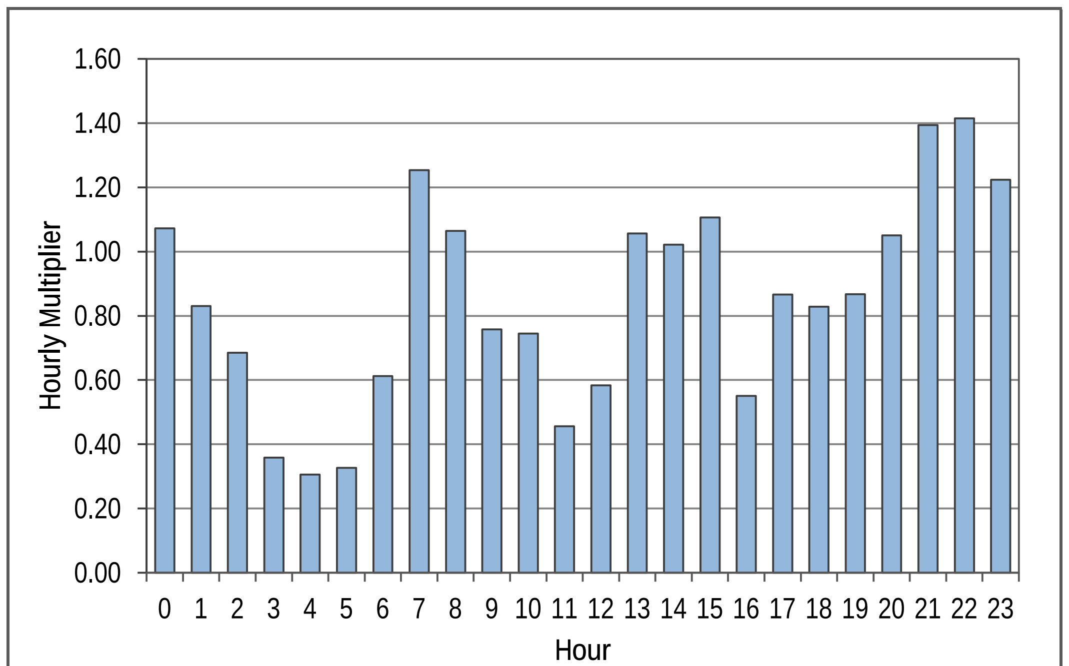
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.379	0.373	0.68	0.53	1.07
	1	0.293	0.289	0.53	0.45	0.83
	2	0.248	0.243	0.45	0.42	0.69
	3	0.234	0.230	0.42	0.44	0.36
	4	0.241	0.236	0.44	0.58	0.31
	5	0.318	0.321	0.58	0.89	0.33
	6	0.490	0.518	0.89	1.32	0.61
	7	0.731	0.751	1.32	1.34	1.25
	8	0.743	0.735	1.34	1.21	1.06
	9	0.670	0.662	1.21	1.20	0.76
	10	0.663	0.655	1.20	1.16	0.75
	11	0.642	0.635	1.16	1.14	0.46
	12	0.631	0.624	1.14	1.12	0.58
	13	0.617	0.610	1.12	1.06	1.06
	14	0.586	0.579	1.06	1.04	1.02
	15	0.575	0.568	1.04	1.10	1.11
	16	0.607	0.600	1.10	1.16	0.55
	17	0.639	0.631	1.16	1.24	0.87
	18	0.687	0.679	1.24	1.25	0.83
	19	0.692	0.684	1.25	1.24	0.87
	20	0.688	0.681	1.24	1.19	1.05
	21	0.658	0.650	1.19	1.09	1.39
	22	0.602	0.595	1.09	0.88	1.42
	23	0.488	0.482	0.88	0.68	1.22
Weekend	24	0.379	0.373	0.69	0.59	1.21
	25	0.328	0.323	0.59	0.49	1.09
	26	0.273	0.268	0.49	0.43	0.86
	27	0.239	0.235	0.43	0.45	1.20
	28	0.250	0.246	0.45	0.45	0.82
	29	0.251	0.246	0.45	0.56	0.55
	30	0.312	0.307	0.56	0.90	0.43
	31	0.496	0.490	0.90	1.21	1.21
	32	0.671	0.664	1.21	1.41	1.95
	33	0.779	0.770	1.41	1.50	2.71
	34	0.829	0.820	1.50	1.50	2.87
	35	0.828	0.820	1.50	1.45	3.07
	36	0.802	0.795	1.45	1.38	2.93
	37	0.763	0.753	1.38	1.28	2.12
	38	0.709	0.701	1.28	1.29	2.11
	39	0.711	0.703	1.29	1.19	1.30
	40	0.655	0.648	1.19	1.18	0.91
	41	0.654	0.646	1.18	1.22	1.09
	42	0.673	0.665	1.22	1.19	0.92
	43	0.657	0.650	1.19	1.18	1.05
	44	0.650	0.643	1.18	1.16	1.54
	45	0.644	0.636	1.16	1.07	1.94
	46	0.594	0.586	1.07	0.89	1.24
	47	0.491	0.485	0.89	0.69	1.24
Average						
Weekday		0.547	0.543	0.99	0.99	0.85
Weekend		0.568	0.561	1.03	1.03	1.52
ADWF[1]		0.553	0.548	1.00	1.00	1.04
% Error						
Weekday			-0.7%			
Weekend			-1.2%			

Notes:

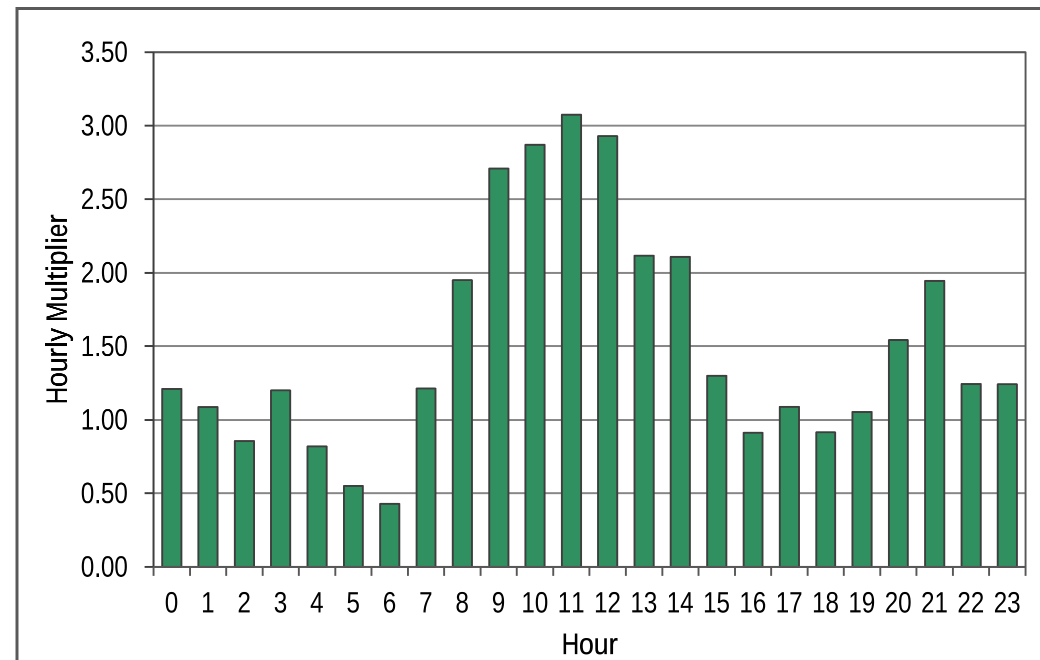
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_82.xlsx

City of Oakland

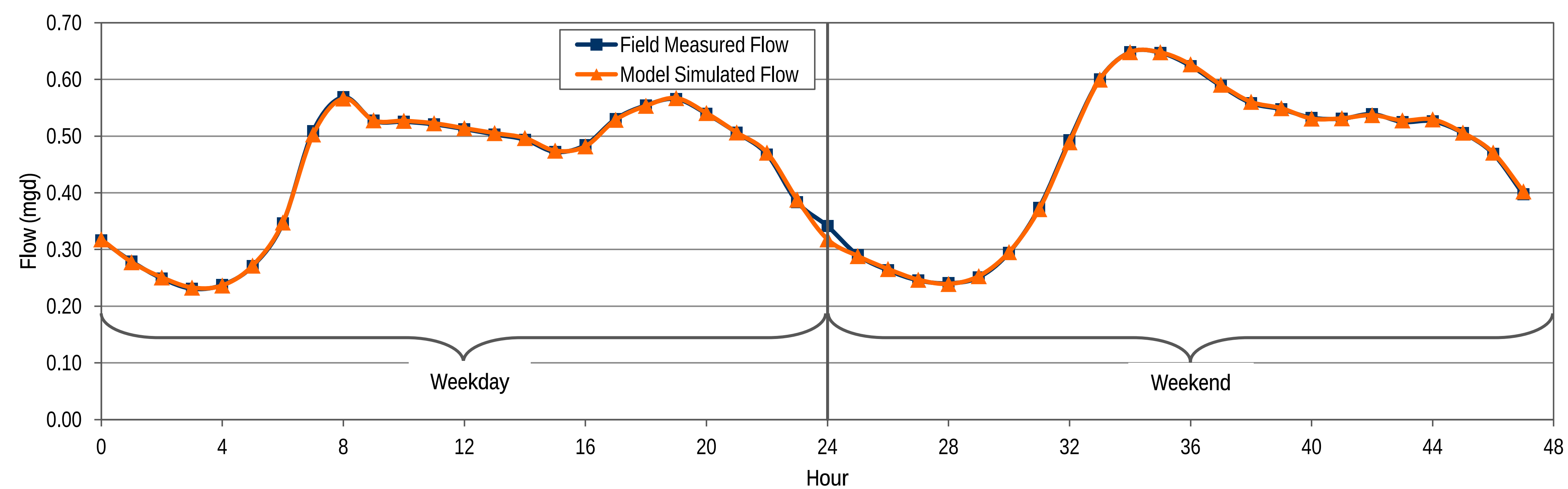
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82L-1 DRY WEATHER CALIBRATION

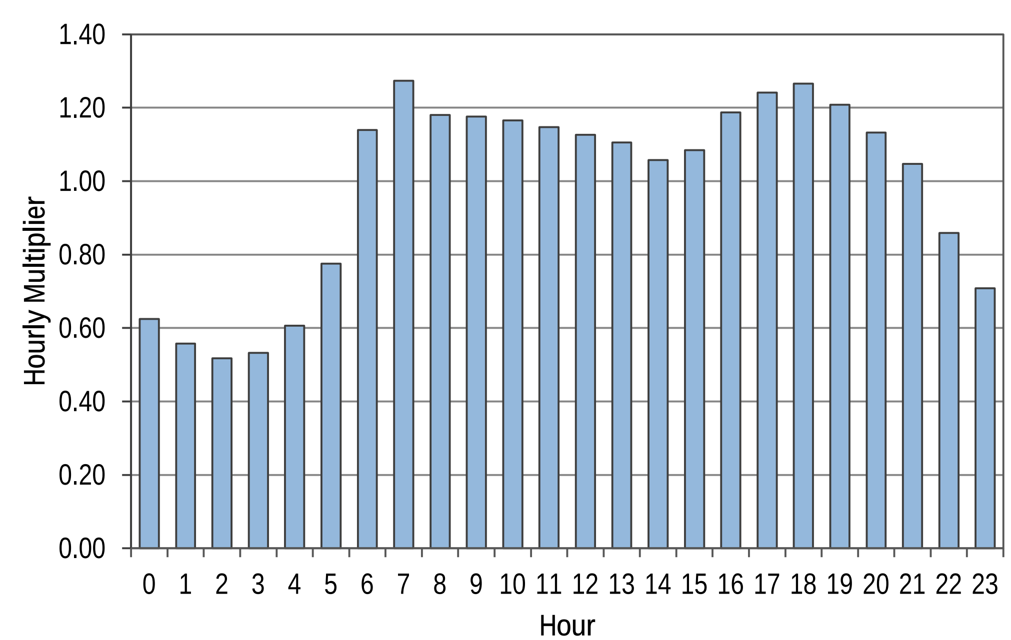
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.316	0.318	0.71	0.62	0.62
	1	0.279	0.278	0.62	0.56	0.56
	2	0.249	0.251	0.56	0.52	0.52
	3	0.231	0.233	0.52	0.53	0.53
	4	0.238	0.237	0.53	0.61	0.61
	5	0.271	0.272	0.61	0.78	0.78
	6	0.346	0.348	0.78	1.14	1.14
	7	0.509	0.503	1.14	1.27	1.27
	8	0.569	0.566	1.27	1.18	1.18
	9	0.527	0.528	1.18	1.18	1.18
	10	0.525	0.527	1.18	1.17	1.17
	11	0.521	0.523	1.17	1.15	1.15
	12	0.512	0.514	1.15	1.13	1.13
	13	0.503	0.505	1.13	1.11	1.11
	14	0.494	0.497	1.11	1.06	1.06
	15	0.472	0.474	1.06	1.08	1.08
	16	0.484	0.482	1.08	1.19	1.19
	17	0.530	0.529	1.19	1.24	1.24
	18	0.554	0.554	1.24	1.27	1.27
	19	0.565	0.567	1.27	1.21	1.21
	20	0.539	0.541	1.21	1.13	1.13
	21	0.506	0.506	1.13	1.05	1.05
	22	0.468	0.471	1.05	0.86	0.86
	23	0.384	0.388	0.86	0.71	0.71
Weekend	24	0.341	0.318	0.76	0.65	0.65
	25	0.290	0.288	0.65	0.59	0.59
	26	0.263	0.266	0.59	0.55	0.55
	27	0.246	0.247	0.55	0.54	0.54
	28	0.241	0.239	0.54	0.56	0.56
	29	0.251	0.253	0.56	0.66	0.66
	30	0.294	0.295	0.66	0.84	0.84
	31	0.374	0.371	0.84	1.10	1.10
	32	0.493	0.489	1.10	1.34	1.34
	33	0.600	0.600	1.34	1.45	1.45
	34	0.648	0.648	1.45	1.45	1.45
	35	0.647	0.648	1.45	1.40	1.40
	36	0.624	0.627	1.40	1.32	1.32
	37	0.589	0.591	1.32	1.25	1.25
	38	0.558	0.560	1.25	1.23	1.23
	39	0.547	0.549	1.23	1.19	1.19
	40	0.532	0.531	1.19	1.19	1.19
	41	0.531	0.531	1.19	1.21	1.21
	42	0.539	0.537	1.21	1.18	1.18
	43	0.525	0.528	1.18	1.18	1.18
	44	0.526	0.530	1.18	1.13	1.13
	45	0.505	0.506	1.13	1.05	1.05
	46	0.469	0.471	1.05	0.89	0.89
	47	0.397	0.402	0.89	0.76	0.76
Average						
	Weekday	0.441	0.442	0.99	0.99	0.99
	Weekend	0.460	0.459	1.03	1.03	1.03
	ADWF[1]	0.447	0.447	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		0.0%			

Notes:

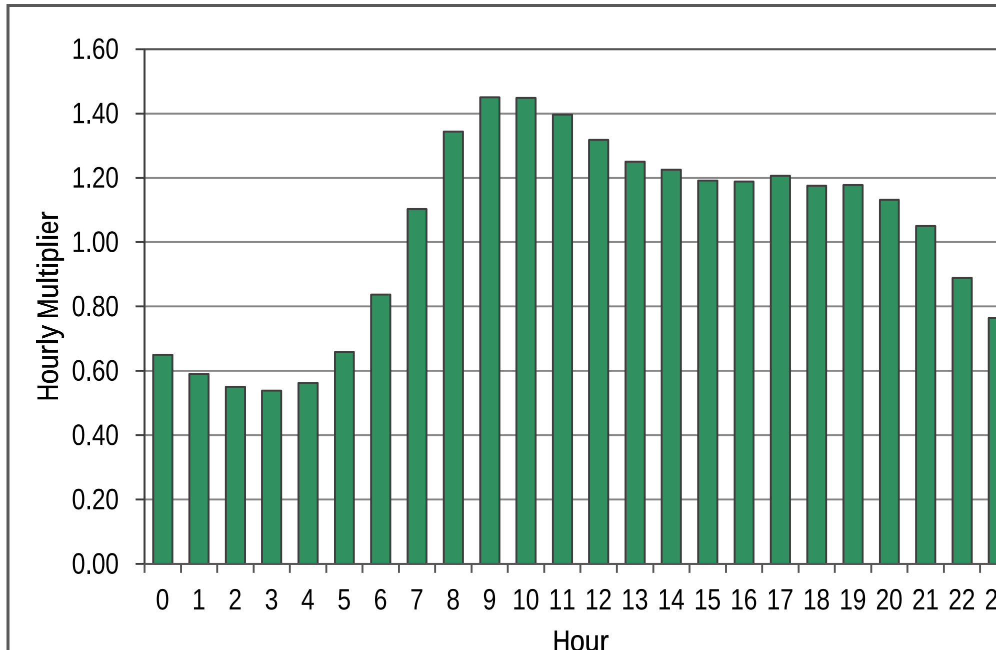
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_82.xlsx

City of Oakland

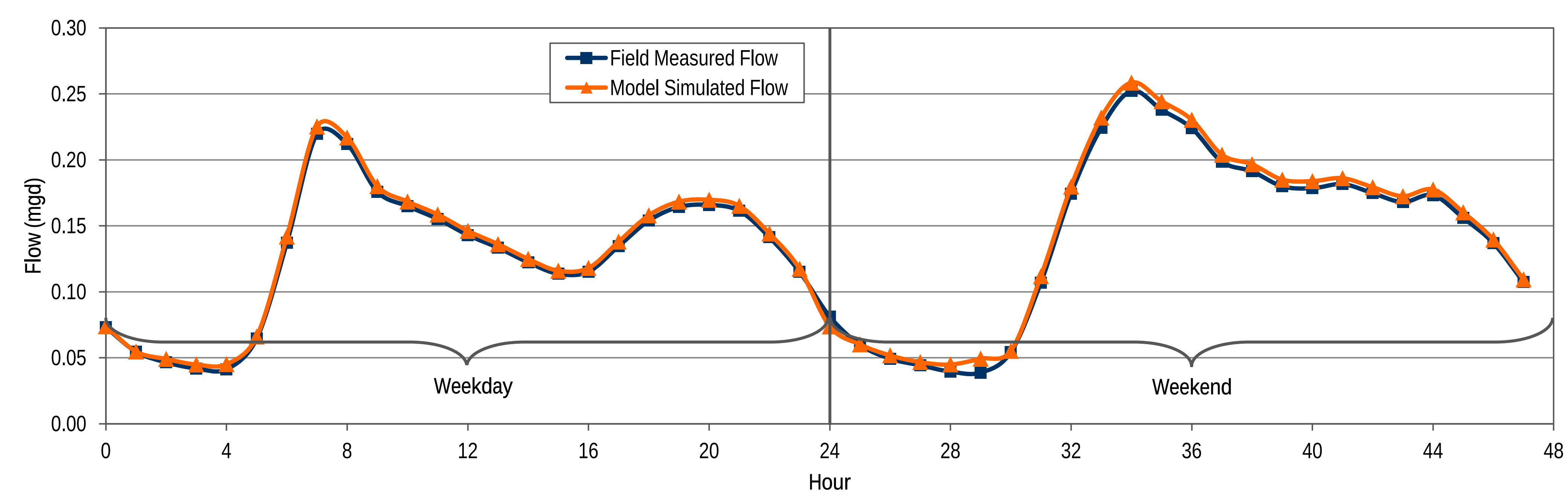
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83B DRY WEATHER CALIBRATION

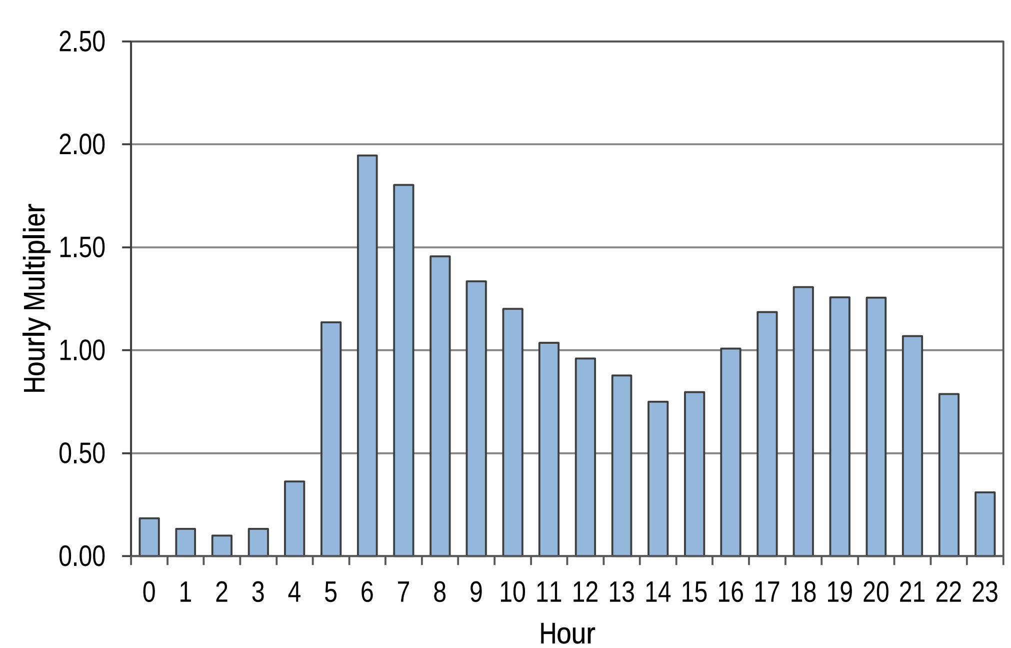
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.073	0.074	0.56	0.41	0.18
	1	0.055	0.055	0.41	0.35	0.13
	2	0.047	0.049	0.35	0.32	0.10
	3	0.042	0.045	0.32	0.31	0.13
	4	0.041	0.045	0.31	0.49	0.36
	5	0.065	0.066	0.49	1.04	1.14
	6	0.137	0.142	1.04	1.67	1.95
	7	0.220	0.225	1.67	1.61	1.80
	8	0.212	0.217	1.61	1.34	1.46
	9	0.176	0.180	1.34	1.25	1.33
	10	0.165	0.168	1.25	1.18	1.20
	11	0.155	0.159	1.18	1.09	1.04
	12	0.143	0.146	1.09	1.01	0.96
	13	0.133	0.136	1.01	0.93	0.88
	14	0.122	0.125	0.93	0.86	0.75
	15	0.114	0.116	0.86	0.88	0.80
	16	0.115	0.118	0.88	1.02	1.01
	17	0.135	0.138	1.02	1.17	1.19
	18	0.154	0.158	1.17	1.25	1.31
	19	0.164	0.168	1.25	1.26	1.26
	20	0.166	0.170	1.26	1.23	1.26
	21	0.161	0.165	1.23	1.07	1.07
	22	0.141	0.144	1.07	0.87	0.79
	23	0.115	0.117	0.87	0.56	0.31
Weekend	24	0.081	0.074	0.62	0.45	0.19
	25	0.060	0.060	0.45	0.37	0.13
	26	0.049	0.052	0.37	0.34	0.08
	27	0.044	0.047	0.34	0.30	0.10
	28	0.040	0.045	0.30	0.29	0.13
	29	0.039	0.049	0.29	0.41	0.17
	30	0.054	0.055	0.41	0.81	0.81
	31	0.107	0.112	0.81	1.32	1.51
	32	0.174	0.180	1.32	1.70	2.08
	33	0.224	0.232	1.70	1.91	2.42
	34	0.252	0.259	1.91	1.81	2.22
	35	0.238	0.244	1.81	1.70	2.06
	36	0.224	0.230	1.70	1.51	1.76
	37	0.199	0.204	1.51	1.45	1.71
	38	0.191	0.197	1.45	1.37	1.62
	39	0.180	0.185	1.37	1.36	1.59
	40	0.179	0.184	1.36	1.38	1.63
	41	0.182	0.186	1.38	1.33	1.49
	42	0.175	0.179	1.33	1.28	1.36
	43	0.168	0.172	1.28	1.32	1.45
	44	0.173	0.178	1.32	1.19	1.24
	45	0.156	0.160	1.19	1.04	1.11
	46	0.137	0.140	1.04	0.82	0.71
	47	0.107	0.109	0.82	0.62	0.44
Average						
	Weekday	0.127	0.130	0.97	0.97	0.93
	Weekend	0.143	0.147	1.09	1.09	1.17
	ADWF[(1)]	0.132	0.135	1.00	1.00	1.00
% Error						
	Weekday		2.5%			
	Weekend		2.9%			

Notes:

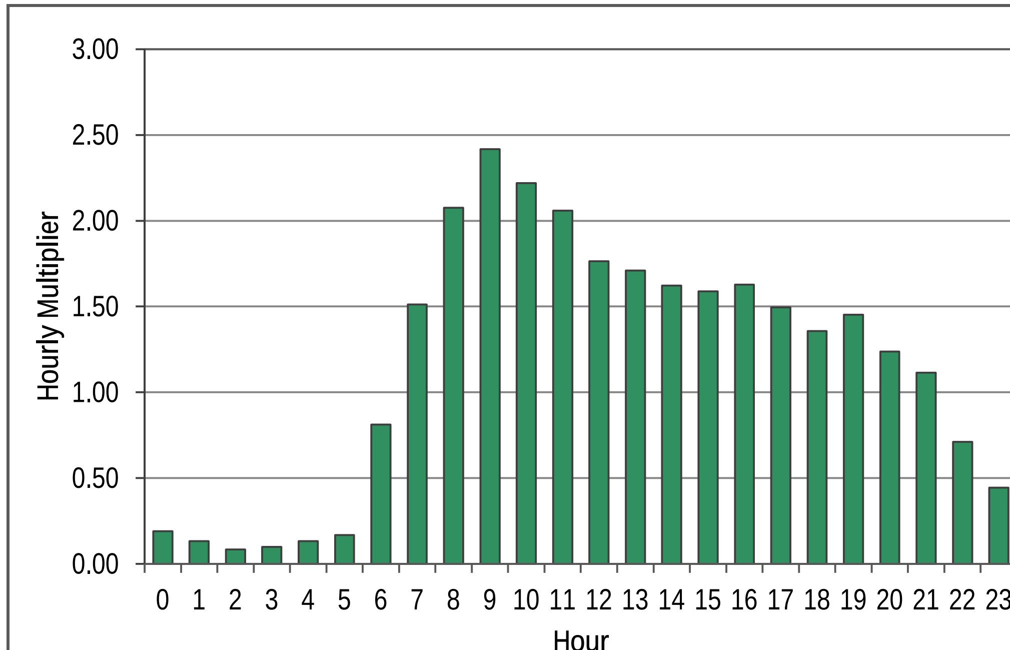
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

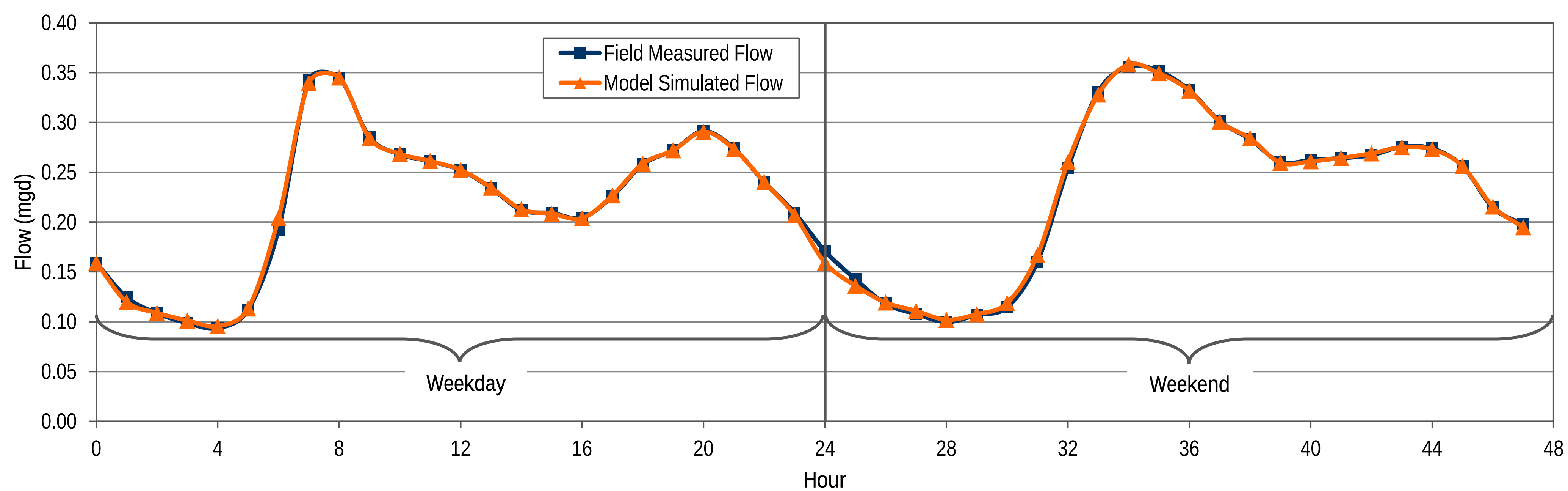
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83B.1 DRY WEATHER CALIBRATION

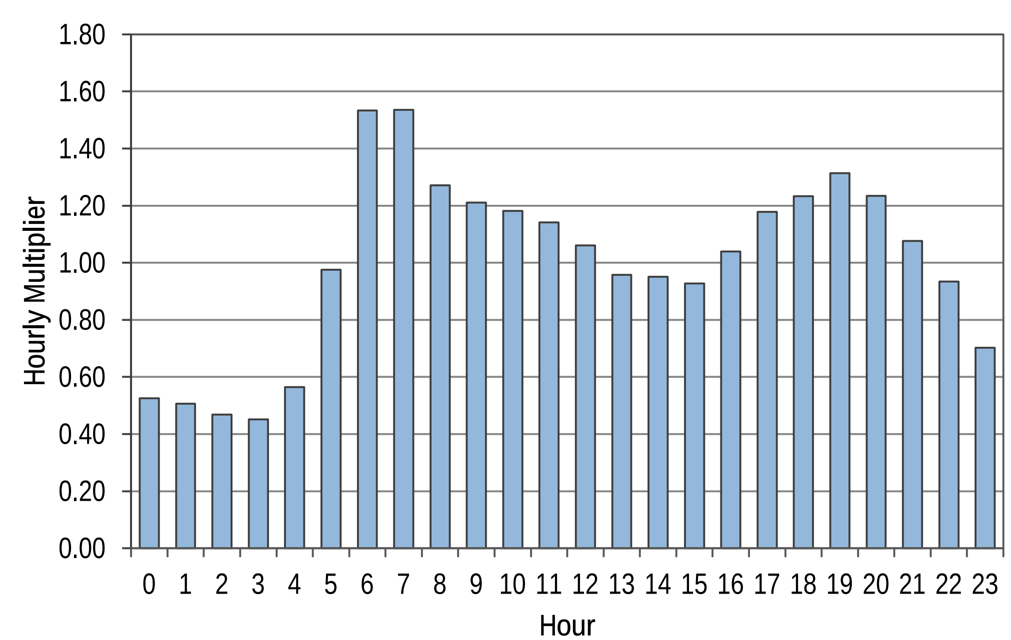
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.159	0.159	0.71	0.56	0.53
	1	0.125	0.120	0.56	0.49	0.51
	2	0.108	0.109	0.49	0.44	0.47
	3	0.099	0.101	0.44	0.42	0.45
	4	0.094	0.096	0.42	0.50	0.56
	5	0.112	0.113	0.50	0.87	0.98
	6	0.192	0.204	0.87	1.54	1.53
	7	0.342	0.340	1.54	1.55	1.54
	8	0.345	0.345	1.55	1.28	1.27
	9	0.285	0.284	1.28	1.20	1.21
	10	0.268	0.269	1.20	1.17	1.18
	11	0.261	0.261	1.17	1.13	1.14
	12	0.252	0.252	1.13	1.05	1.06
	13	0.234	0.235	1.05	0.95	0.96
	14	0.212	0.213	0.95	0.94	0.95
	15	0.209	0.208	0.94	0.92	0.93
	16	0.204	0.204	0.92	1.02	1.04
	17	0.226	0.227	1.02	1.16	1.18
	18	0.258	0.259	1.16	1.22	1.23
	19	0.272	0.272	1.22	1.31	1.31
	20	0.291	0.291	1.31	1.23	1.23
	21	0.274	0.273	1.23	1.08	1.08
	22	0.240	0.240	1.08	0.94	0.93
	23	0.209	0.207	0.94	0.71	0.70
Weekend	24	0.171	0.159	0.77	0.64	0.62
	25	0.143	0.136	0.64	0.53	0.54
	26	0.118	0.119	0.53	0.48	0.51
	27	0.108	0.111	0.48	0.45	0.48
	28	0.100	0.102	0.45	0.48	0.52
	29	0.107	0.108	0.48	0.52	0.57
	30	0.115	0.119	0.52	0.72	0.81
	31	0.160	0.167	0.72	1.14	1.19
	32	0.254	0.260	1.14	1.49	1.48
	33	0.331	0.328	1.49	1.60	1.59
	34	0.356	0.358	1.60	1.58	1.56
	35	0.352	0.349	1.58	1.49	1.48
	36	0.332	0.332	1.49	1.35	1.34
	37	0.301	0.301	1.35	1.27	1.27
	38	0.283	0.284	1.27	1.17	1.17
	39	0.260	0.260	1.17	1.18	1.18
	40	0.262	0.261	1.18	1.19	1.20
	41	0.264	0.264	1.19	1.20	1.21
	42	0.267	0.269	1.20	1.24	1.25
	43	0.275	0.275	1.24	1.23	1.23
	44	0.274	0.273	1.23	1.15	1.16
	45	0.256	0.256	1.15	0.96	0.96
	46	0.215	0.216	0.96	0.89	0.89
	47	0.198	0.195	0.89	0.77	0.67
Average						
	Weekday	0.220	0.220	0.99	0.99	1.00
	Weekend	0.229	0.229	1.03	1.03	1.04
	ADWF(1)	0.222	0.223	1.00	1.00	1.01
% Error						
	Weekday		0.2%			
	Weekend		0.0%			

Notes:

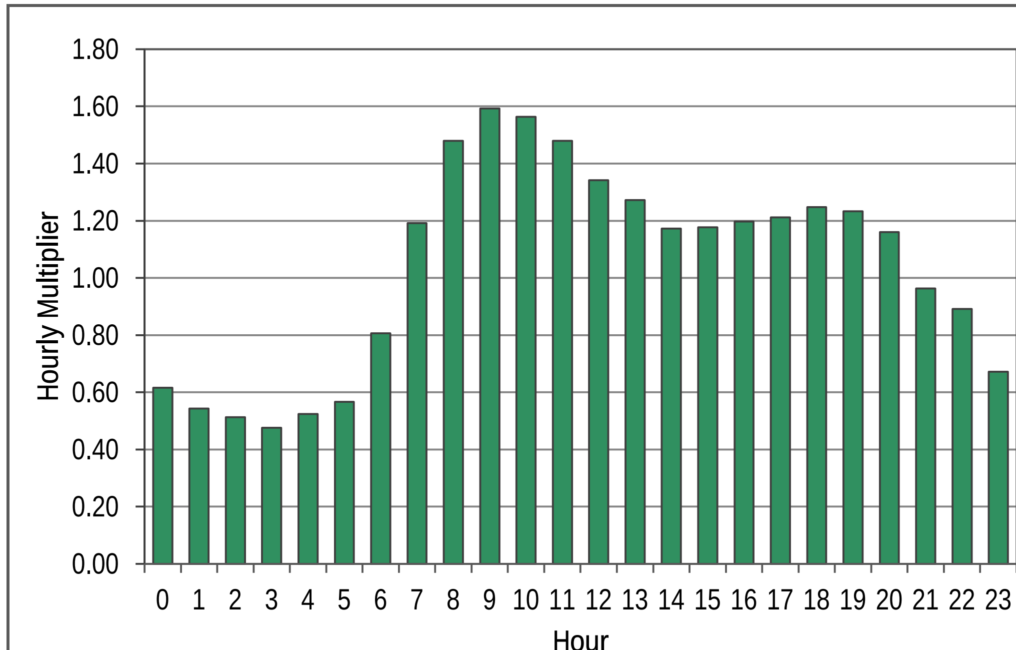
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_83.xlsx

City of Oakland

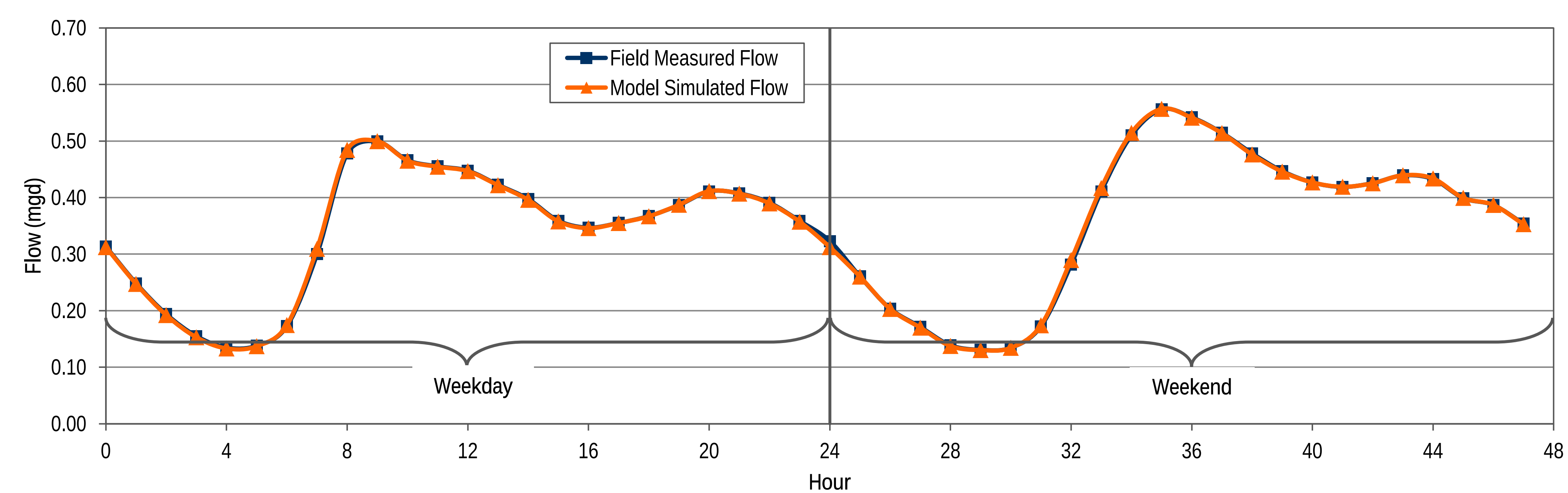
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83C DRY WEATHER CALIBRATION

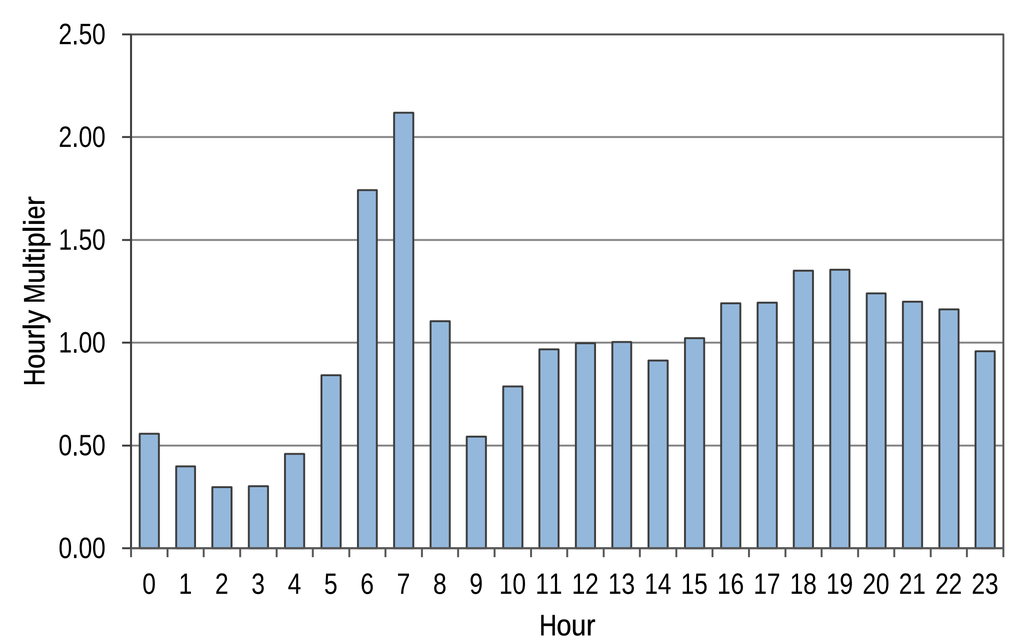
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.313	0.312	0.91	0.72	0.56
	1	0.248	0.247	0.72	0.56	0.40
	2	0.194	0.192	0.56	0.45	0.30
	3	0.155	0.153	0.45	0.39	0.30
	4	0.135	0.133	0.39	0.40	0.46
	5	0.138	0.137	0.40	0.50	0.84
	6	0.173	0.175	0.50	0.87	1.74
	7	0.300	0.309	0.87	1.38	2.12
	8	0.478	0.484	1.38	1.44	1.10
	9	0.499	0.500	1.44	1.35	0.54
	10	0.466	0.465	1.35	1.32	0.79
	11	0.455	0.455	1.32	1.29	0.97
	12	0.448	0.447	1.29	1.22	1.00
	13	0.423	0.422	1.22	1.15	1.00
	14	0.397	0.396	1.15	1.04	0.91
	15	0.359	0.358	1.04	1.00	1.02
	16	0.347	0.346	1.00	1.03	1.19
	17	0.355	0.355	1.03	1.06	1.19
	18	0.367	0.367	1.06	1.12	1.35
	19	0.387	0.387	1.12	1.19	1.36
	20	0.411	0.411	1.19	1.18	1.24
	21	0.408	0.407	1.18	1.13	1.20
	22	0.391	0.390	1.13	1.04	1.16
	23	0.359	0.357	1.04	0.91	0.96
Weekend	24	0.323	0.312	0.93	0.75	0.69
	25	0.261	0.260	0.75	0.59	0.32
	26	0.204	0.203	0.59	0.50	0.31
	27	0.171	0.170	0.50	0.40	0.22
	28	0.139	0.138	0.40	0.38	0.27
	29	0.131	0.130	0.38	0.39	0.35
	30	0.135	0.134	0.39	0.50	0.72
	31	0.172	0.174	0.50	0.81	1.47
	32	0.281	0.290	0.81	1.19	1.67
	33	0.411	0.417	1.19	1.47	1.20
	34	0.510	0.515	1.47	1.61	0.78
	35	0.556	0.557	1.61	1.57	0.72
	36	0.542	0.541	1.57	1.49	0.85
	37	0.515	0.514	1.49	1.38	0.88
	38	0.478	0.476	1.38	1.29	1.13
	39	0.447	0.446	1.29	1.23	1.24
	40	0.427	0.427	1.23	1.21	1.23
	41	0.419	0.419	1.21	1.23	1.42
	42	0.426	0.425	1.23	1.27	1.78
	43	0.439	0.439	1.27	1.25	1.83
	44	0.433	0.434	1.25	1.15	1.56
	45	0.399	0.399	1.15	1.12	1.60
	46	0.387	0.387	1.12	1.02	1.40
	47	0.354	0.353	1.02	0.93	1.09
Average						
	Weekday	0.342	0.342	0.99	0.99	0.99
	Weekend	0.357	0.357	1.03	1.03	1.03
	ADWF[(1)]	0.346	0.346	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

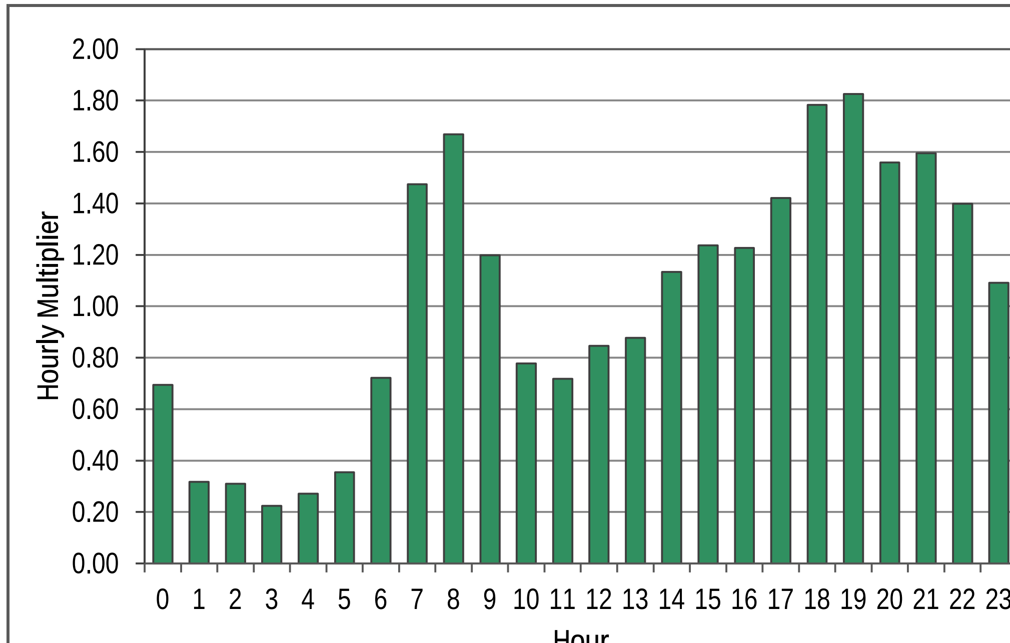
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

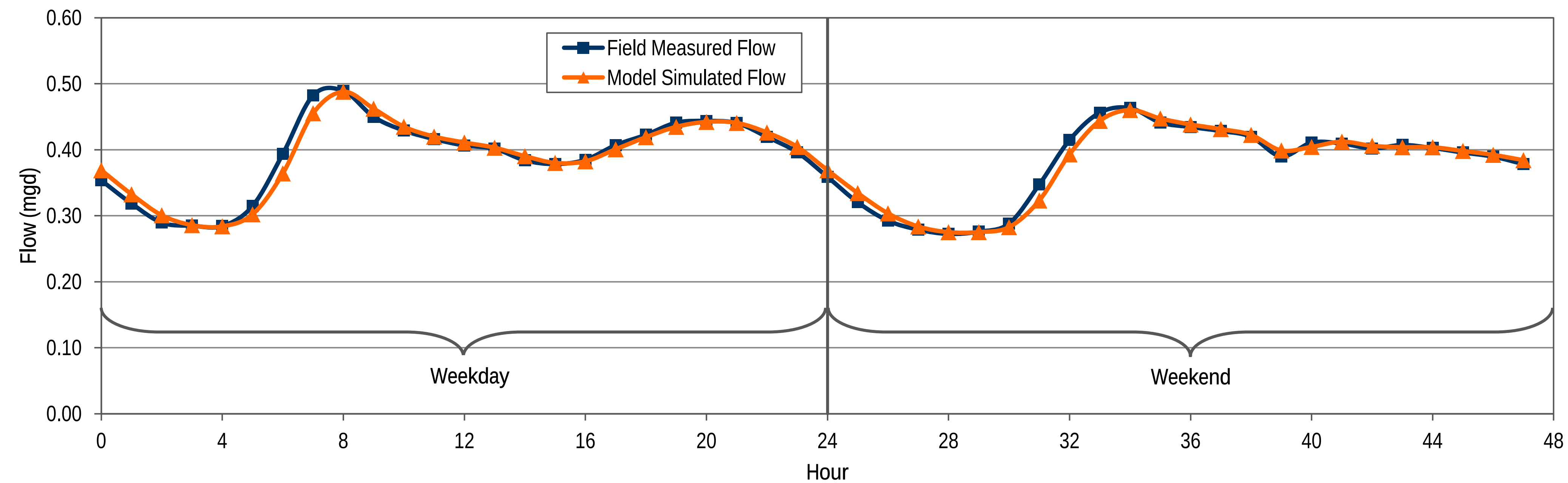
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83D DRY WEATHER CALIBRATION

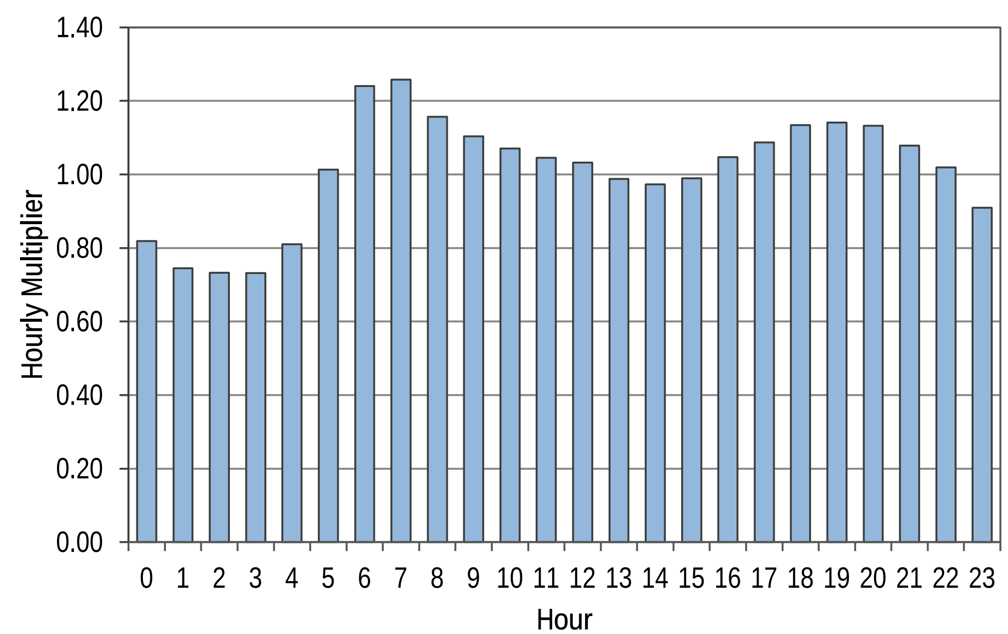
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.354	0.369	0.91	0.82	0.82
	1	0.319	0.332	0.82	0.74	0.74
	2	0.290	0.301	0.74	0.73	0.73
	3	0.285	0.286	0.73	0.73	0.73
	4	0.285	0.284	0.73	0.81	0.81
	5	0.315	0.302	0.81	1.01	1.01
	6	0.394	0.364	1.01	1.24	1.24
	7	0.482	0.455	1.24	1.26	1.26
	8	0.489	0.488	1.26	1.16	1.16
	9	0.450	0.462	1.16	1.10	1.10
	10	0.429	0.435	1.10	1.07	1.07
	11	0.416	0.420	1.07	1.05	1.05
	12	0.407	0.411	1.05	1.03	1.03
	13	0.402	0.403	1.03	0.99	0.99
	14	0.384	0.390	0.99	0.97	0.97
	15	0.378	0.380	0.97	0.99	0.99
	16	0.385	0.382	0.99	1.05	1.05
	17	0.407	0.401	1.05	1.09	1.09
	18	0.423	0.419	1.09	1.13	1.13
	19	0.441	0.435	1.13	1.14	1.14
	20	0.444	0.442	1.14	1.13	1.13
	21	0.440	0.441	1.13	1.08	1.08
	22	0.420	0.426	1.08	1.02	1.02
	23	0.396	0.404	1.02	0.91	0.91
Weekend	24	0.359	0.369	0.92	0.82	0.82
	25	0.320	0.334	0.82	0.75	0.75
	26	0.293	0.304	0.75	0.72	0.72
	27	0.279	0.284	0.72	0.70	0.70
	28	0.273	0.275	0.70	0.71	0.71
	29	0.276	0.275	0.71	0.74	0.74
	30	0.288	0.283	0.74	0.89	0.89
	31	0.347	0.323	0.89	1.07	1.07
	32	0.415	0.393	1.07	1.17	1.17
	33	0.456	0.444	1.17	1.19	1.19
	34	0.463	0.460	1.19	1.14	1.14
	35	0.441	0.447	1.14	1.12	1.12
	36	0.435	0.438	1.12	1.10	1.10
	37	0.428	0.431	1.10	1.08	1.08
	38	0.420	0.423	1.08	1.00	1.00
	39	0.390	0.399	1.00	1.06	1.06
	40	0.411	0.404	1.06	1.05	1.05
	41	0.409	0.412	1.05	1.03	1.03
	42	0.402	0.406	1.03	1.05	1.05
	43	0.407	0.404	1.05	1.04	1.04
	44	0.403	0.404	1.04	1.02	1.02
	45	0.396	0.398	1.02	1.00	1.00
	46	0.390	0.392	1.00	0.97	0.97
	47	0.378	0.384	0.97	0.92	0.92
Average						
	Weekday	0.393	0.393	1.01	1.01	1.01
	Weekend	0.378	0.379	0.97	0.97	0.97
	ADWF[1]	0.389	0.389	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.1%			

Notes:

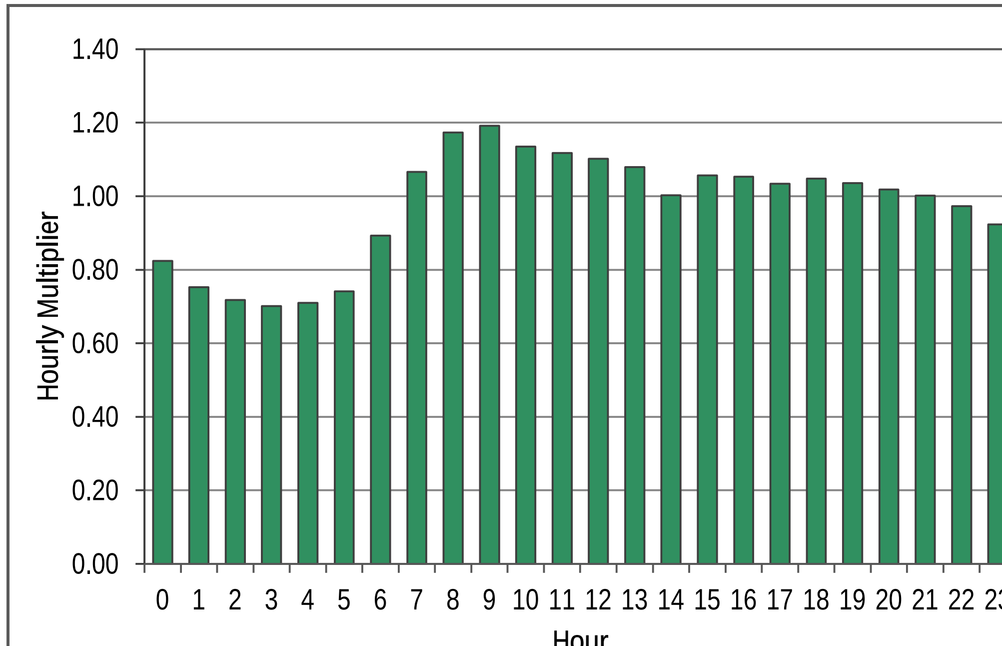
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal

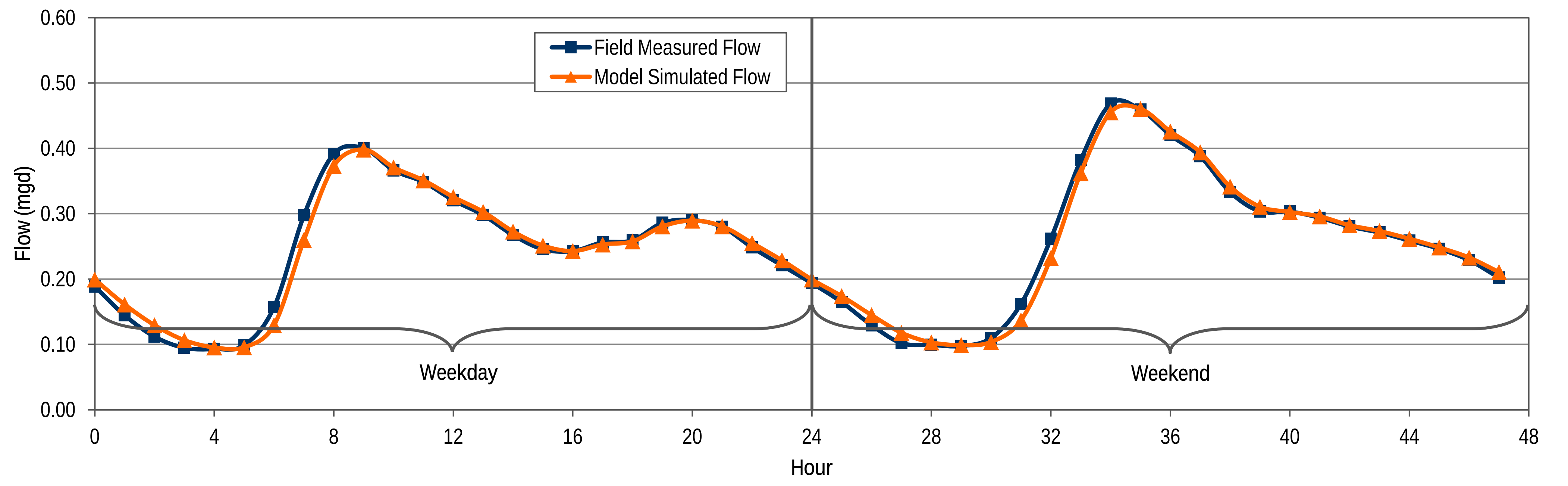


Dry Weather Flow Weekend Diurnal

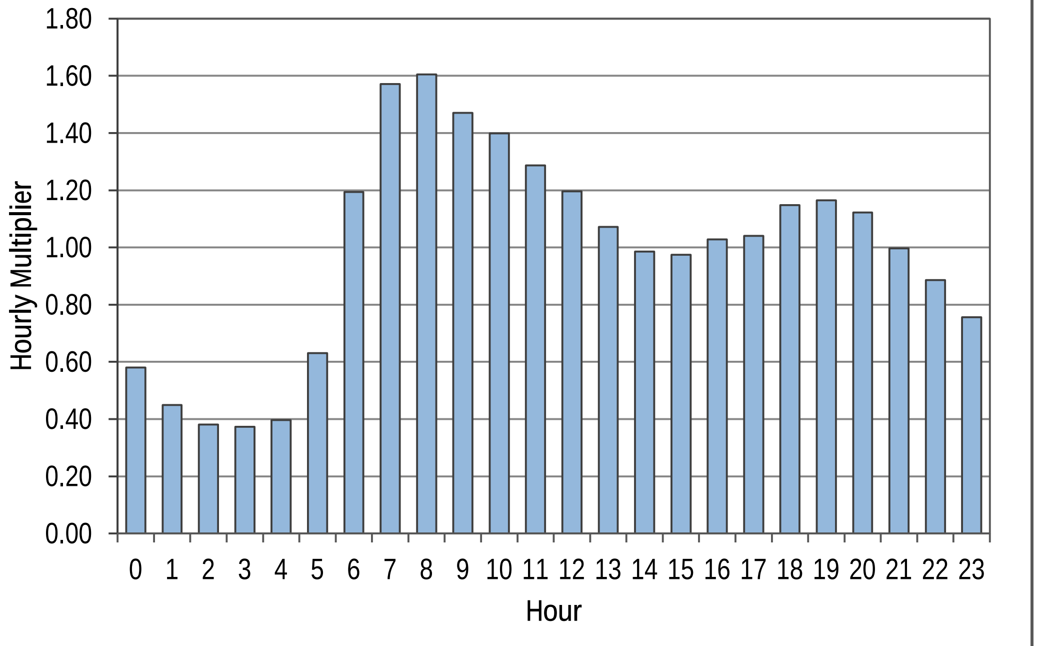
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 83E DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.189	0.199	0.76	0.58	0.58
	1	0.145	0.161	0.58	0.45	0.45
	2	0.112	0.129	0.45	0.38	0.38
	3	0.095	0.106	0.38	0.37	0.37
	4	0.093	0.095	0.37	0.40	0.40
	5	0.099	0.095	0.40	0.63	0.63
	6	0.157	0.129	0.63	1.19	1.19
	7	0.298	0.260	1.19	1.57	1.57
	8	0.392	0.373	1.57	1.61	1.61
	9	0.400	0.398	1.61	1.47	1.47
	10	0.367	0.371	1.47	1.40	1.40
	11	0.349	0.351	1.40	1.29	1.29
	12	0.321	0.325	1.29	1.20	1.20
	13	0.298	0.303	1.20	1.07	1.07
	14	0.273	0.273	1.07	0.99	0.99
	15	0.246	0.251	0.99	0.97	0.97
	16	0.243	0.243	0.97	1.03	1.03
	17	0.256	0.253	1.03	1.04	1.04
	18	0.259	0.258	1.04	1.15	1.15
	19	0.286	0.281	1.15	1.17	1.17
	20	0.290	0.289	1.17	1.12	1.12
	21	0.280	0.281	1.12	1.00	1.00
	22	0.249	0.255	1.00	0.89	0.89
	23	0.221	0.229	0.89	0.76	0.76
Weekend	24	0.194	0.199	0.78	0.66	0.66
	25	0.165	0.174	0.66	0.52	0.52
	26	0.129	0.145	0.52	0.41	0.41
	27	0.102	0.118	0.41	0.40	0.40
	28	0.099	0.103	0.40	0.39	0.39
	29	0.098	0.099	0.39	0.44	0.44
	30	0.110	0.104	0.44	0.65	0.65
	31	0.162	0.137	0.65	1.05	1.05
	32	0.262	0.232	1.05	1.53	1.53
	33	0.382	0.362	1.53	1.88	1.88
	34	0.468	0.455	1.88	1.84	1.84
	35	0.459	0.460	1.84	1.69	1.69
	36	0.420	0.426	1.69	1.56	1.56
	37	0.388	0.394	1.56	1.34	1.34
	38	0.333	0.342	1.34	1.22	1.22
	39	0.304	0.311	1.22	1.22	1.22
	40	0.303	0.303	1.22	1.18	1.18
	41	0.294	0.296	1.18	1.13	1.13
	42	0.281	0.282	1.13	1.09	1.09
	43	0.271	0.273	1.09	1.04	1.04
	44	0.259	0.262	1.04	0.99	0.99
	45	0.246	0.248	0.99	0.92	0.92
	46	0.229	0.233	0.92	0.81	0.81
	47	0.202	0.211	0.81	0.78	0.78
Average						
	Weekday	0.246	0.246	0.99	0.99	0.99
	Weekend	0.257	0.257	1.03	1.03	1.03
	ADWF[(1)]	0.249	0.249	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.1%			

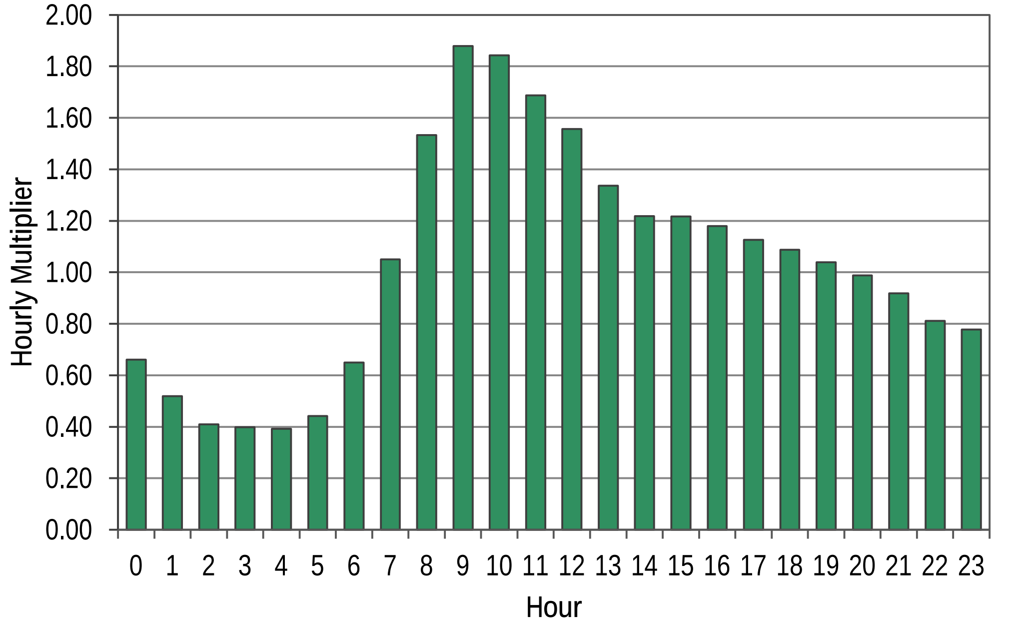
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

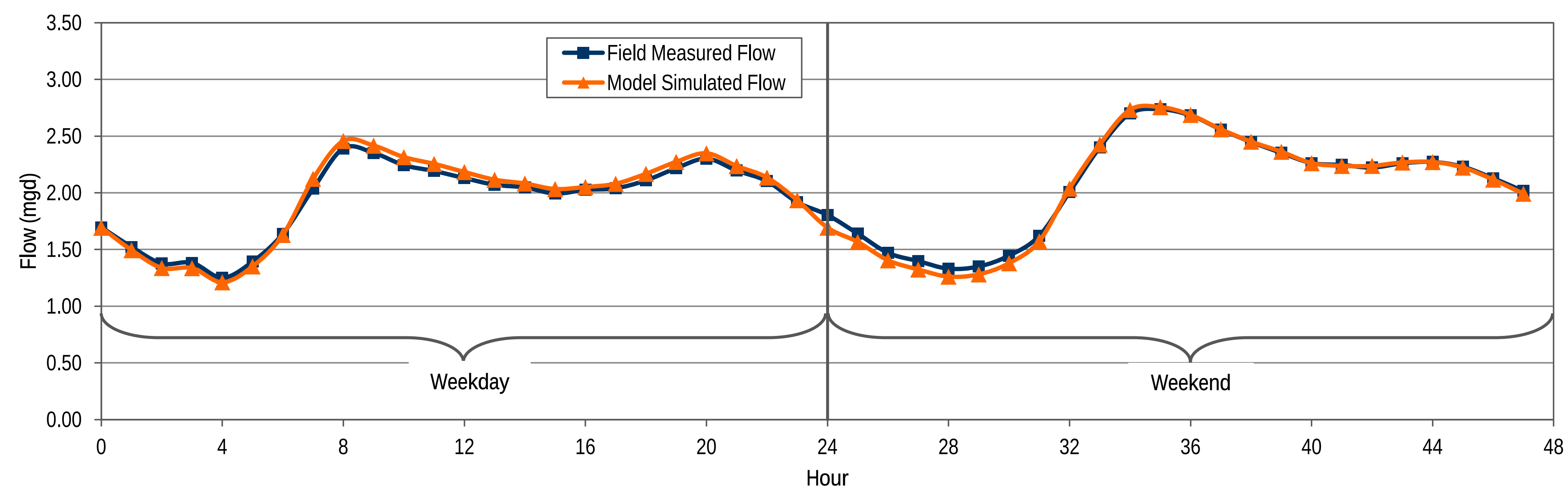
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83L-1 DRY WEATHER CALIBRATION

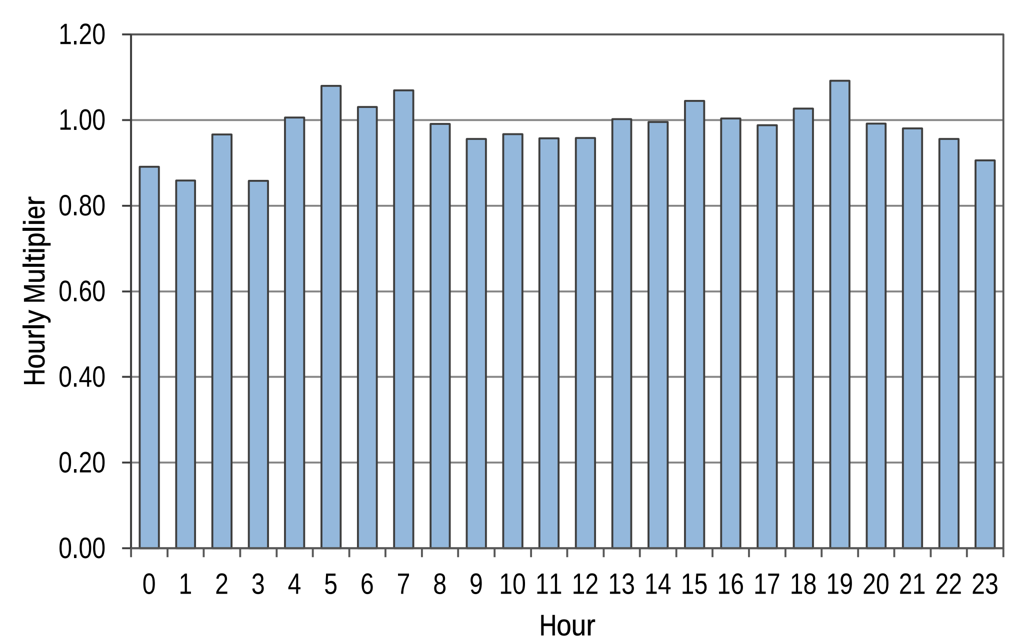
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.695	1.692	0.86	0.77	0.89
	1	1.522	1.494	0.77	0.70	0.86
	2	1.376	1.337	0.70	0.70	0.97
	3	1.382	1.335	0.70	0.63	0.86
	4	1.250	1.211	0.63	0.70	1.01
	5	1.393	1.351	0.70	0.83	1.08
	6	1.639	1.628	0.83	1.03	1.03
	7	2.036	2.123	1.03	1.21	1.07
	8	2.392	2.457	1.21	1.19	0.99
	9	2.352	2.416	1.19	1.13	0.96
	10	2.244	2.314	1.13	1.11	0.97
	11	2.192	2.254	1.11	1.08	0.96
	12	2.130	2.183	1.08	1.05	0.96
	13	2.071	2.115	1.05	1.04	1.00
	14	2.048	2.082	1.04	1.01	1.00
	15	1.994	2.033	1.01	1.02	1.04
	16	2.026	2.051	1.02	1.03	1.00
	17	2.040	2.079	1.03	1.07	0.99
	18	2.110	2.167	1.07	1.12	1.03
	19	2.217	2.273	1.12	1.16	1.09
	20	2.301	2.348	1.16	1.11	0.99
	21	2.196	2.236	1.11	1.06	0.98
	22	2.103	2.134	1.06	0.97	0.96
	23	1.917	1.935	0.97	0.86	0.91
Weekend	24	1.804	1.693	0.91	0.83	0.98
	25	1.640	1.566	0.83	0.74	0.91
	26	1.470	1.405	0.74	0.71	0.92
	27	1.397	1.324	0.71	0.67	0.90
	28	1.331	1.261	0.67	0.68	0.94
	29	1.350	1.281	0.68	0.73	1.02
	30	1.445	1.379	0.73	0.82	1.02
	31	1.620	1.573	0.82	1.01	1.05
	32	2.006	2.037	1.01	1.21	1.14
	33	2.401	2.426	1.21	1.36	1.25
	34	2.700	2.731	1.36	1.38	1.24
	35	2.737	2.755	1.38	1.36	1.21
	36	2.684	2.687	1.36	1.29	1.14
	37	2.559	2.560	1.29	1.24	1.10
	38	2.449	2.451	1.24	1.19	1.07
	39	2.353	2.362	1.19	1.14	1.03
	40	2.262	2.261	1.14	1.14	1.04
	41	2.246	2.237	1.14	1.12	0.99
	42	2.223	2.237	1.12	1.14	1.02
	43	2.261	2.267	1.14	1.15	1.04
	44	2.272	2.271	1.15	1.13	1.03
	45	2.230	2.222	1.13	1.08	1.01
	46	2.129	2.116	1.08	1.02	1.03
	47	2.016	1.992	1.02	0.91	0.99
Average						
	Weekday	1.943	1.969	0.98	0.98	0.98
	Weekend	2.066	2.046	1.04	1.04	1.04
	ADWF[1]	1.978	1.991	1.00	1.00	1.00
% Error						
	Weekday		1.3%			
	Weekend		-1.0%			

Notes:

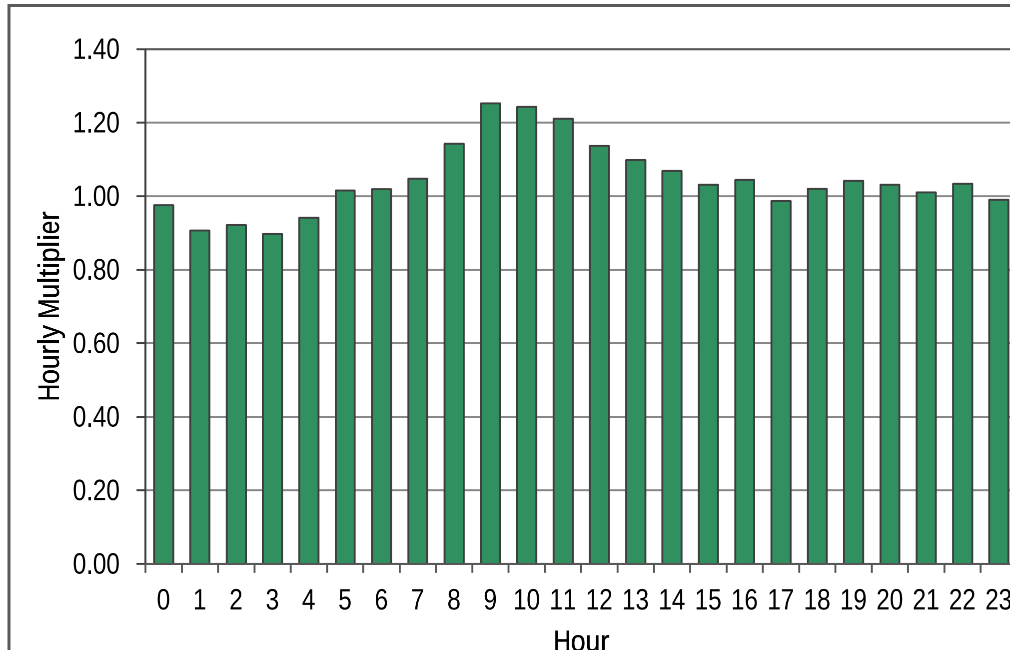
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

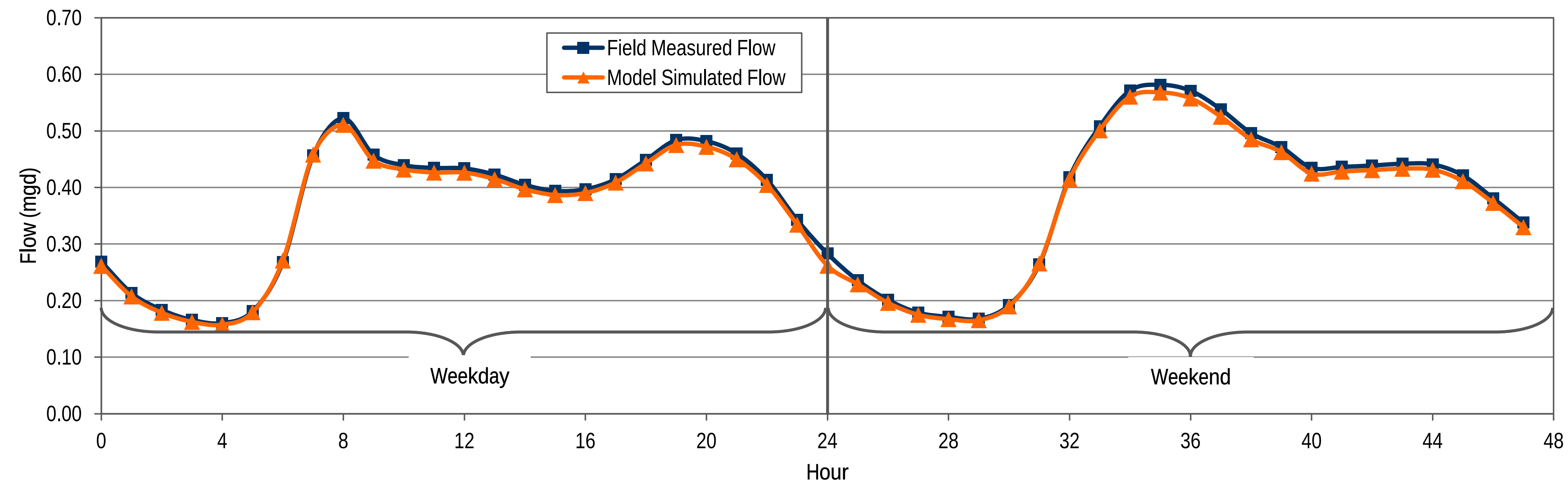
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83L-2 DRY WEATHER CALIBRATION

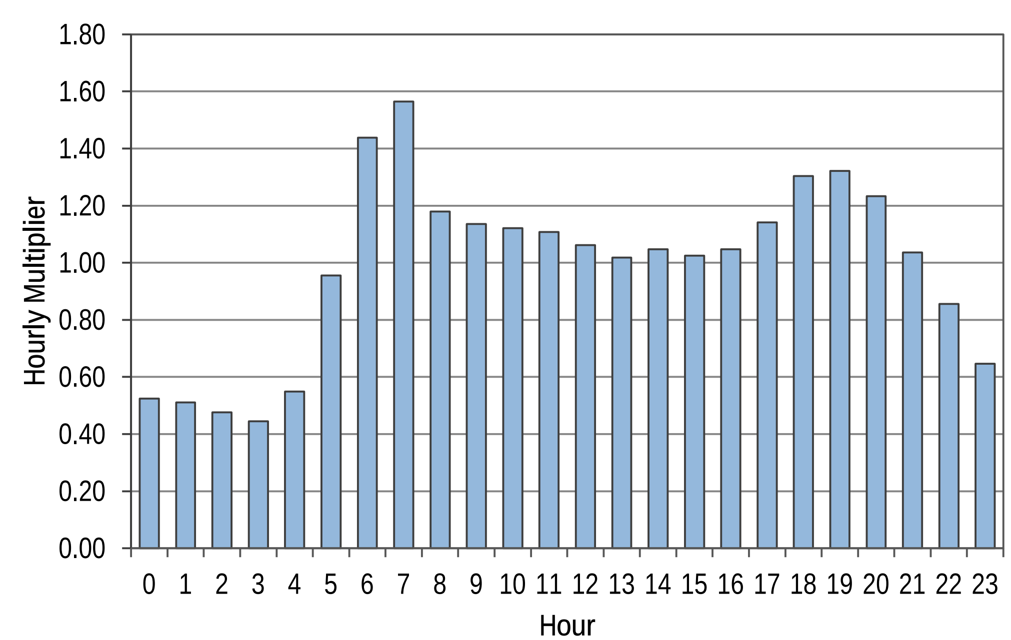
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.269	0.261	0.72	0.57	0.52
	1	0.214	0.207	0.57	0.49	0.51
	2	0.184	0.179	0.49	0.45	0.48
	3	0.166	0.162	0.45	0.43	0.44
	4	0.161	0.158	0.43	0.49	0.55
	5	0.182	0.180	0.49	0.72	0.96
	6	0.268	0.271	0.72	1.23	1.44
	7	0.457	0.458	1.23	1.40	1.56
	8	0.523	0.511	1.40	1.23	1.18
	9	0.458	0.447	1.23	1.18	1.14
	10	0.439	0.432	1.18	1.17	1.12
	11	0.435	0.426	1.17	1.16	1.11
	12	0.434	0.426	1.16	1.13	1.06
	13	0.423	0.415	1.13	1.09	1.02
	14	0.405	0.397	1.09	1.06	1.05
	15	0.394	0.387	1.06	1.06	1.02
	16	0.397	0.390	1.06	1.11	1.05
	17	0.415	0.409	1.11	1.20	1.14
	18	0.449	0.443	1.20	1.30	1.30
	19	0.484	0.475	1.30	1.29	1.32
	20	0.482	0.472	1.29	1.23	1.23
	21	0.460	0.450	1.23	1.11	1.04
	22	0.414	0.404	1.11	0.92	0.86
	23	0.343	0.334	0.92	0.72	0.65
Weekend	24	0.283	0.262	0.76	0.63	0.67
	25	0.236	0.229	0.63	0.54	0.52
	26	0.201	0.196	0.54	0.48	0.47
	27	0.179	0.175	0.48	0.46	0.46
	28	0.172	0.167	0.46	0.45	0.40
	29	0.168	0.165	0.45	0.52	0.56
	30	0.192	0.190	0.52	0.71	0.83
	31	0.264	0.266	0.71	1.12	1.38
	32	0.418	0.415	1.12	1.36	1.48
	33	0.508	0.501	1.36	1.53	1.63
	34	0.571	0.561	1.53	1.56	1.65
	35	0.582	0.568	1.56	1.53	1.62
	36	0.571	0.557	1.53	1.44	1.48
	37	0.538	0.525	1.44	1.33	1.25
	38	0.496	0.485	1.33	1.26	1.12
	39	0.471	0.463	1.26	1.17	0.98
	40	0.435	0.425	1.17	1.17	1.13
	41	0.436	0.428	1.17	1.18	1.11
	42	0.439	0.431	1.18	1.19	1.11
	43	0.442	0.433	1.19	1.18	1.14
	44	0.441	0.431	1.18	1.13	1.08
	45	0.422	0.411	1.13	1.02	0.94
	46	0.381	0.373	1.02	0.91	0.87
	47	0.338	0.330	0.91	0.76	0.76
Average						
	Weekday	0.369	0.362	0.99	0.99	0.99
	Weekend	0.383	0.374	1.03	1.03	1.03
	ADWF[1]	0.373	0.366	1.00	1.00	1.00
% Error						
	Weekday		-1.8%			
	Weekend		-2.2%			

Notes:

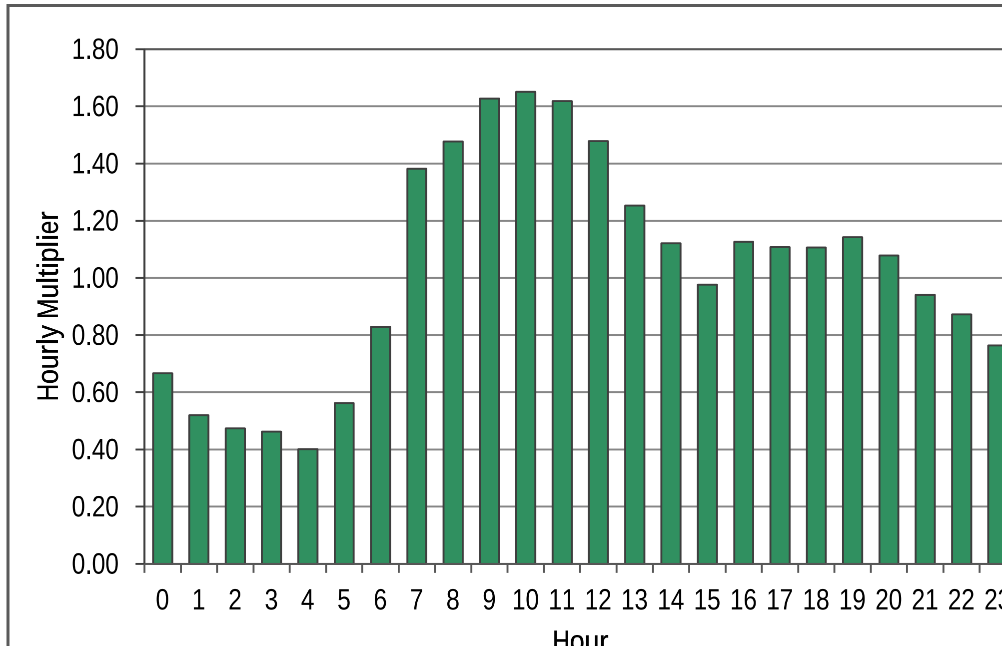
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_83.xlsx

City of Oakland

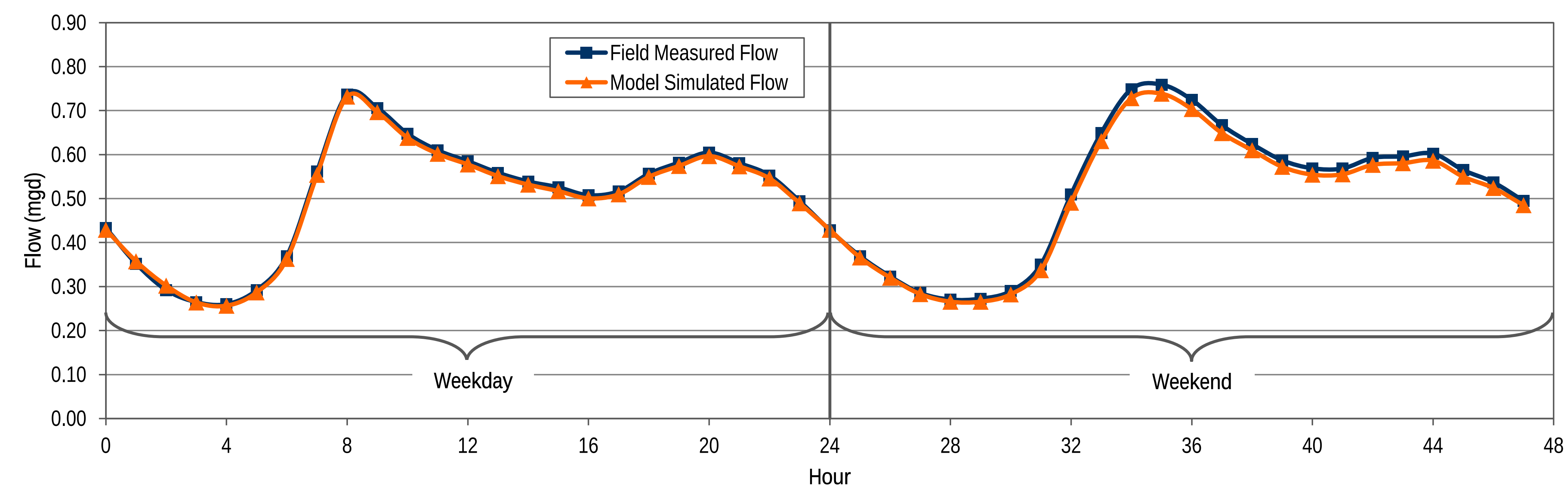
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-1 DRY WEATHER CALIBRATION

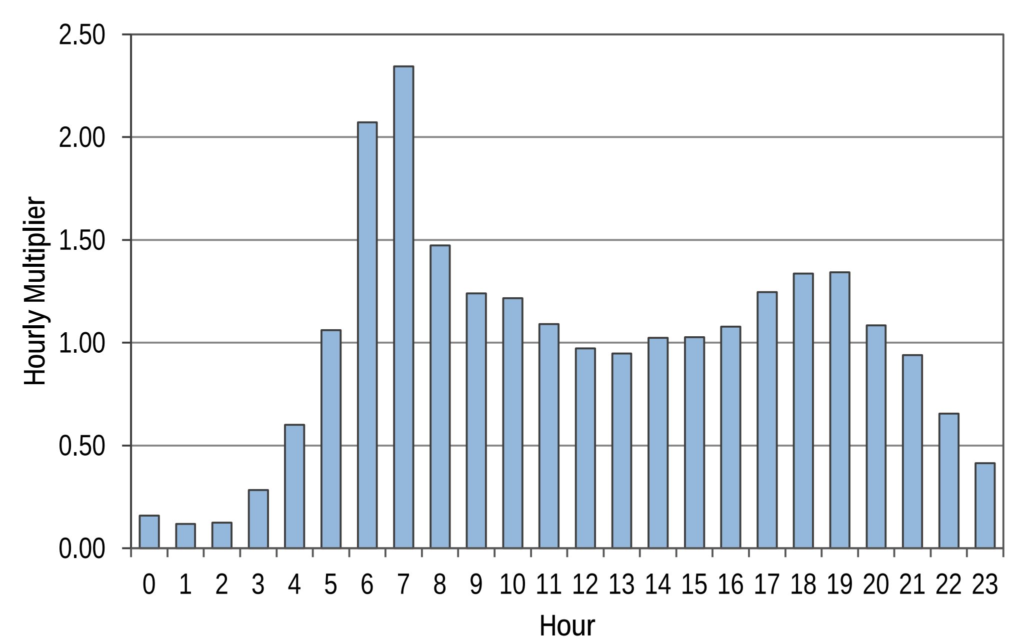
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.433	0.429	0.85	0.69	0.16
	1	0.352	0.357	0.69	0.57	0.12
	2	0.292	0.302	0.57	0.52	0.13
	3	0.264	0.264	0.52	0.51	0.28
	4	0.260	0.256	0.51	0.57	0.60
	5	0.292	0.287	0.57	0.73	1.06
	6	0.369	0.363	0.73	1.11	2.07
	7	0.562	0.554	1.11	1.45	2.34
	8	0.737	0.732	1.45	1.39	1.47
	9	0.706	0.697	1.39	1.27	1.24
	10	0.647	0.638	1.27	1.20	1.22
	11	0.610	0.602	1.20	1.15	1.09
	12	0.585	0.578	1.15	1.10	0.97
	13	0.558	0.551	1.10	1.06	0.95
	14	0.539	0.532	1.06	1.03	1.02
	15	0.525	0.517	1.03	1.00	1.03
	16	0.508	0.501	1.00	1.02	1.08
	17	0.516	0.510	1.02	1.09	1.25
	18	0.556	0.549	1.09	1.14	1.34
	19	0.582	0.574	1.14	1.19	1.34
	20	0.604	0.597	1.19	1.14	1.08
	21	0.580	0.573	1.14	1.09	0.94
	22	0.553	0.546	1.09	0.97	0.66
	23	0.494	0.489	0.97	0.85	0.41
Weekend	24	0.428	0.429	0.84	0.73	0.23
	25	0.369	0.366	0.73	0.64	0.19
	26	0.323	0.320	0.64	0.56	0.23
	27	0.285	0.283	0.56	0.53	0.30
	28	0.270	0.266	0.53	0.54	0.46
	29	0.272	0.265	0.54	0.57	0.60
	30	0.290	0.282	0.57	0.69	0.98
	31	0.350	0.337	0.69	1.00	1.77
	32	0.509	0.491	1.00	1.28	1.99
	33	0.649	0.631	1.28	1.47	1.99
	34	0.749	0.728	1.47	1.49	1.74
	35	0.759	0.738	1.49	1.43	1.56
	36	0.725	0.704	1.43	1.31	1.28
	37	0.667	0.649	1.31	1.23	1.10
	38	0.624	0.610	1.23	1.15	1.04
	39	0.587	0.572	1.15	1.12	1.05
	40	0.569	0.554	1.12	1.12	1.03
	41	0.568	0.555	1.12	1.17	1.22
	42	0.592	0.577	1.17	1.17	1.25
	43	0.596	0.580	1.17	1.19	1.26
	44	0.602	0.586	1.19	1.11	1.03
	45	0.565	0.550	1.11	1.06	0.96
	46	0.537	0.524	1.06	0.97	0.74
	47	0.495	0.485	0.97	0.84	0.36
Average						
	Weekday	0.505	0.500	0.99	0.99	0.99
	Weekend	0.516	0.503	1.01	1.01	1.01
	ADWF[(1)]	0.508	0.501	1.00	1.00	1.00
% Error						
	Weekday		-1.0%			
	Weekend		-2.4%			

Notes:

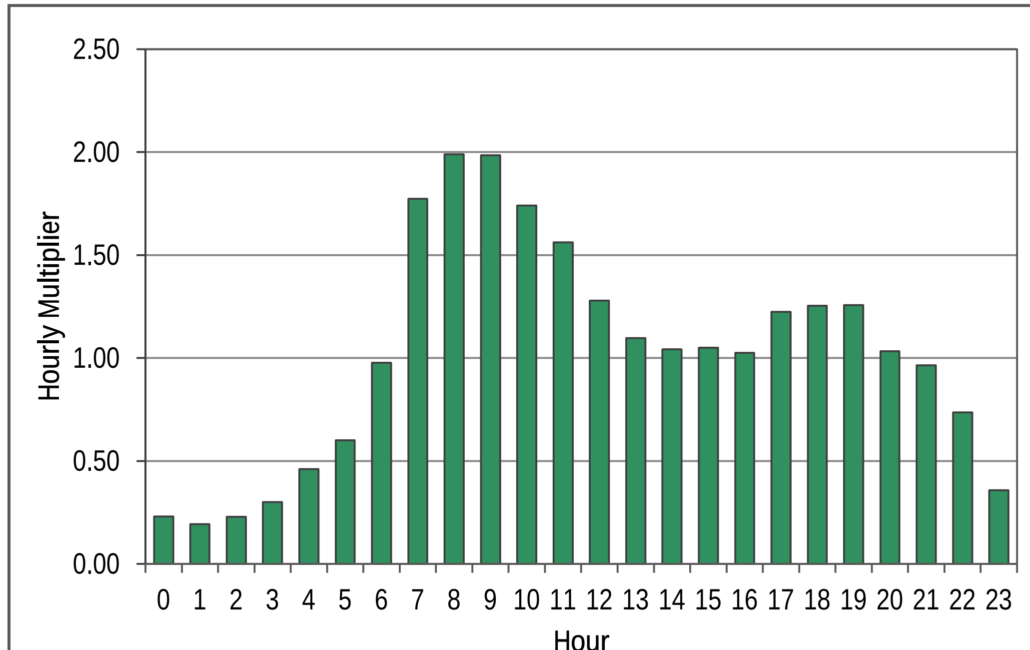
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal

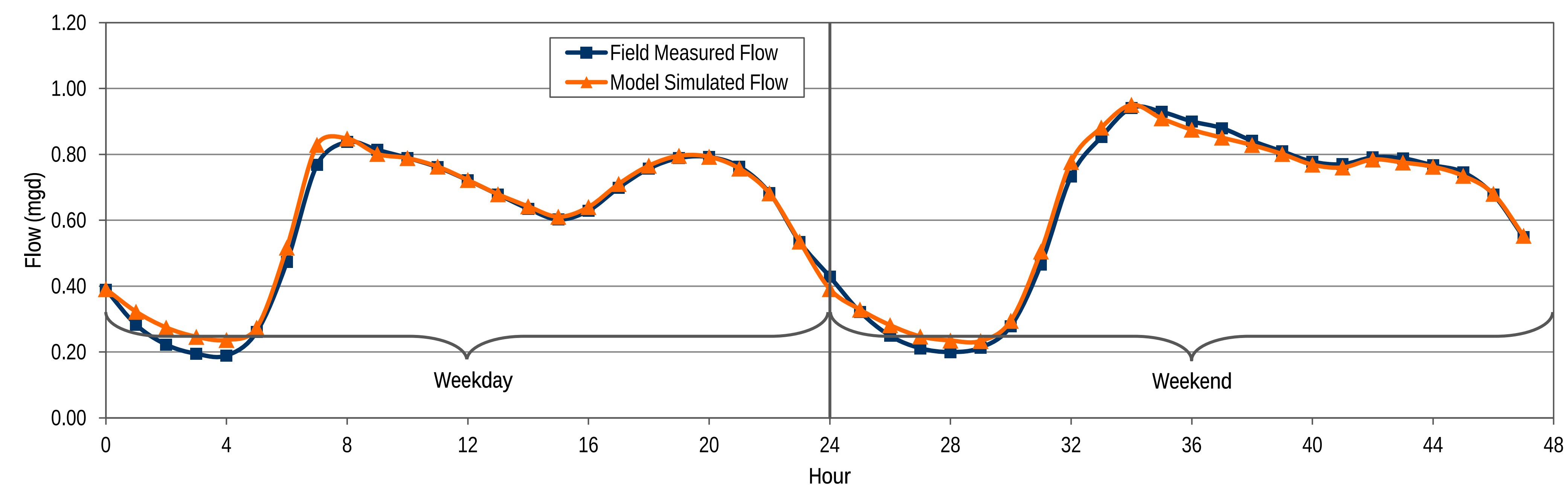


Dry Weather Flow Weekend Diurnal

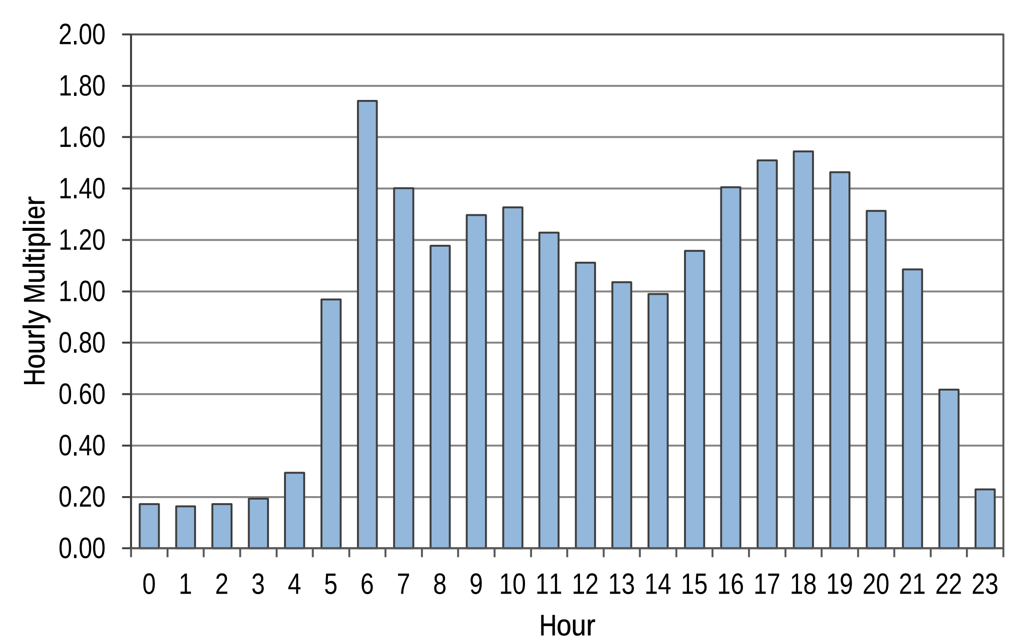
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 83U-2 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.389	0.391	0.64	0.47	0.17
	1	0.282	0.322	0.47	0.37	0.16
	2	0.222	0.274	0.37	0.32	0.17
	3	0.194	0.246	0.32	0.31	0.19
	4	0.189	0.237	0.31	0.43	0.29
	5	0.261	0.274	0.43	0.78	0.97
	6	0.473	0.517	0.78	1.27	1.74
	7	0.768	0.829	1.27	1.39	1.40
	8	0.838	0.848	1.39	1.35	1.18
	9	0.813	0.802	1.35	1.31	1.30
	10	0.789	0.789	1.31	1.26	1.33
	11	0.761	0.763	1.26	1.19	1.23
	12	0.721	0.722	1.19	1.12	1.11
	13	0.678	0.679	1.12	1.05	1.03
	14	0.635	0.642	1.05	1.00	0.99
	15	0.602	0.611	1.00	1.04	1.16
	16	0.629	0.640	1.04	1.16	1.40
	17	0.699	0.710	1.16	1.25	1.51
	18	0.757	0.766	1.25	1.30	1.54
	19	0.789	0.796	1.30	1.31	1.46
	20	0.792	0.793	1.31	1.26	1.31
	21	0.763	0.757	1.26	1.13	1.09
	22	0.683	0.682	1.13	0.88	0.62
	23	0.534	0.535	0.88	0.64	0.23
Weekend	24	0.429	0.391	0.71	0.53	0.19
	25	0.322	0.329	0.53	0.41	0.14
	26	0.249	0.281	0.41	0.35	0.14
	27	0.211	0.247	0.35	0.33	0.16
	28	0.200	0.235	0.33	0.35	0.19
	29	0.213	0.233	0.35	0.46	0.44
	30	0.278	0.295	0.46	0.77	1.06
	31	0.466	0.505	0.77	1.21	1.77
	32	0.733	0.777	1.21	1.41	1.68
	33	0.852	0.881	1.41	1.56	1.63
	34	0.941	0.950	1.56	1.54	1.43
	35	0.929	0.909	1.54	1.49	1.39
	36	0.900	0.875	1.49	1.46	1.44
	37	0.880	0.851	1.46	1.39	1.44
	38	0.841	0.828	1.39	1.34	1.43
	39	0.809	0.801	1.34	1.29	1.36
	40	0.778	0.769	1.29	1.27	1.32
	41	0.770	0.760	1.27	1.31	1.44
	42	0.791	0.785	1.31	1.30	1.43
	43	0.788	0.775	1.30	1.27	1.32
	44	0.767	0.763	1.27	1.23	1.29
	45	0.746	0.735	1.23	1.12	1.15
	46	0.678	0.680	1.12	0.91	0.77
	47	0.549	0.553	0.91	0.71	0.39
Average						
	Weekday	0.594	0.609	0.98	0.98	0.98
	Weekend	0.630	0.634	1.04	1.04	1.04
	ADWF(1)	0.604	0.616	1.00	1.00	1.00
% Error						
	Weekday		2.5%			
	Weekend		0.6%			

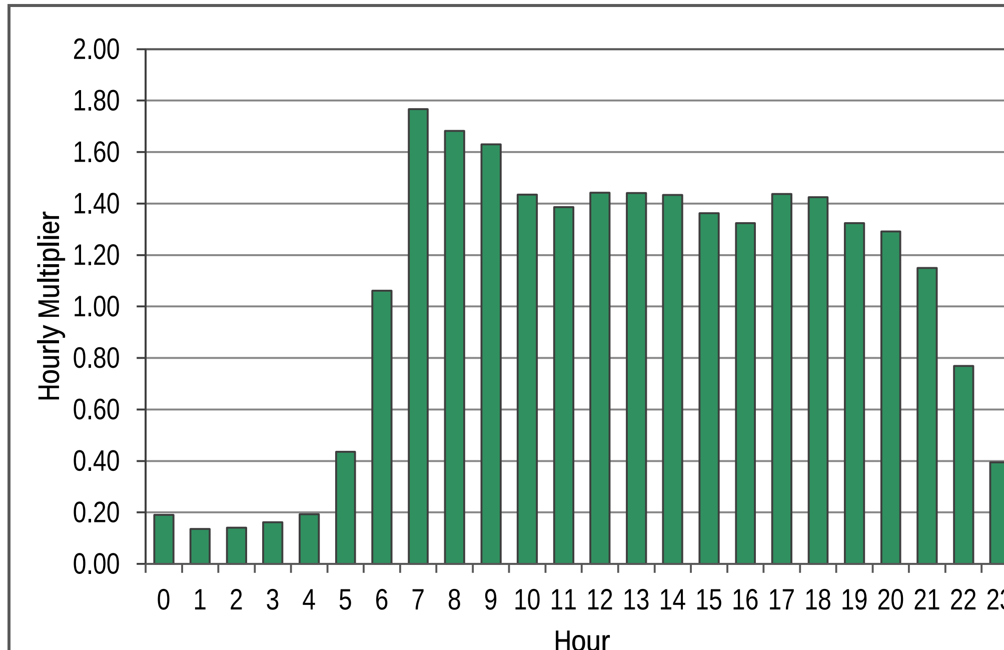
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_83.xlsx

City of Oakland

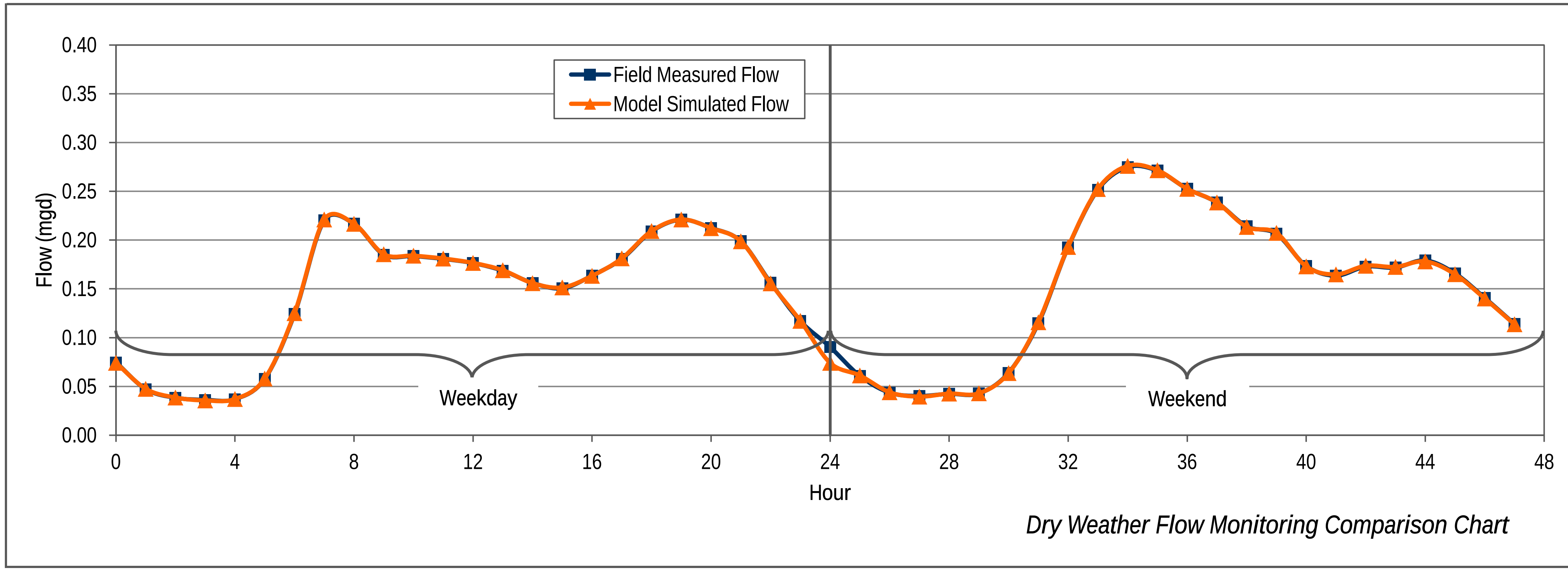
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-3 DRY WEATHER CALIBRATION

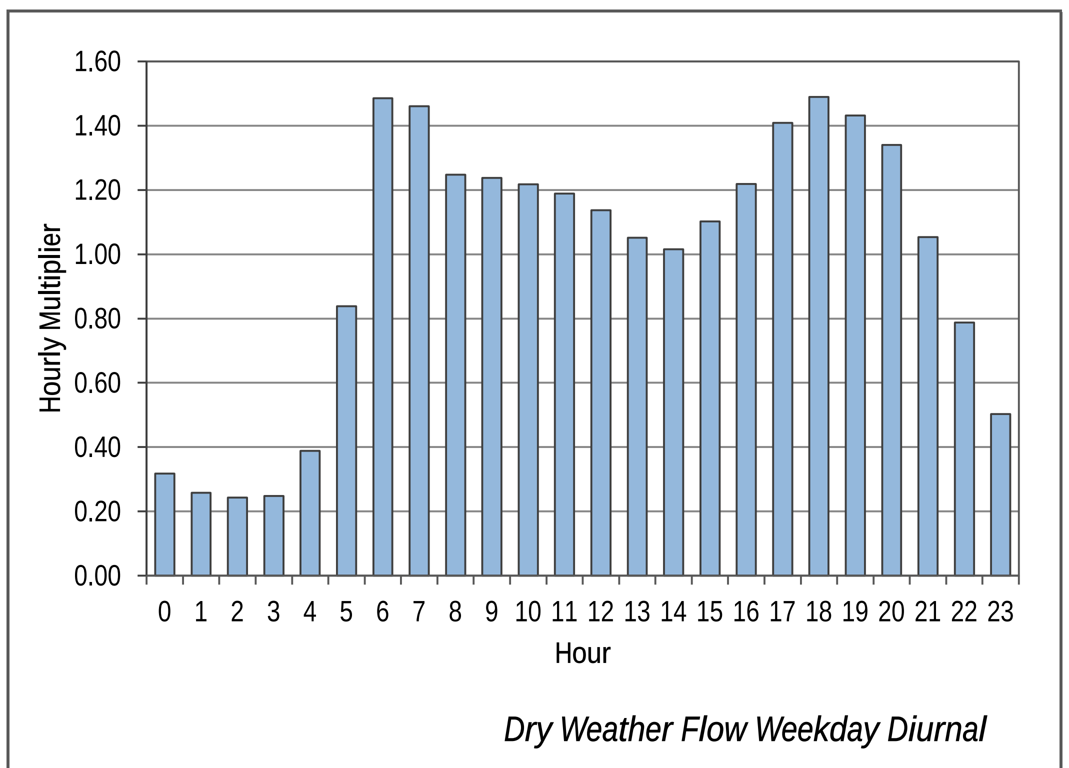
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.075	0.074	0.50	0.32	0.32
	1	0.047	0.048	0.32	0.26	0.26
	2	0.038	0.039	0.26	0.24	0.24
	3	0.036	0.036	0.24	0.25	0.25
	4	0.037	0.037	0.25	0.39	0.39
	5	0.058	0.058	0.39	0.84	0.84
	6	0.124	0.125	0.84	1.49	1.49
	7	0.220	0.221	1.49	1.46	1.46
	8	0.217	0.217	1.46	1.25	1.25
	9	0.185	0.186	1.25	1.24	1.24
	10	0.184	0.184	1.24	1.22	1.22
	11	0.181	0.181	1.22	1.19	1.19
	12	0.176	0.177	1.19	1.14	1.14
	13	0.169	0.169	1.14	1.05	1.05
	14	0.156	0.156	1.05	1.02	1.02
	15	0.151	0.151	1.02	1.10	1.10
	16	0.164	0.163	1.10	1.22	1.22
	17	0.181	0.181	1.22	1.41	1.41
	18	0.209	0.209	1.41	1.49	1.49
	19	0.221	0.221	1.49	1.43	1.43
	20	0.212	0.212	1.43	1.34	1.34
	21	0.199	0.199	1.34	1.05	1.05
	22	0.156	0.156	1.05	0.79	0.79
	23	0.117	0.117	0.79	0.50	0.50
Weekend	24	0.090	0.074	0.61	0.41	0.41
	25	0.061	0.061	0.41	0.29	0.29
	26	0.043	0.044	0.29	0.27	0.27
	27	0.040	0.040	0.27	0.29	0.29
	28	0.042	0.043	0.29	0.29	0.29
	29	0.043	0.043	0.29	0.43	0.43
	30	0.064	0.064	0.43	0.77	0.77
	31	0.115	0.116	0.77	1.30	1.30
	32	0.193	0.193	1.30	1.70	1.70
	33	0.252	0.252	1.70	1.85	1.85
	34	0.275	0.276	1.85	1.83	1.83
	35	0.271	0.272	1.83	1.70	1.70
	36	0.253	0.253	1.70	1.61	1.61
	37	0.238	0.239	1.61	1.44	1.44
	38	0.214	0.213	1.44	1.39	1.39
	39	0.206	0.207	1.39	1.17	1.17
	40	0.173	0.173	1.17	1.10	1.10
	41	0.164	0.165	1.10	1.17	1.17
	42	0.173	0.174	1.17	1.16	1.16
	43	0.172	0.173	1.16	1.21	1.21
	44	0.179	0.178	1.21	1.12	1.12
	45	0.166	0.165	1.12	0.95	0.95
	46	0.141	0.140	0.95	0.77	0.77
	47	0.114	0.114	0.77	0.61	0.61
Average						
	Weekday	0.146	0.147	0.99	0.99	0.99
	Weekend	0.153	0.153	1.03	1.03	1.03
	ADWF[(1)]	0.148	0.148	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		-0.3%			

Notes:

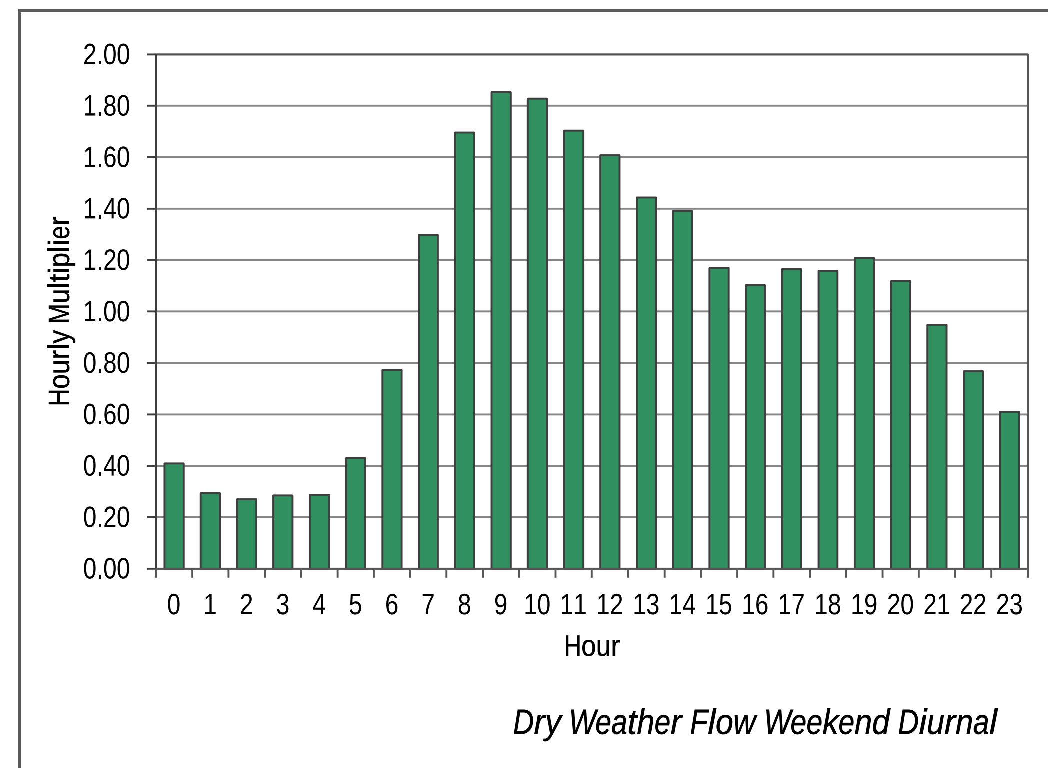
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

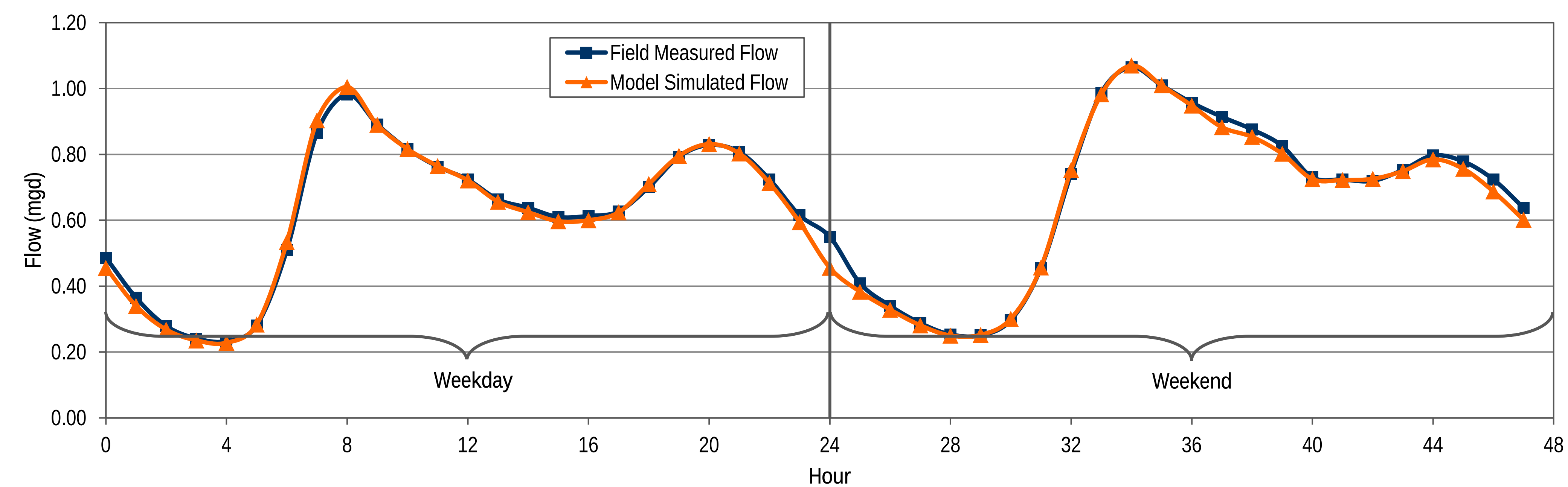
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-4 DRY WEATHER CALIBRATION

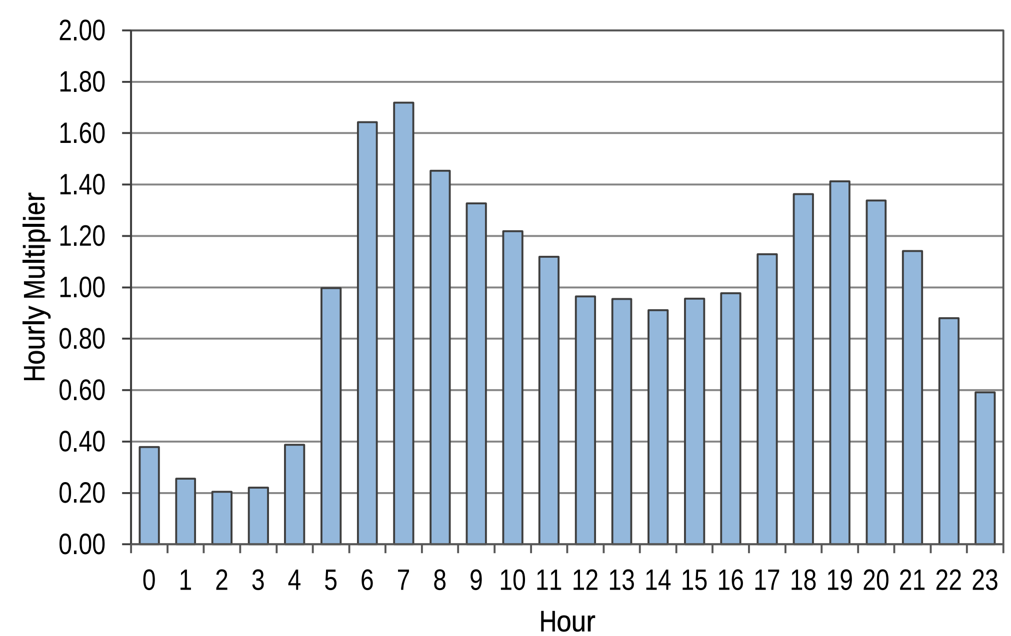
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.486	0.456	0.76	0.57	0.38
	1	0.365	0.340	0.57	0.44	0.25
	2	0.279	0.268	0.44	0.38	0.20
	3	0.241	0.235	0.38	0.36	0.22
	4	0.233	0.228	0.36	0.44	0.39
	5	0.281	0.284	0.44	0.80	1.00
	6	0.510	0.534	0.80	1.35	1.64
	7	0.866	0.903	1.35	1.54	1.72
	8	0.982	1.005	1.54	1.39	1.45
	9	0.890	0.890	1.39	1.28	1.33
	10	0.816	0.816	1.28	1.19	1.22
	11	0.763	0.765	1.19	1.13	1.12
	12	0.723	0.721	1.13	1.04	0.96
	13	0.663	0.656	1.04	1.00	0.95
	14	0.638	0.624	1.00	0.95	0.91
	15	0.610	0.597	0.95	0.96	0.96
	16	0.613	0.600	0.96	0.98	0.98
	17	0.626	0.624	0.98	1.10	1.13
	18	0.700	0.710	1.10	1.24	1.36
	19	0.792	0.796	1.24	1.30	1.41
	20	0.828	0.831	1.30	1.26	1.34
	21	0.807	0.803	1.26	1.13	1.14
	22	0.724	0.713	1.13	0.96	0.88
	23	0.615	0.594	0.96	0.76	0.59
Weekend	24	0.550	0.456	0.86	0.64	0.50
	25	0.409	0.383	0.64	0.53	0.42
	26	0.340	0.328	0.53	0.45	0.33
	27	0.288	0.281	0.45	0.40	0.26
	28	0.253	0.250	0.40	0.39	0.28
	29	0.251	0.252	0.39	0.46	0.42
	30	0.296	0.301	0.46	0.71	0.83
	31	0.454	0.457	0.71	1.16	1.46
	32	0.741	0.753	1.16	1.54	1.85
	33	0.987	0.983	1.54	1.66	1.85
	34	1.064	1.070	1.66	1.58	1.58
	35	1.009	1.010	1.58	1.50	1.44
	36	0.957	0.948	1.50	1.43	1.40
	37	0.914	0.883	1.43	1.37	1.41
	38	0.875	0.853	1.37	1.29	1.35
	39	0.825	0.802	1.29	1.14	1.08
	40	0.730	0.725	1.14	1.13	1.06
	41	0.723	0.722	1.13	1.13	1.04
	42	0.719	0.726	1.13	1.18	1.14
	43	0.753	0.749	1.18	1.25	1.26
	44	0.796	0.785	1.25	1.22	1.24
	45	0.778	0.756	1.22	1.13	1.17
	46	0.724	0.688	1.13	1.00	0.99
	47	0.638	0.602	1.00	0.86	0.77
Average						
	Weekday	0.627	0.625	0.98	0.98	0.98
	Weekend	0.670	0.657	1.05	1.05	1.05
	ADWF[(1)]	0.639	0.634	1.00	1.00	1.00
% Error						
	Weekday		-0.4%			
	Weekend		-1.9%			

Notes:

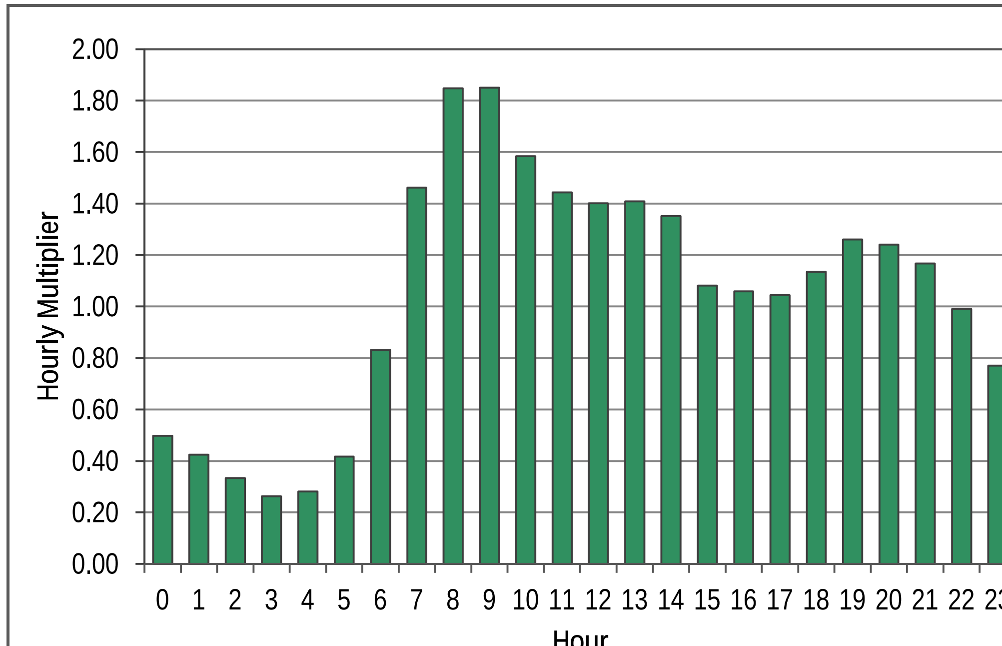
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

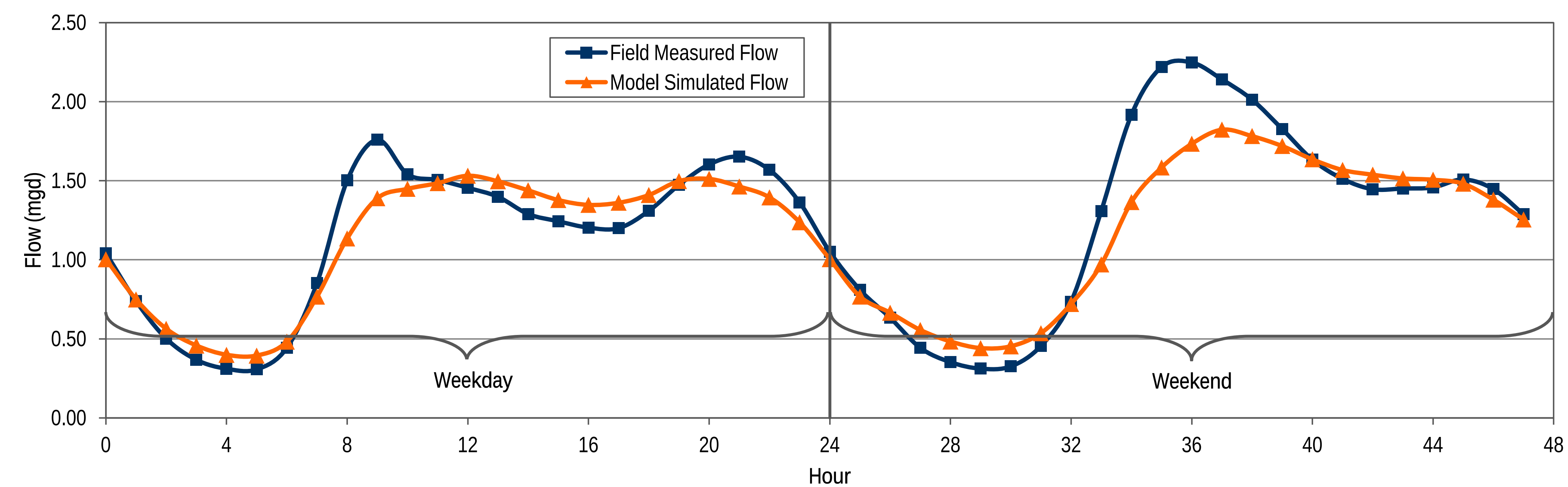
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-F DRY WEATHER CALIBRATION

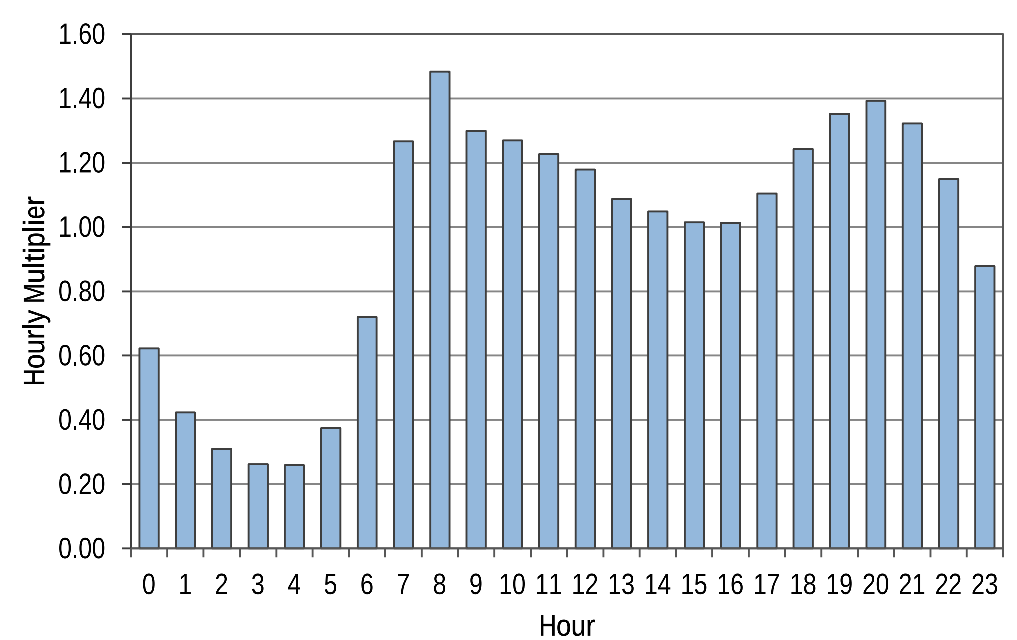
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.042	1.003	0.88	0.62	0.62
	1	0.738	0.749	0.62	0.42	0.42
	2	0.502	0.563	0.42	0.31	0.31
	3	0.368	0.457	0.31	0.26	0.26
	4	0.311	0.399	0.26	0.26	0.26
	5	0.307	0.394	0.26	0.37	0.37
	6	0.444	0.482	0.37	0.72	0.72
	7	0.854	0.767	0.72	1.27	1.27
	8	1.502	1.135	1.27	1.48	1.48
	9	1.759	1.389	1.48	1.30	1.30
	10	1.541	1.449	1.30	1.27	1.27
	11	1.505	1.485	1.27	1.23	1.23
	12	1.455	1.532	1.23	1.18	1.18
	13	1.398	1.497	1.18	1.09	1.09
	14	1.290	1.439	1.09	1.05	1.05
	15	1.244	1.378	1.05	1.01	1.01
	16	1.204	1.347	1.01	1.01	1.01
	17	1.200	1.361	1.01	1.10	1.10
	18	1.310	1.410	1.10	1.24	1.24
	19	1.474	1.498	1.24	1.35	1.35
	20	1.603	1.512	1.35	1.39	1.39
	21	1.652	1.464	1.39	1.32	1.32
	22	1.568	1.395	1.32	1.15	1.15
	23	1.363	1.237	1.15	0.88	0.88
Weekend	24	1.051	1.004	0.89	0.68	0.68
	25	0.810	0.767	0.68	0.53	0.53
	26	0.634	0.665	0.53	0.37	0.37
	27	0.444	0.556	0.37	0.30	0.30
	28	0.353	0.483	0.30	0.26	0.26
	29	0.312	0.441	0.26	0.27	0.27
	30	0.326	0.452	0.27	0.38	0.38
	31	0.455	0.536	0.38	0.62	0.62
	32	0.735	0.721	0.62	1.10	1.10
	33	1.309	0.971	1.10	1.62	1.62
	34	1.917	1.365	1.62	1.87	1.87
	35	2.219	1.584	1.87	1.90	1.90
	36	2.248	1.734	1.90	1.81	1.81
	37	2.141	1.823	1.81	1.70	1.70
	38	2.013	1.783	1.70	1.54	1.54
	39	1.827	1.720	1.54	1.38	1.38
	40	1.633	1.636	1.38	1.27	1.27
	41	1.512	1.568	1.27	1.22	1.22
	42	1.447	1.539	1.22	1.22	1.22
	43	1.451	1.515	1.22	1.23	1.23
	44	1.458	1.506	1.23	1.27	1.27
	45	1.508	1.481	1.27	1.22	1.22
	46	1.447	1.380	1.22	1.09	1.09
	47	1.288	1.255	1.09	0.89	0.89
Average						
Weekday		1.151	1.139	0.97	0.97	0.97
Weekend		1.272	1.187	1.07	1.07	1.07
ADWF[(1)]		1.186	1.153	1.00	1.00	1.00
% Error						
Weekday			-1.1%			
Weekend			-6.7%			

Notes:

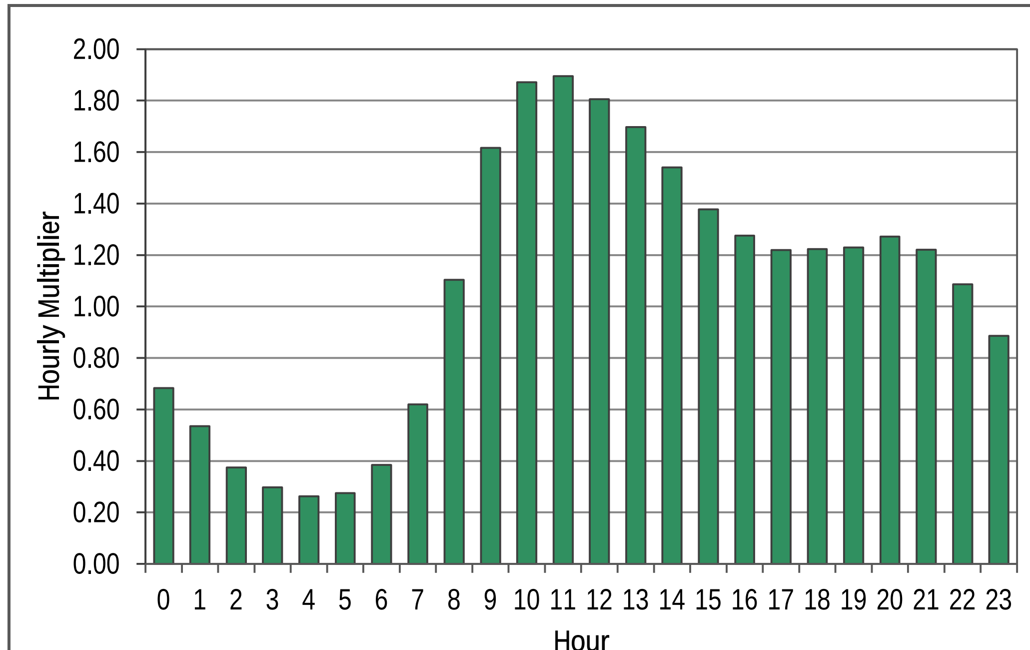
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

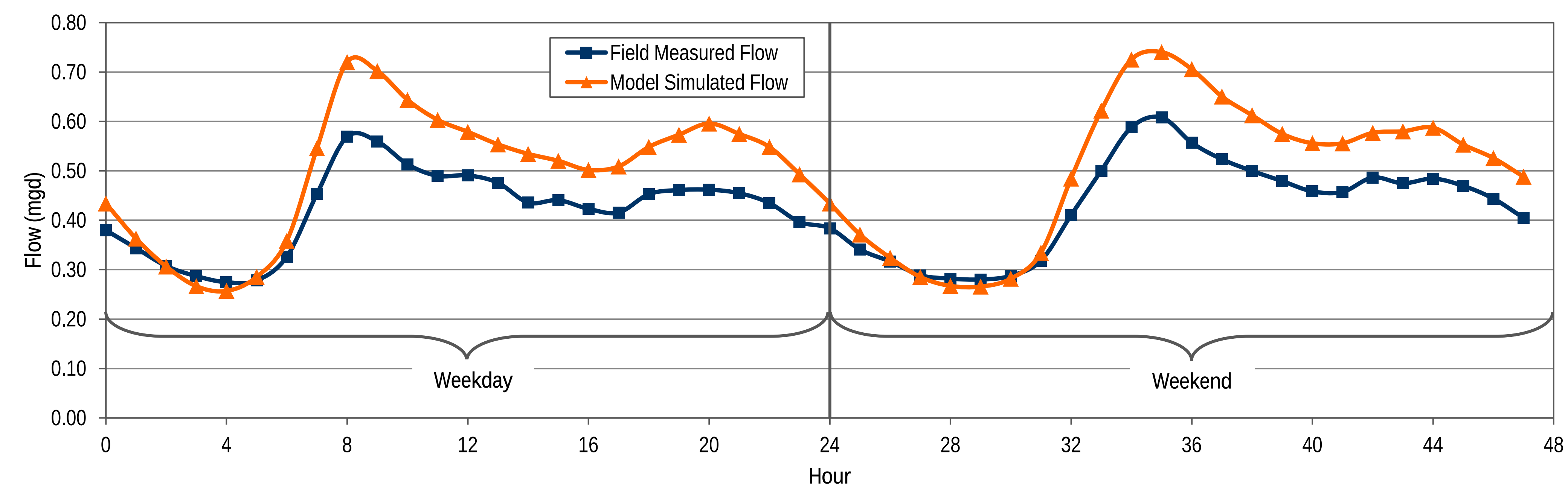
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-1X DRY WEATHER CALIBRATION

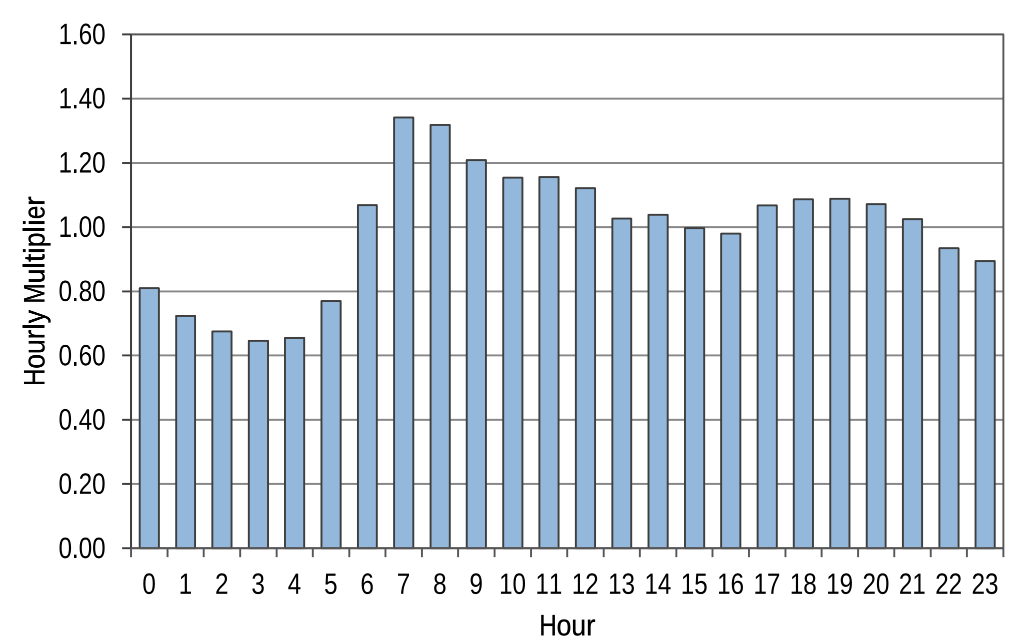
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.380	0.434	0.89	0.81	0.81
	1	0.343	0.363	0.81	0.72	0.72
	2	0.307	0.306	0.72	0.68	0.68
	3	0.287	0.266	0.68	0.65	0.65
	4	0.274	0.257	0.65	0.65	0.65
	5	0.278	0.285	0.65	0.77	0.77
	6	0.326	0.359	0.77	1.07	1.07
	7	0.454	0.546	1.07	1.34	1.34
	8	0.569	0.720	1.34	1.32	1.32
	9	0.559	0.702	1.32	1.21	1.21
	10	0.513	0.643	1.21	1.15	1.15
	11	0.490	0.603	1.15	1.16	1.16
	12	0.491	0.579	1.16	1.12	1.12
	13	0.476	0.554	1.12	1.03	1.03
	14	0.436	0.534	1.03	1.04	1.04
	15	0.441	0.520	1.04	1.00	1.00
	16	0.423	0.502	1.00	0.98	0.98
	17	0.416	0.509	0.98	1.07	1.07
	18	0.453	0.548	1.07	1.09	1.09
	19	0.461	0.573	1.09	1.09	1.09
	20	0.462	0.596	1.09	1.07	1.07
	21	0.455	0.575	1.07	1.02	1.02
	22	0.435	0.548	1.02	0.93	0.93
	23	0.397	0.493	0.93	0.89	0.89
Weekend	24	0.384	0.434	0.90	0.80	0.80
	25	0.341	0.371	0.80	0.75	0.75
	26	0.316	0.324	0.75	0.68	0.68
	27	0.289	0.285	0.68	0.66	0.66
	28	0.282	0.267	0.66	0.66	0.66
	29	0.280	0.266	0.66	0.68	0.68
	30	0.287	0.282	0.68	0.75	0.75
	31	0.318	0.334	0.75	0.97	0.97
	32	0.410	0.484	0.97	1.18	1.18
	33	0.500	0.622	1.18	1.39	1.39
	34	0.588	0.725	1.39	1.43	1.43
	35	0.608	0.740	1.43	1.31	1.31
	36	0.557	0.706	1.31	1.23	1.23
	37	0.524	0.650	1.23	1.18	1.18
	38	0.500	0.612	1.18	1.13	1.13
	39	0.479	0.575	1.13	1.08	1.08
	40	0.458	0.556	1.08	1.08	1.08
	41	0.457	0.556	1.08	1.15	1.15
	42	0.486	0.577	1.15	1.12	1.12
	43	0.475	0.580	1.12	1.14	1.14
	44	0.484	0.587	1.14	1.11	1.11
	45	0.470	0.553	1.11	1.05	1.05
	46	0.444	0.526	1.05	0.95	0.95
	47	0.405	0.488	0.95	0.90	0.90
Average						
	Weekday	0.422	0.501	0.99	0.99	0.99
	Weekend	0.431	0.504	1.02	1.02	1.02
	ADWF[1]	0.424	0.502	1.00	1.00	1.00
% Error						
	Weekday		18.7%			
	Weekend		17.0%			

Notes:

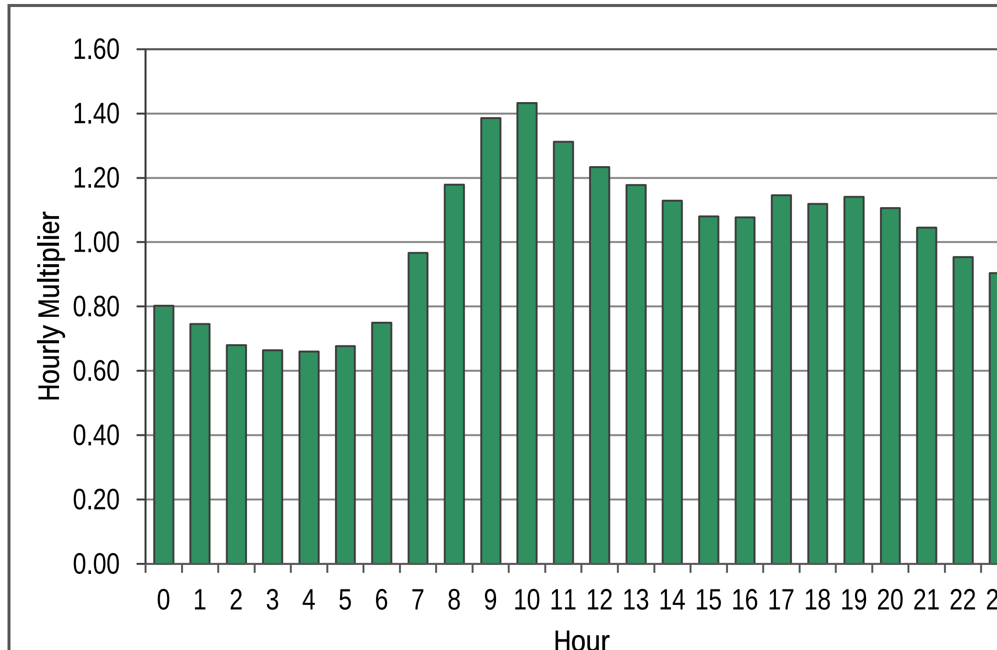
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

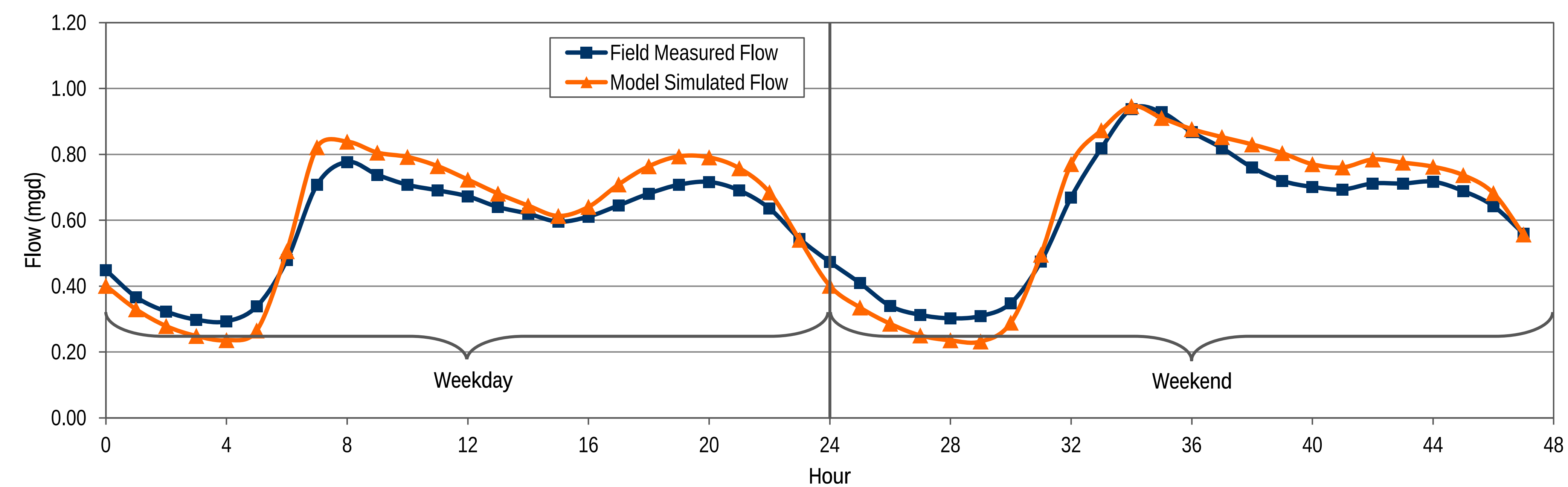
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-2X DRY WEATHER CALIBRATION

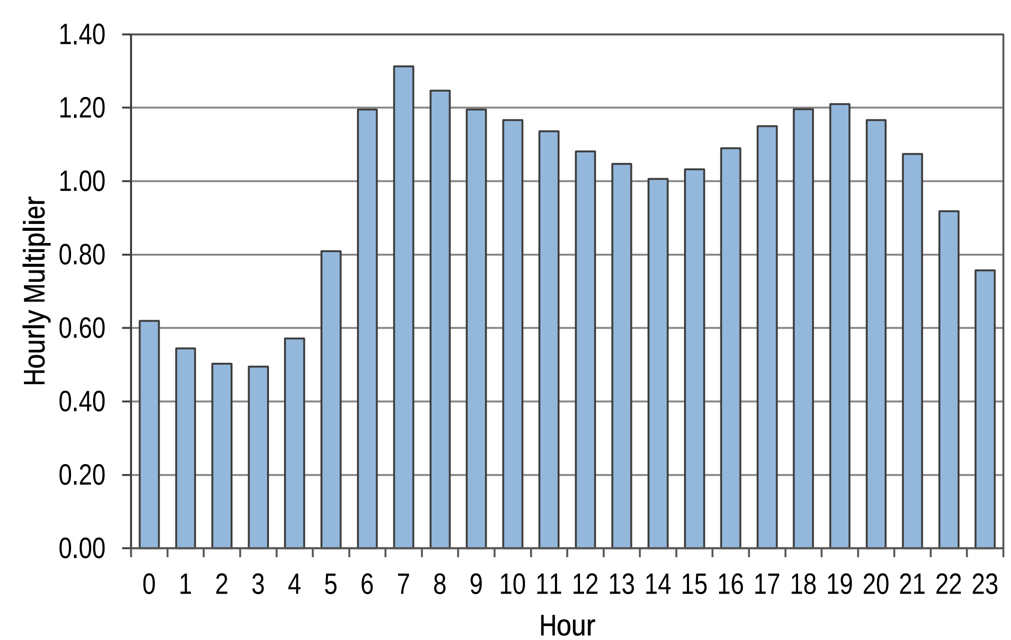
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.448	0.401	0.76	0.62	0.62
	1	0.367	0.330	0.62	0.54	0.54
	2	0.323	0.279	0.54	0.50	0.50
	3	0.298	0.249	0.50	0.49	0.49
	4	0.293	0.236	0.49	0.57	0.57
	5	0.338	0.265	0.57	0.81	0.81
	6	0.479	0.506	0.81	1.19	1.19
	7	0.707	0.822	1.19	1.31	1.31
	8	0.777	0.839	1.31	1.25	1.25
	9	0.738	0.805	1.25	1.20	1.20
	10	0.707	0.792	1.20	1.17	1.17
	11	0.691	0.764	1.17	1.14	1.14
	12	0.672	0.723	1.14	1.08	1.08
	13	0.640	0.681	1.08	1.05	1.05
	14	0.620	0.645	1.05	1.01	1.01
	15	0.596	0.613	1.01	1.03	1.03
	16	0.611	0.641	1.03	1.09	1.09
	17	0.645	0.709	1.09	1.15	1.15
	18	0.681	0.764	1.15	1.20	1.20
	19	0.708	0.794	1.20	1.21	1.21
	20	0.716	0.791	1.21	1.17	1.17
	21	0.690	0.758	1.17	1.07	1.07
	22	0.636	0.685	1.07	0.92	0.92
	23	0.544	0.541	0.92	0.76	0.76
Weekend	24	0.473	0.401	0.80	0.69	0.69
	25	0.409	0.335	0.69	0.57	0.57
	26	0.340	0.286	0.57	0.53	0.53
	27	0.312	0.250	0.53	0.51	0.51
	28	0.302	0.236	0.51	0.52	0.52
	29	0.309	0.232	0.52	0.59	0.59
	30	0.348	0.289	0.59	0.80	0.80
	31	0.474	0.496	0.80	1.13	1.13
	32	0.669	0.771	1.13	1.38	1.38
	33	0.818	0.873	1.38	1.58	1.58
	34	0.938	0.946	1.58	1.57	1.57
	35	0.928	0.911	1.57	1.47	1.47
	36	0.868	0.877	1.47	1.38	1.38
	37	0.819	0.853	1.38	1.28	1.28
	38	0.760	0.830	1.28	1.22	1.22
	39	0.719	0.804	1.22	1.18	1.18
	40	0.701	0.770	1.18	1.17	1.17
	41	0.693	0.760	1.17	1.20	1.20
	42	0.712	0.785	1.20	1.20	1.20
	43	0.711	0.775	1.20	1.21	1.21
	44	0.717	0.763	1.21	1.16	1.16
	45	0.689	0.737	1.16	1.09	1.09
	46	0.643	0.682	1.09	0.95	0.95
	47	0.559	0.557	0.95	0.80	0.80
Average						
Weekday		0.580	0.610	0.98	0.98	0.98
Weekend		0.621	0.634	1.05	1.05	1.05
ADWF[(1)]		0.592	0.617	1.00	1.00	1.00
% Error						
Weekday			5.1%			
Weekend			2.1%			

Notes:

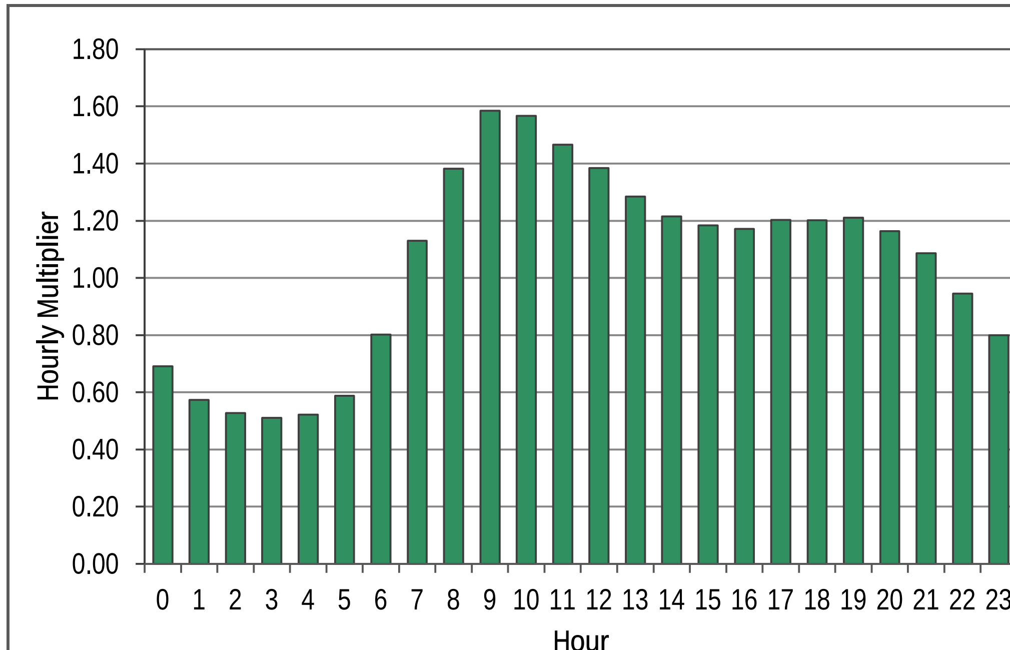
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

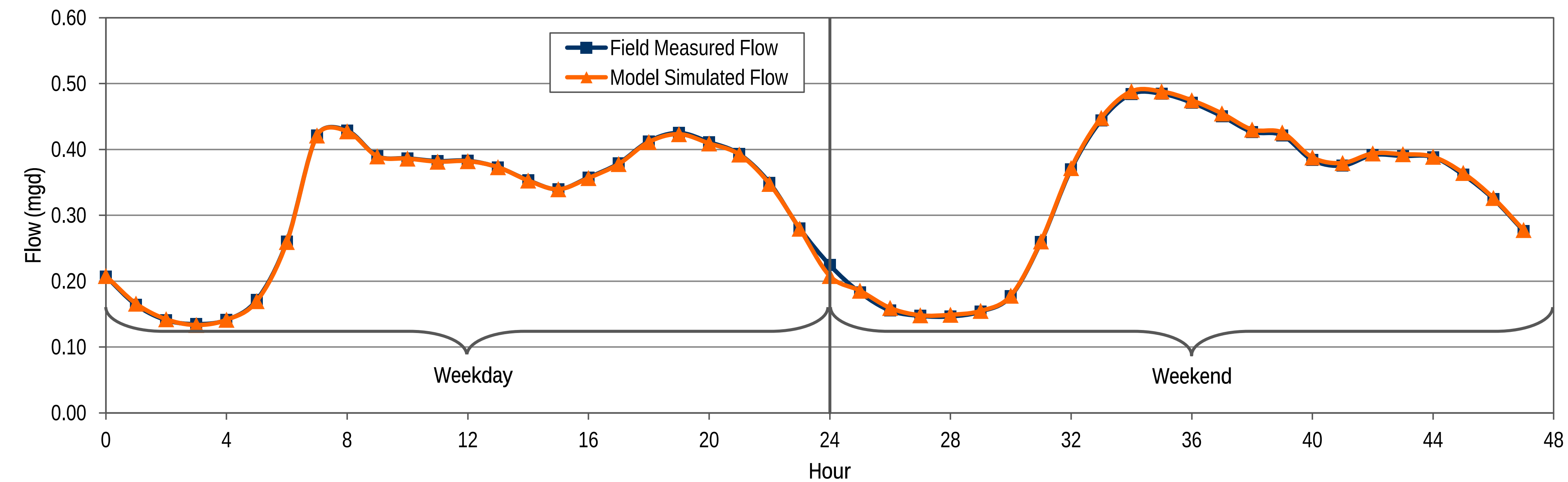
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-3X DRY WEATHER CALIBRATION

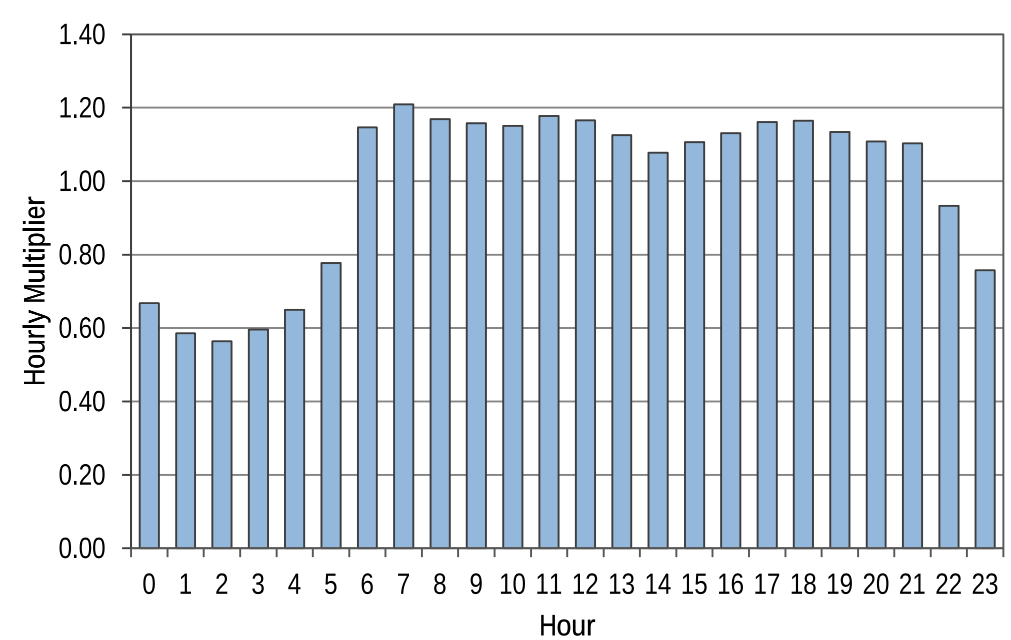
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.207	0.208	0.64	0.51	0.67
	1	0.164	0.166	0.51	0.44	0.59
	2	0.141	0.142	0.44	0.42	0.56
	3	0.135	0.134	0.42	0.44	0.60
	4	0.141	0.141	0.44	0.53	0.65
	5	0.172	0.170	0.53	0.81	0.78
	6	0.260	0.260	0.81	1.31	1.15
	7	0.421	0.421	1.31	1.33	1.21
	8	0.429	0.428	1.33	1.21	1.17
	9	0.390	0.390	1.21	1.20	1.16
	10	0.387	0.386	1.20	1.18	1.15
	11	0.382	0.381	1.18	1.19	1.18
	12	0.383	0.382	1.19	1.16	1.17
	13	0.373	0.373	1.16	1.09	1.13
	14	0.353	0.353	1.09	1.05	1.08
	15	0.339	0.340	1.05	1.11	1.11
	16	0.357	0.357	1.11	1.17	1.13
	17	0.379	0.378	1.17	1.28	1.16
	18	0.412	0.411	1.28	1.32	1.16
	19	0.425	0.423	1.32	1.27	1.13
	20	0.411	0.409	1.27	1.22	1.11
	21	0.393	0.392	1.22	1.08	1.10
	22	0.349	0.348	1.08	0.87	0.93
	23	0.280	0.280	0.87	0.64	0.76
Weekend	24	0.225	0.208	0.70	0.57	0.71
	25	0.183	0.186	0.57	0.48	0.65
	26	0.155	0.159	0.48	0.46	0.62
	27	0.147	0.148	0.46	0.45	0.61
	28	0.147	0.149	0.45	0.48	0.65
	29	0.154	0.155	0.48	0.55	0.66
	30	0.177	0.178	0.55	0.80	0.84
	31	0.259	0.260	0.80	1.15	1.03
	32	0.370	0.372	1.15	1.38	1.12
	33	0.444	0.448	1.38	1.50	1.22
	34	0.484	0.488	1.50	1.50	1.24
	35	0.484	0.488	1.50	1.46	1.27
	36	0.471	0.475	1.46	1.40	1.23
	37	0.450	0.455	1.40	1.32	1.24
	38	0.427	0.430	1.32	1.31	1.25
	39	0.421	0.426	1.31	1.19	1.22
	40	0.384	0.388	1.19	1.16	1.23
	41	0.375	0.379	1.16	1.21	1.27
	42	0.391	0.394	1.21	1.21	1.27
	43	0.390	0.393	1.21	1.20	1.21
	44	0.388	0.389	1.20	1.12	1.14
	45	0.362	0.364	1.12	1.01	1.07
	46	0.325	0.326	1.01	0.86	0.94
	47	0.276	0.278	0.86	0.70	0.78
Average						
	Weekday	0.320	0.320	0.99	0.99	0.99
	Weekend	0.329	0.331	1.02	1.02	1.02
	ADWF[1]	0.323	0.323	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		0.6%			

Notes:

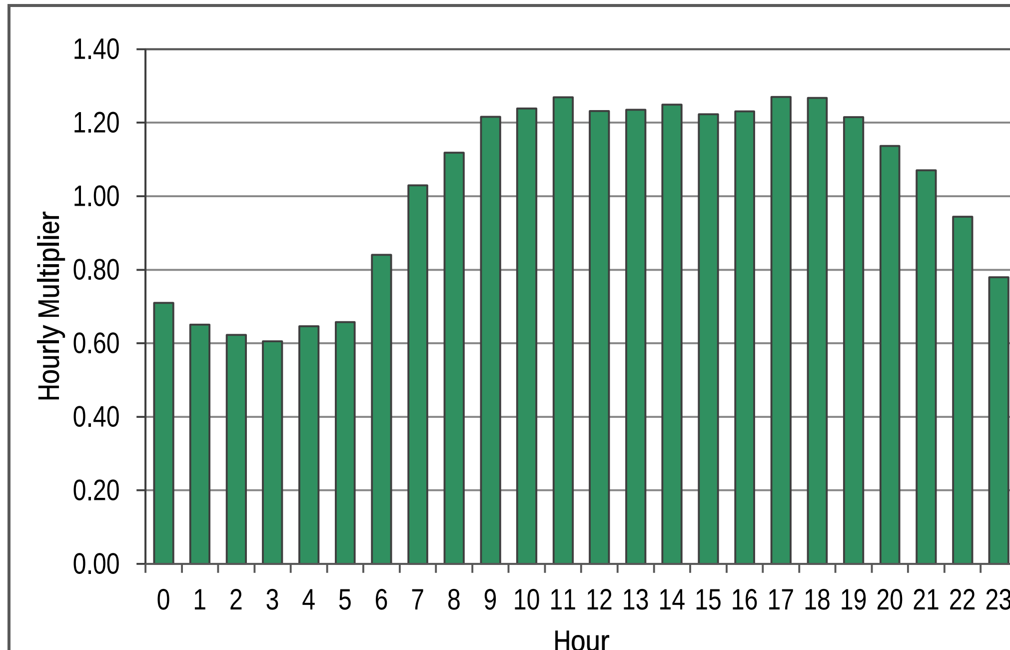
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

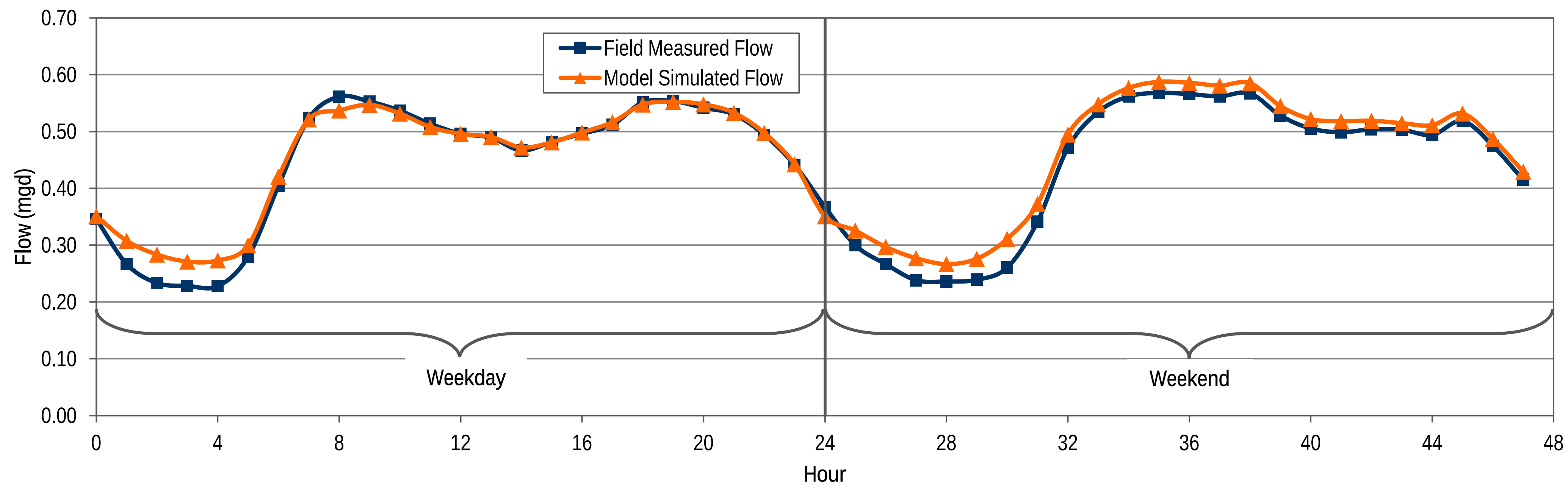
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84A DRY WEATHER CALIBRATION

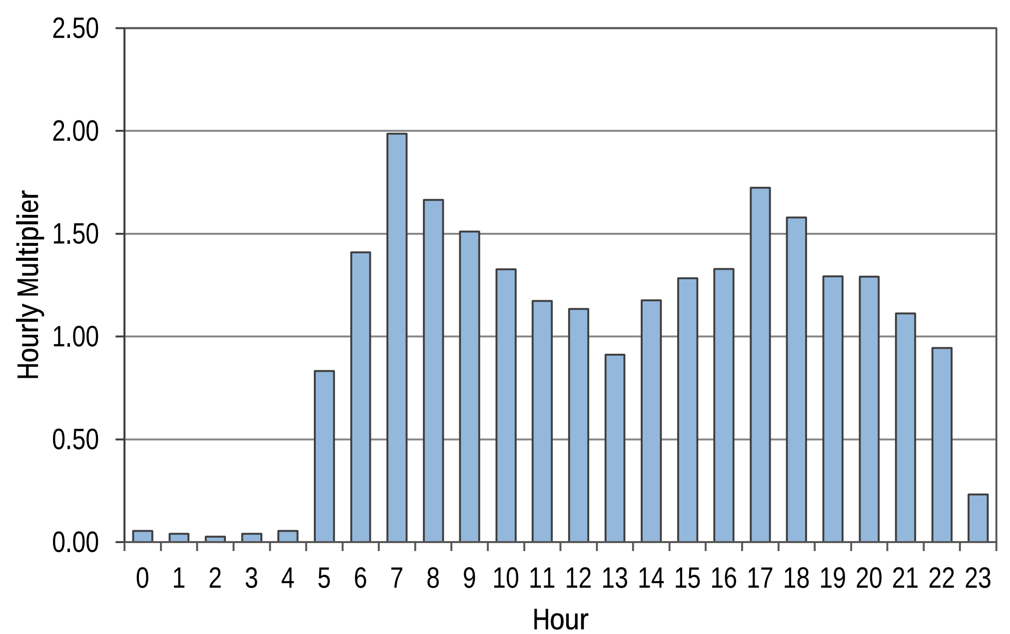
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.346	0.351	0.78	0.60	0.05
	1	0.267	0.308	0.60	0.52	0.04
	2	0.233	0.283	0.52	0.51	0.03
	3	0.228	0.271	0.51	0.51	0.04
	4	0.228	0.273	0.51	0.63	0.05
	5	0.280	0.300	0.63	0.91	0.83
	6	0.405	0.421	0.91	1.18	1.41
	7	0.523	0.521	1.18	1.26	1.99
	8	0.561	0.537	1.26	1.24	1.67
	9	0.553	0.547	1.24	1.21	1.51
	10	0.537	0.532	1.21	1.16	1.33
	11	0.514	0.508	1.16	1.12	1.17
	12	0.496	0.496	1.12	1.10	1.13
	13	0.489	0.490	1.10	1.05	0.91
	14	0.467	0.472	1.05	1.08	1.18
	15	0.481	0.481	1.08	1.12	1.28
	16	0.496	0.498	1.12	1.15	1.33
	17	0.512	0.516	1.15	1.24	1.72
	18	0.551	0.547	1.24	1.24	1.58
	19	0.553	0.552	1.24	1.22	1.29
	20	0.542	0.548	1.22	1.19	1.29
	21	0.530	0.533	1.19	1.11	1.11
	22	0.494	0.497	1.11	0.99	0.94
	23	0.441	0.442	0.99	0.78	0.23
Weekend	24	0.367	0.351	0.83	0.67	0.08
	25	0.300	0.326	0.67	0.60	0.07
	26	0.267	0.297	0.60	0.54	0.05
	27	0.238	0.277	0.54	0.53	0.07
	28	0.236	0.267	0.53	0.54	0.08
	29	0.239	0.276	0.54	0.59	0.10
	30	0.261	0.311	0.59	0.77	0.13
	31	0.341	0.373	0.77	1.06	1.07
	32	0.471	0.495	1.06	1.20	1.54
	33	0.534	0.548	1.20	1.26	1.64
	34	0.562	0.576	1.26	1.28	1.53
	35	0.568	0.587	1.28	1.27	1.48
	36	0.566	0.586	1.27	1.26	1.55
	37	0.562	0.581	1.26	1.28	1.82
	38	0.567	0.585	1.28	1.19	1.51
	39	0.528	0.545	1.19	1.14	1.28
	40	0.505	0.522	1.14	1.12	1.22
	41	0.499	0.518	1.12	1.13	1.33
	42	0.504	0.519	1.13	1.13	1.45
	43	0.503	0.515	1.13	1.11	1.24
	44	0.494	0.511	1.11	1.17	1.73
	45	0.518	0.532	1.17	1.07	1.34
	46	0.475	0.487	1.07	0.93	0.73
	47	0.415	0.429	0.93	0.83	0.63
Average						
	Weekday	0.447	0.455	1.01	1.01	1.01
	Weekend	0.438	0.459	0.99	0.99	0.99
	ADWF[1]	0.444	0.456	1.00	1.00	1.00
% Error						
	Weekday		1.8%			
	Weekend		4.7%			

Notes:

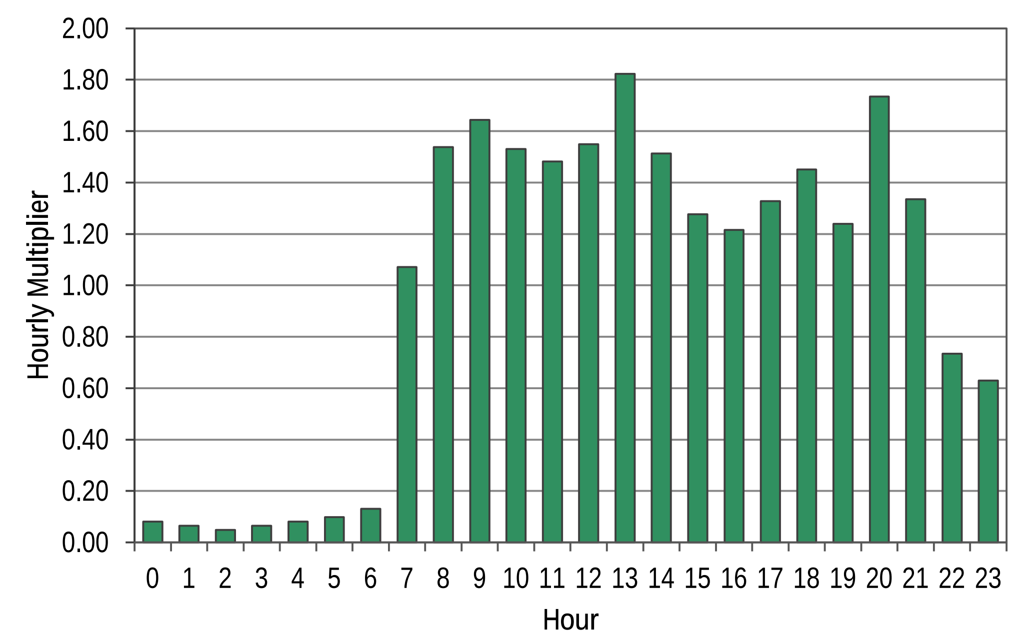
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

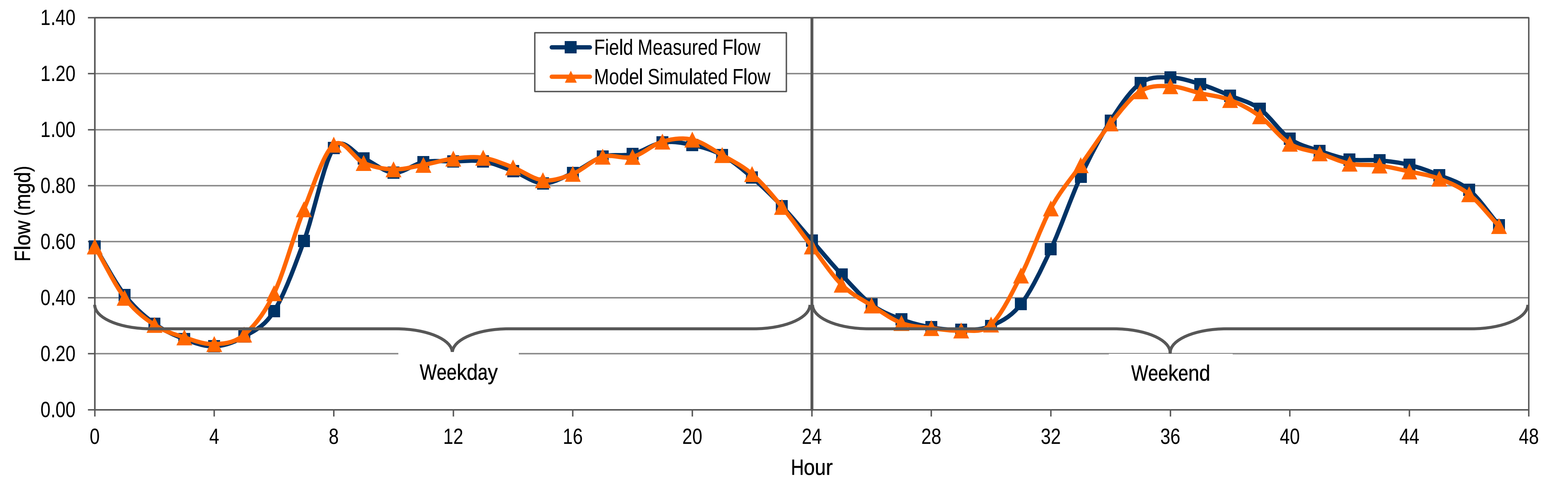
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84B DRY WEATHER CALIBRATION

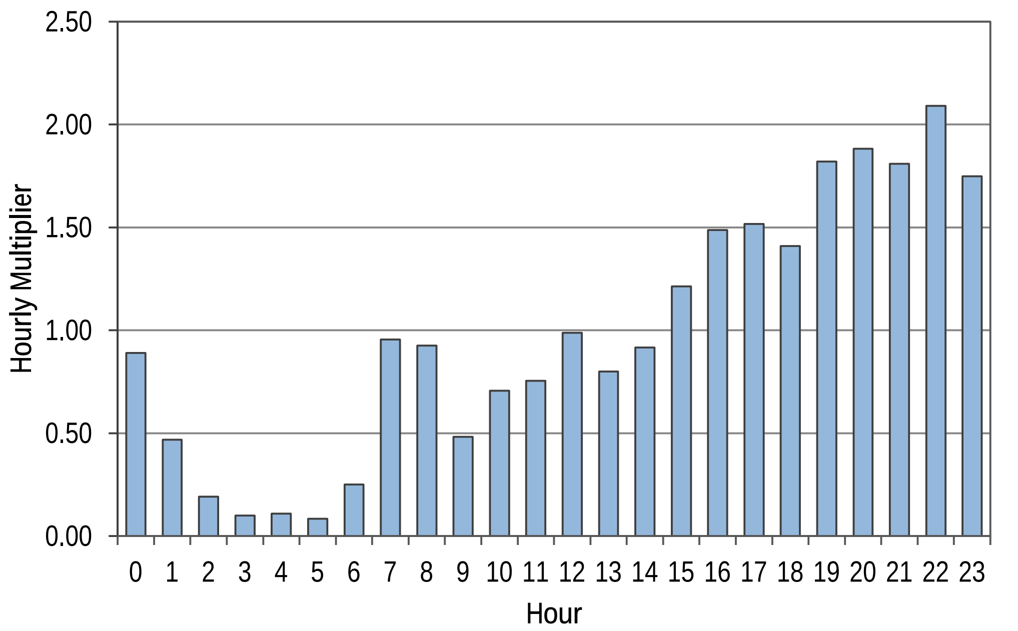
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.583	0.583	0.81	0.57	0.89
	1	0.410	0.400	0.57	0.43	0.47
	2	0.307	0.303	0.43	0.35	0.19
	3	0.252	0.258	0.35	0.31	0.10
	4	0.227	0.235	0.31	0.36	0.11
	5	0.261	0.268	0.36	0.49	0.08
	6	0.352	0.416	0.49	0.84	0.25
	7	0.603	0.716	0.84	1.30	0.96
	8	0.935	0.946	1.30	1.24	0.93
	9	0.897	0.881	1.24	1.17	0.48
	10	0.846	0.858	1.17	1.23	0.71
	11	0.884	0.874	1.23	1.23	0.75
	12	0.887	0.897	1.23	1.23	0.99
	13	0.887	0.900	1.23	1.18	0.80
	14	0.853	0.865	1.18	1.12	0.92
	15	0.809	0.819	1.12	1.17	1.21
	16	0.846	0.842	1.17	1.25	1.49
	17	0.903	0.904	1.25	1.27	1.52
	18	0.913	0.903	1.27	1.32	1.41
	19	0.954	0.957	1.32	1.31	1.82
	20	0.946	0.964	1.31	1.26	1.88
	21	0.909	0.909	1.26	1.15	1.81
	22	0.829	0.841	1.15	1.01	2.09
	23	0.727	0.724	1.01	0.81	1.75
Weekend	24	0.604	0.583	0.84	0.67	1.29
	25	0.482	0.447	0.67	0.52	0.79
	26	0.376	0.372	0.52	0.45	0.58
	27	0.323	0.310	0.45	0.41	0.42
	28	0.294	0.292	0.41	0.40	0.31
	29	0.285	0.283	0.40	0.42	0.19
	30	0.300	0.304	0.42	0.52	0.11
	31	0.377	0.479	0.52	0.79	0.06
	32	0.573	0.719	0.79	1.15	0.11
	33	0.833	0.873	1.15	1.43	0.68
	34	1.032	1.022	1.43	1.62	1.53
	35	1.166	1.137	1.62	1.65	1.92
	36	1.186	1.155	1.65	1.61	1.84
	37	1.163	1.130	1.61	1.56	1.85
	38	1.121	1.106	1.56	1.49	1.60
	39	1.074	1.048	1.49	1.34	1.70
	40	0.968	0.950	1.34	1.28	1.04
	41	0.924	0.915	1.28	1.24	0.82
	42	0.894	0.879	1.24	1.23	1.22
	43	0.890	0.872	1.23	1.21	1.32
	44	0.874	0.851	1.21	1.16	0.99
	45	0.837	0.825	1.16	1.09	1.52
	46	0.785	0.770	1.09	0.91	1.38
	47	0.659	0.656	0.91	0.84	1.73
Average						
	Weekday	0.709	0.719	0.98	0.98	0.98
	Weekend	0.751	0.749	1.04	1.04	1.04
	ADWF[1]	0.721	0.728	1.00	1.00	1.00
% Error						
	Weekday		1.5%			
	Weekend		-0.2%			

Notes:

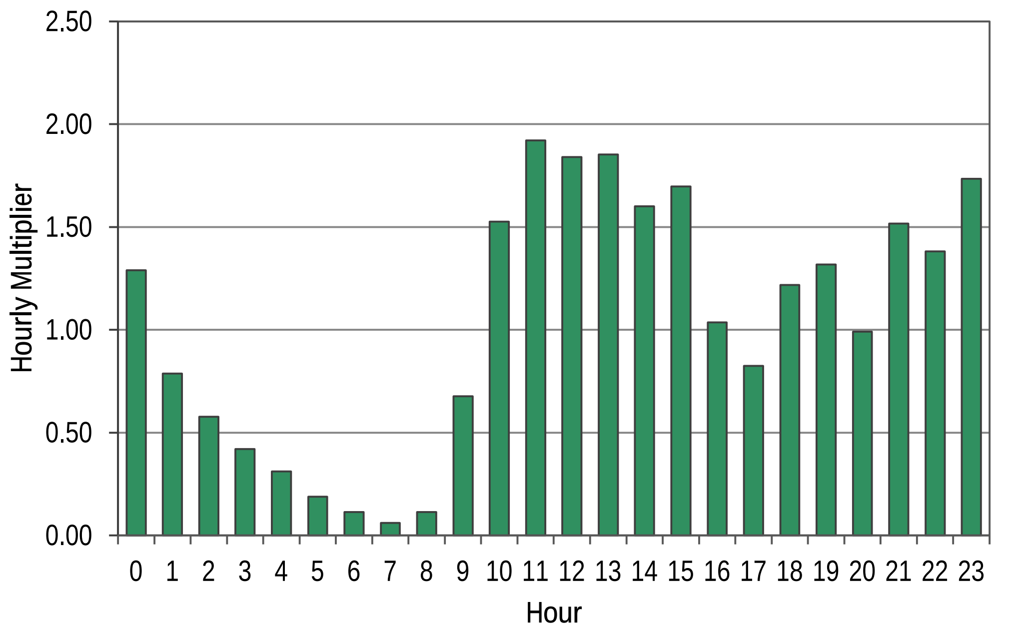
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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City of Oakland

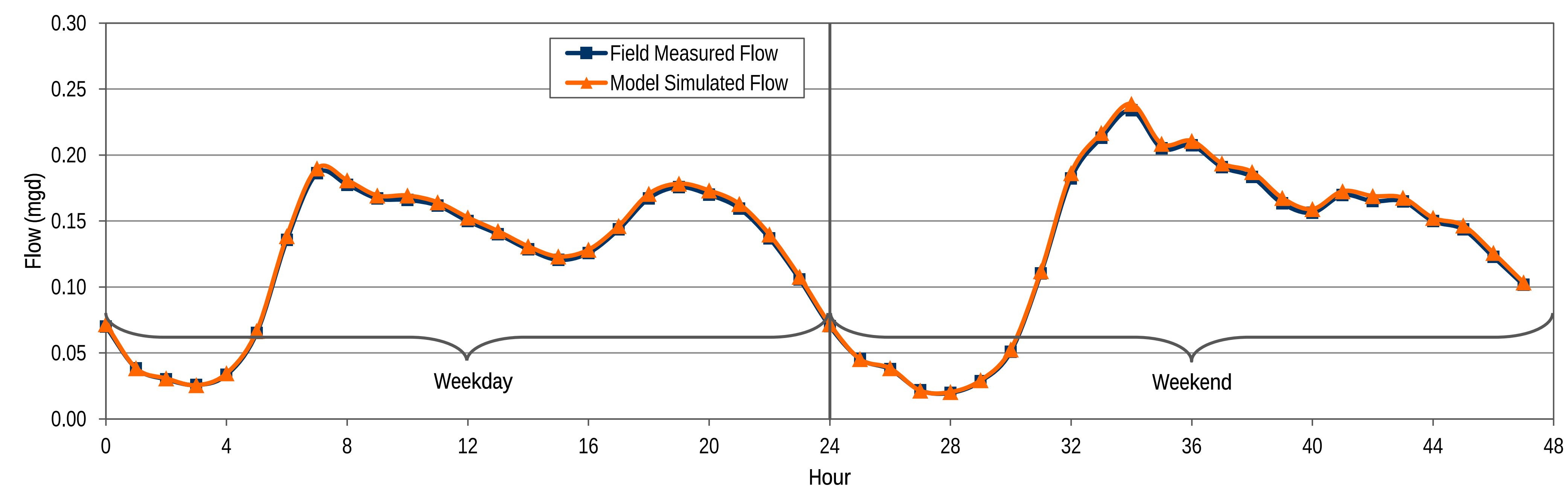
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84C DRY WEATHER CALIBRATION

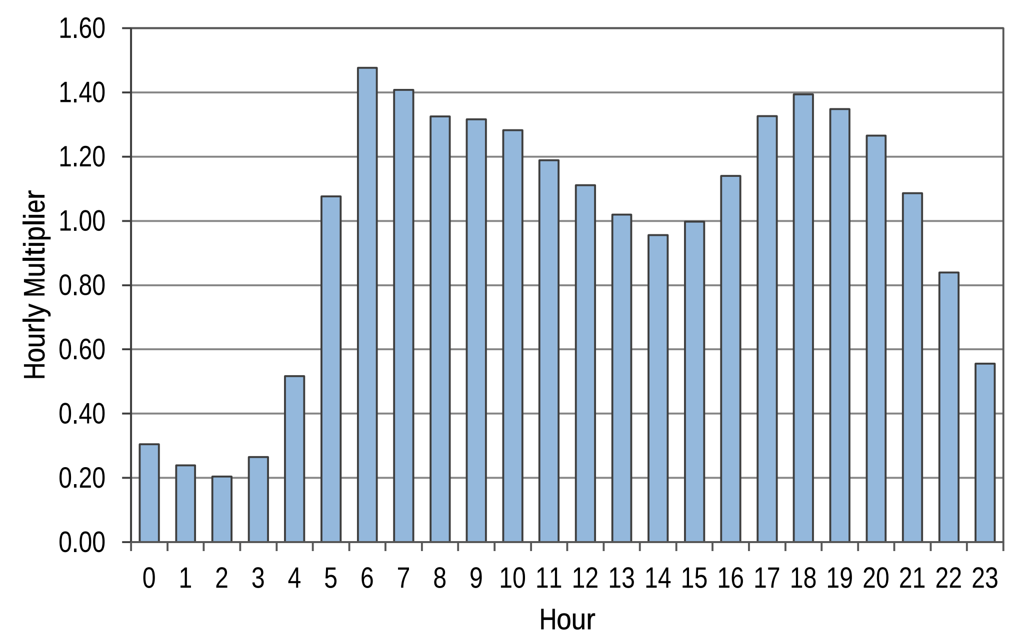
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.070	0.072	0.56	0.30	0.30
	1	0.038	0.038	0.30	0.24	0.24
	2	0.030	0.031	0.24	0.20	0.20
	3	0.026	0.026	0.20	0.27	0.27
	4	0.033	0.035	0.27	0.52	0.52
	5	0.065	0.067	0.52	1.08	1.08
	6	0.136	0.139	1.08	1.48	1.48
	7	0.186	0.190	1.48	1.41	1.41
	8	0.178	0.181	1.41	1.32	1.32
	9	0.167	0.169	1.32	1.32	1.32
	10	0.166	0.169	1.32	1.28	1.28
	11	0.162	0.164	1.28	1.19	1.19
	12	0.150	0.153	1.19	1.11	1.11
	13	0.140	0.142	1.11	1.02	1.02
	14	0.129	0.131	1.02	0.96	0.96
	15	0.121	0.123	0.96	1.00	1.00
	16	0.126	0.128	1.00	1.14	1.14
	17	0.144	0.146	1.14	1.33	1.33
	18	0.167	0.171	1.33	1.39	1.39
	19	0.176	0.178	1.39	1.35	1.35
	20	0.170	0.173	1.35	1.27	1.27
	21	0.160	0.163	1.27	1.09	1.09
	22	0.137	0.140	1.09	0.84	0.84
	23	0.106	0.108	0.84	0.56	0.56
Weekend	24	0.070	0.072	0.56	0.36	0.36
	25	0.046	0.045	0.36	0.30	0.30
	26	0.038	0.038	0.30	0.17	0.17
	27	0.022	0.022	0.17	0.16	0.16
	28	0.020	0.020	0.16	0.23	0.23
	29	0.029	0.029	0.23	0.40	0.40
	30	0.051	0.053	0.40	0.88	0.88
	31	0.110	0.112	0.88	1.45	1.45
	32	0.182	0.186	1.45	1.69	1.69
	33	0.213	0.217	1.69	1.85	1.85
	34	0.234	0.239	1.85	1.63	1.63
	35	0.205	0.209	1.63	1.64	1.64
	36	0.207	0.211	1.64	1.51	1.51
	37	0.191	0.194	1.51	1.45	1.45
	38	0.183	0.187	1.45	1.30	1.30
	39	0.163	0.167	1.30	1.24	1.24
	40	0.156	0.159	1.24	1.35	1.35
	41	0.170	0.173	1.35	1.31	1.31
	42	0.165	0.169	1.31	1.31	1.31
	43	0.165	0.168	1.31	1.19	1.19
	44	0.150	0.152	1.19	1.14	1.14
	45	0.144	0.147	1.14	0.97	0.97
	46	0.123	0.126	0.97	0.81	0.81
	47	0.102	0.103	0.81	0.56	0.56
Average						
	Weekday	0.124	0.127	0.99	0.99	0.99
	Weekend	0.131	0.133	1.04	1.04	1.04
	ADWF(1)	0.126	0.128	1.00	1.00	1.00
% Error						
	Weekday		1.9%			
	Weekend		1.9%			

Notes:

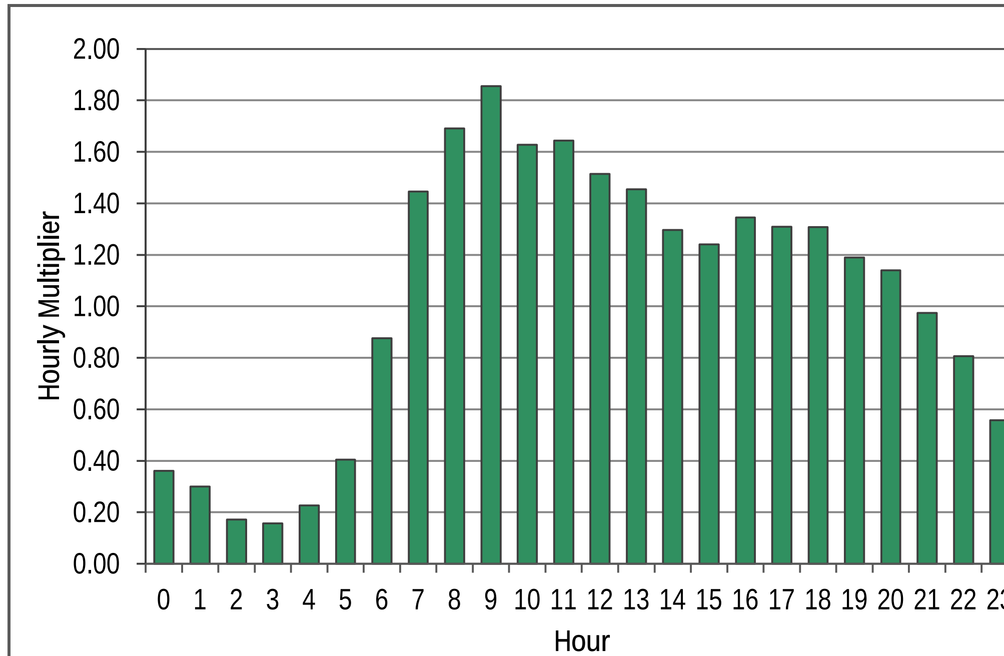
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

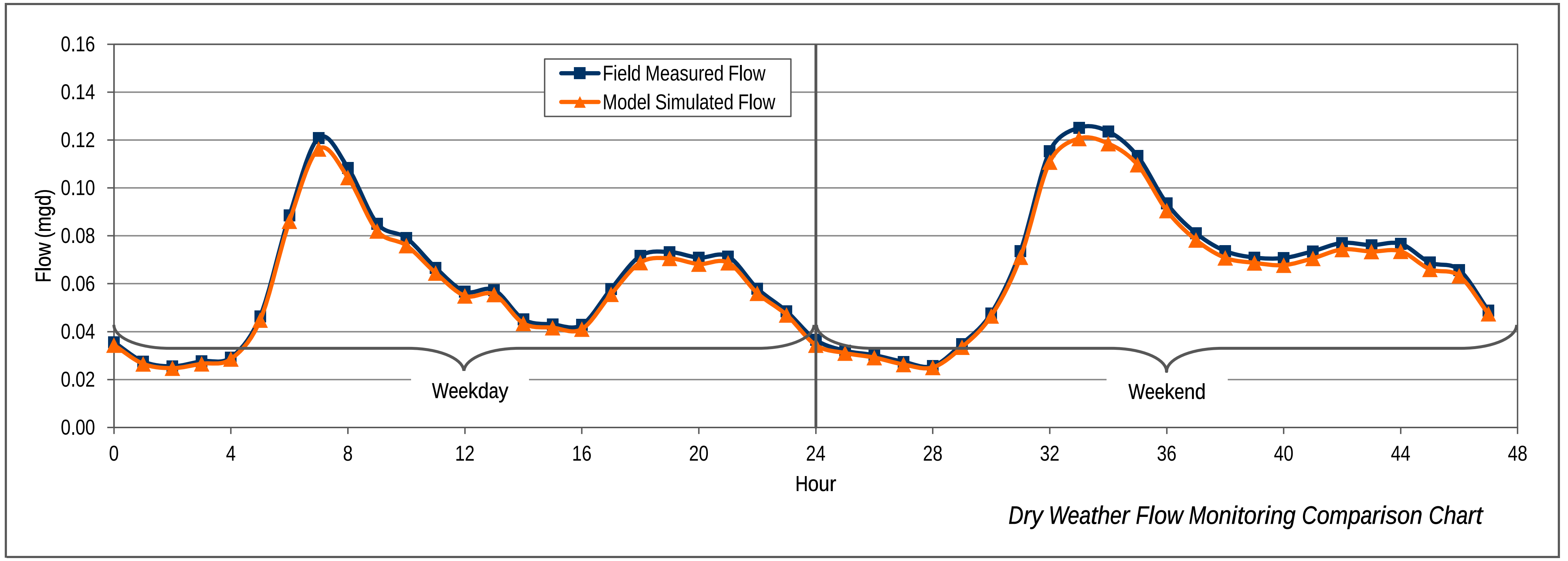
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84C.1 DRY WEATHER CALIBRATION

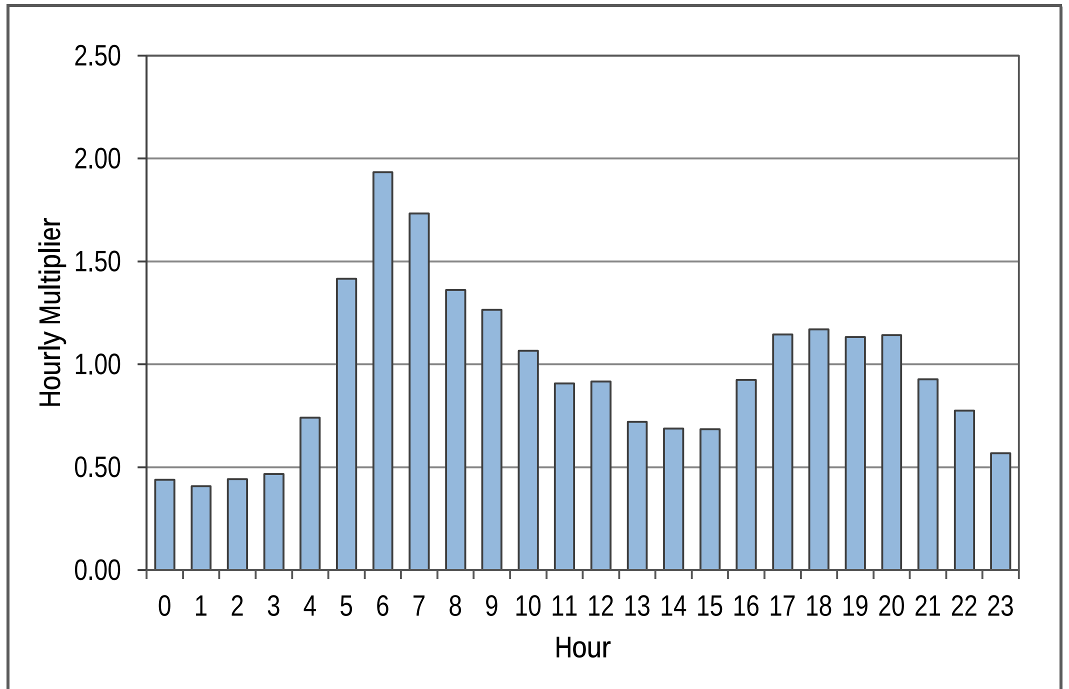
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.036	0.034	0.57	0.44	0.44
	1	0.027	0.027	0.44	0.41	0.41
	2	0.025	0.025	0.41	0.44	0.44
	3	0.028	0.027	0.44	0.47	0.47
	4	0.029	0.029	0.47	0.74	0.74
	5	0.046	0.045	0.74	1.42	1.42
	6	0.089	0.086	1.42	1.93	1.93
	7	0.121	0.116	1.93	1.73	1.73
	8	0.108	0.104	1.73	1.36	1.36
	9	0.085	0.082	1.36	1.26	1.26
	10	0.079	0.076	1.26	1.07	1.07
	11	0.067	0.064	1.07	0.91	0.91
	12	0.057	0.055	0.91	0.92	0.92
	13	0.057	0.055	0.92	0.72	0.72
	14	0.045	0.043	0.72	0.69	0.69
	15	0.043	0.042	0.69	0.68	0.68
	16	0.043	0.041	0.68	0.92	0.92
	17	0.058	0.056	0.92	1.14	1.14
	18	0.072	0.069	1.14	1.17	1.17
	19	0.073	0.071	1.17	1.13	1.13
	20	0.071	0.068	1.13	1.14	1.14
	21	0.071	0.069	1.14	0.93	0.93
	22	0.058	0.056	0.93	0.78	0.78
	23	0.048	0.047	0.78	0.57	0.57
Weekend	24	0.037	0.034	0.58	0.51	0.51
	25	0.032	0.031	0.51	0.48	0.48
	26	0.030	0.029	0.48	0.44	0.44
	27	0.027	0.026	0.44	0.41	0.41
	28	0.026	0.025	0.41	0.56	0.56
	29	0.035	0.034	0.56	0.76	0.76
	30	0.048	0.047	0.76	1.18	1.18
	31	0.074	0.071	1.18	1.84	1.84
	32	0.115	0.111	1.84	2.00	2.00
	33	0.125	0.121	2.00	1.98	1.98
	34	0.124	0.118	1.98	1.81	1.81
	35	0.113	0.110	1.81	1.50	1.50
	36	0.094	0.091	1.50	1.30	1.30
	37	0.081	0.078	1.30	1.18	1.18
	38	0.074	0.071	1.18	1.13	1.13
	39	0.071	0.069	1.13	1.13	1.13
	40	0.071	0.068	1.13	1.18	1.18
	41	0.074	0.071	1.18	1.23	1.23
	42	0.077	0.074	1.23	1.22	1.22
	43	0.076	0.073	1.22	1.23	1.23
	44	0.077	0.074	1.23	1.10	1.10
	45	0.069	0.066	1.10	1.05	1.05
	46	0.066	0.063	1.05	0.78	0.78
	47	0.049	0.047	0.78	0.58	0.58
Average						
	Weekday	0.060	0.058	0.96	0.96	0.96
	Weekend	0.069	0.067	1.11	1.11	1.11
	ADWF[1]	0.063	0.060	1.00	1.00	1.00
% Error						
	Weekday		-3.5%			
	Weekend		-3.6%			

Notes:

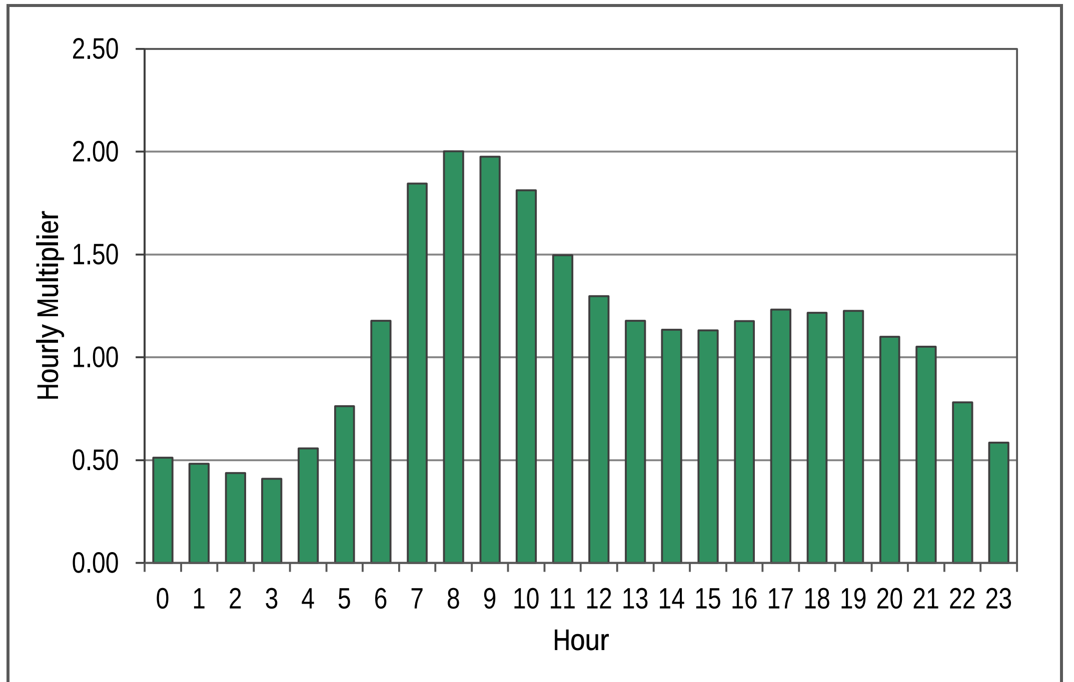
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

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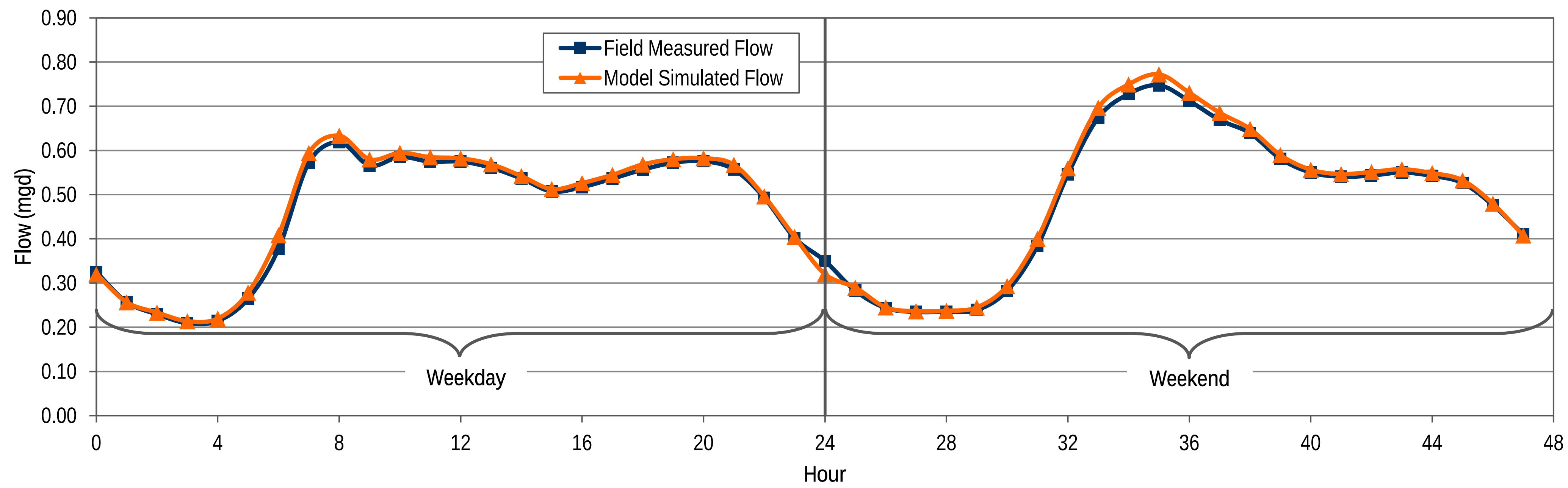
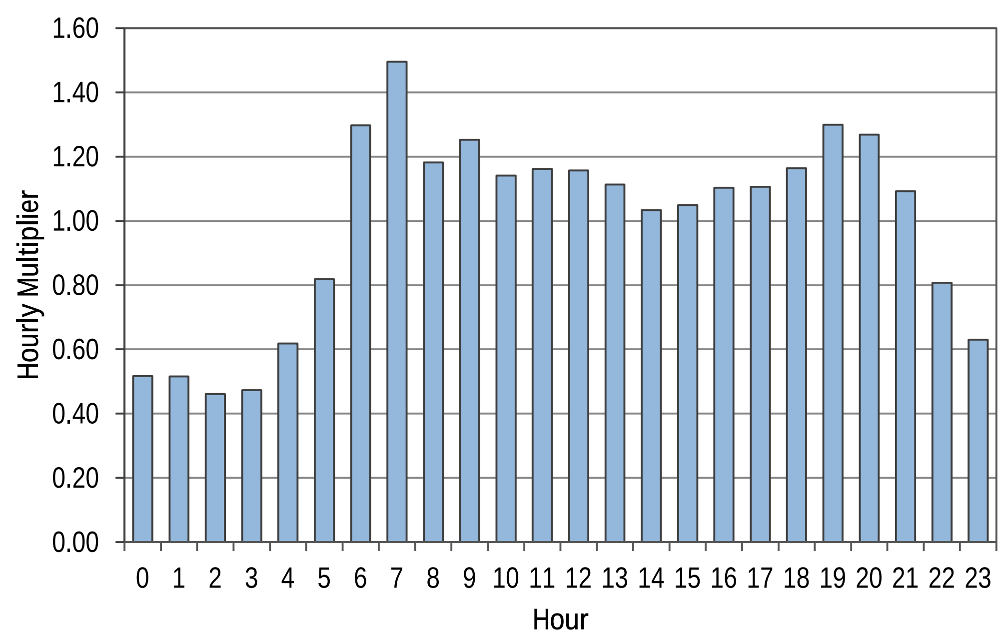
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84U-1 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.325	0.320	0.69	0.54	0.52
	1	0.257	0.256	0.54	0.49	0.52
	2	0.229	0.233	0.49	0.44	0.46
	3	0.209	0.213	0.44	0.45	0.47
	4	0.214	0.219	0.45	0.56	0.62
	5	0.265	0.278	0.56	0.80	0.82
	6	0.378	0.408	0.80	1.21	1.30
	7	0.572	0.594	1.21	1.31	1.50
	8	0.619	0.633	1.31	1.20	1.18
	9	0.566	0.580	1.20	1.24	1.25
	10	0.585	0.594	1.24	1.22	1.14
	11	0.574	0.585	1.22	1.22	1.16
	12	0.575	0.582	1.22	1.19	1.16
	13	0.561	0.569	1.19	1.14	1.11
	14	0.536	0.542	1.14	1.07	1.03
	15	0.507	0.512	1.07	1.10	1.05
	16	0.517	0.526	1.10	1.14	1.10
	17	0.536	0.545	1.14	1.18	1.11
	18	0.557	0.568	1.18	1.21	1.16
	19	0.572	0.580	1.21	1.22	1.30
	20	0.576	0.582	1.22	1.18	1.27
	21	0.557	0.568	1.18	1.04	1.09
	22	0.493	0.496	1.04	0.85	0.81
	23	0.402	0.404	0.85	0.69	0.63
Weekend	24	0.350	0.320	0.74	0.60	0.57
	25	0.283	0.290	0.60	0.52	0.40
	26	0.244	0.245	0.52	0.50	0.42
	27	0.235	0.236	0.50	0.50	0.44
	28	0.235	0.237	0.50	0.51	0.45
	29	0.239	0.245	0.51	0.60	0.53
	30	0.282	0.293	0.60	0.81	0.74
	31	0.384	0.400	0.81	1.16	1.28
	32	0.546	0.560	1.16	1.43	1.77
	33	0.674	0.697	1.43	1.54	1.94
	34	0.728	0.749	1.54	1.58	1.94
	35	0.747	0.772	1.58	1.51	1.73
	36	0.712	0.731	1.51	1.42	1.47
	37	0.669	0.685	1.42	1.35	1.38
	38	0.639	0.649	1.35	1.23	1.11
	39	0.581	0.590	1.23	1.17	1.03
	40	0.550	0.556	1.17	1.15	1.04
	41	0.541	0.546	1.15	1.15	1.04
	42	0.543	0.551	1.15	1.17	1.07
	43	0.550	0.557	1.17	1.15	1.02
	44	0.542	0.549	1.15	1.12	0.96
	45	0.526	0.532	1.12	1.01	0.83
	46	0.476	0.480	1.01	0.87	0.73
	47	0.410	0.408	0.87	0.74	0.74
Average						
	Weekday	0.466	0.475	0.99	0.99	0.99
	Weekend	0.487	0.495	1.03	1.03	1.03
	ADWF(1)	0.472	0.480	1.00	1.00	1.00
% Error						
	Weekday		1.8%			
	Weekend		1.6%			

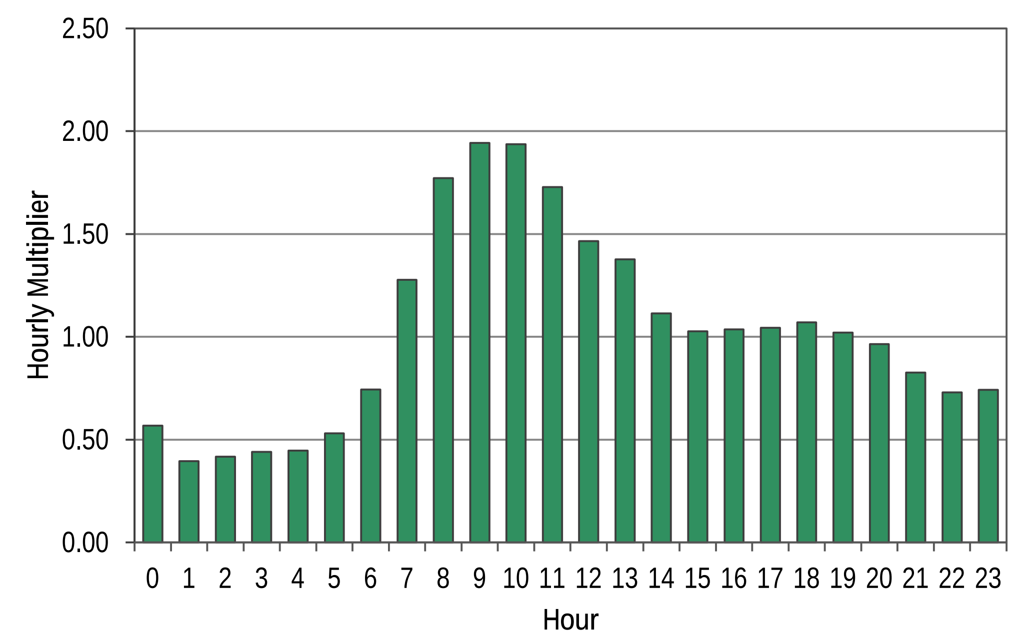
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

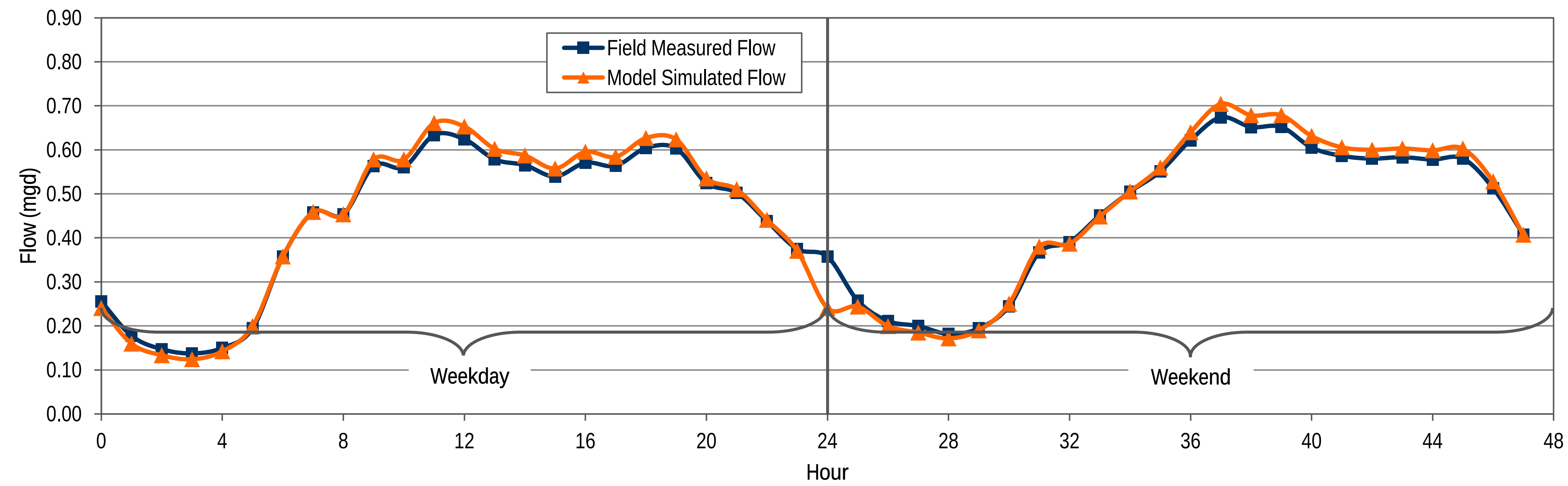
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-2 DRY WEATHER CALIBRATION

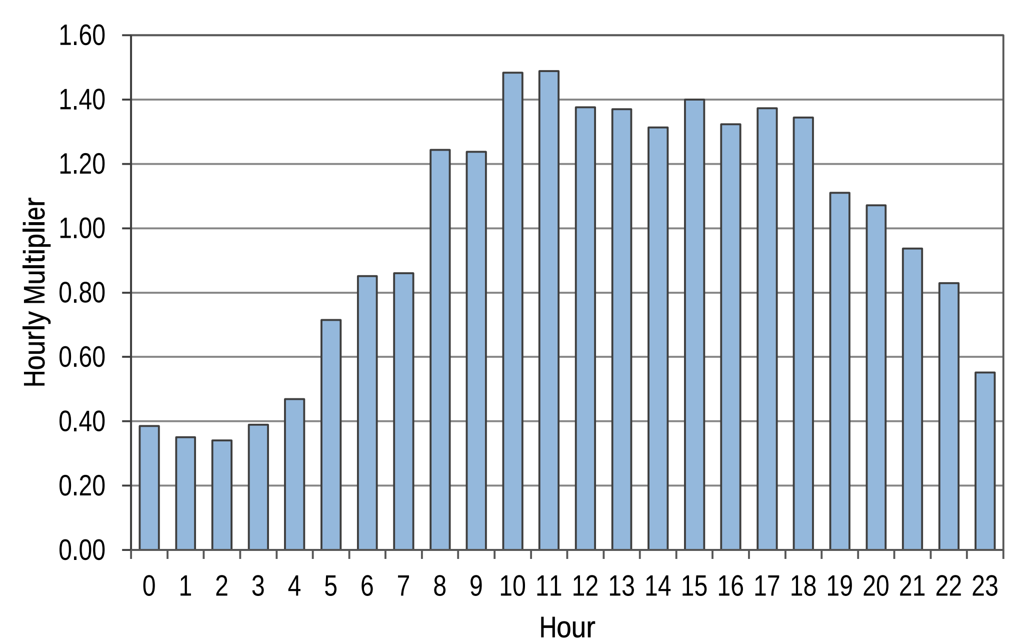
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.255	0.241	0.57	0.40	0.39
	1	0.177	0.160	0.40	0.33	0.35
	2	0.147	0.133	0.33	0.31	0.34
	3	0.138	0.124	0.31	0.34	0.39
	4	0.150	0.142	0.34	0.44	0.47
	5	0.194	0.200	0.44	0.80	0.71
	6	0.357	0.358	0.80	1.03	0.85
	7	0.458	0.459	1.03	1.02	0.86
	8	0.453	0.454	1.02	1.27	1.24
	9	0.563	0.578	1.27	1.26	1.24
	10	0.561	0.578	1.26	1.42	1.48
	11	0.633	0.661	1.42	1.40	1.49
	12	0.624	0.653	1.40	1.30	1.38
	13	0.578	0.603	1.30	1.27	1.37
	14	0.565	0.587	1.27	1.21	1.31
	15	0.539	0.558	1.21	1.28	1.40
	16	0.570	0.596	1.28	1.27	1.32
	17	0.564	0.584	1.27	1.36	1.37
	18	0.604	0.627	1.36	1.35	1.34
	19	0.603	0.624	1.35	1.18	1.11
	20	0.524	0.535	1.18	1.13	1.07
	21	0.502	0.511	1.13	0.98	0.94
	22	0.438	0.441	0.98	0.84	0.83
	23	0.375	0.371	0.84	0.57	0.55
Weekend	24	0.357	0.241	0.80	0.58	0.63
	25	0.257	0.244	0.58	0.47	0.53
	26	0.211	0.200	0.47	0.45	0.52
	27	0.200	0.185	0.45	0.41	0.51
	28	0.182	0.172	0.41	0.44	0.55
	29	0.194	0.190	0.44	0.55	0.66
	30	0.245	0.250	0.55	0.82	0.85
	31	0.367	0.380	0.82	0.88	0.65
	32	0.390	0.387	0.88	1.01	0.74
	33	0.451	0.449	1.01	1.13	0.84
	34	0.505	0.505	1.13	1.24	1.08
	35	0.551	0.560	1.24	1.40	1.30
	36	0.622	0.640	1.40	1.51	1.52
	37	0.674	0.704	1.51	1.46	1.47
	38	0.652	0.679	1.46	1.46	1.53
	39	0.652	0.679	1.46	1.36	1.41
	40	0.605	0.632	1.36	1.32	1.31
	41	0.586	0.606	1.32	1.30	1.30
	42	0.580	0.600	1.30	1.31	1.31
	43	0.583	0.603	1.31	1.30	1.34
	44	0.578	0.599	1.30	1.30	1.37
	45	0.580	0.603	1.30	1.15	1.22
	46	0.513	0.528	1.15	0.92	0.95
	47	0.407	0.407	0.92	0.80	0.87
Average						
Weekday		0.441	0.449	0.99	0.99	0.99
Weekend		0.456	0.460	1.02	1.02	1.02
ADWF[1]		0.445	0.452	1.00	1.00	1.00
% Error						
Weekday			1.9%			
Weekend			0.9%			

Notes:

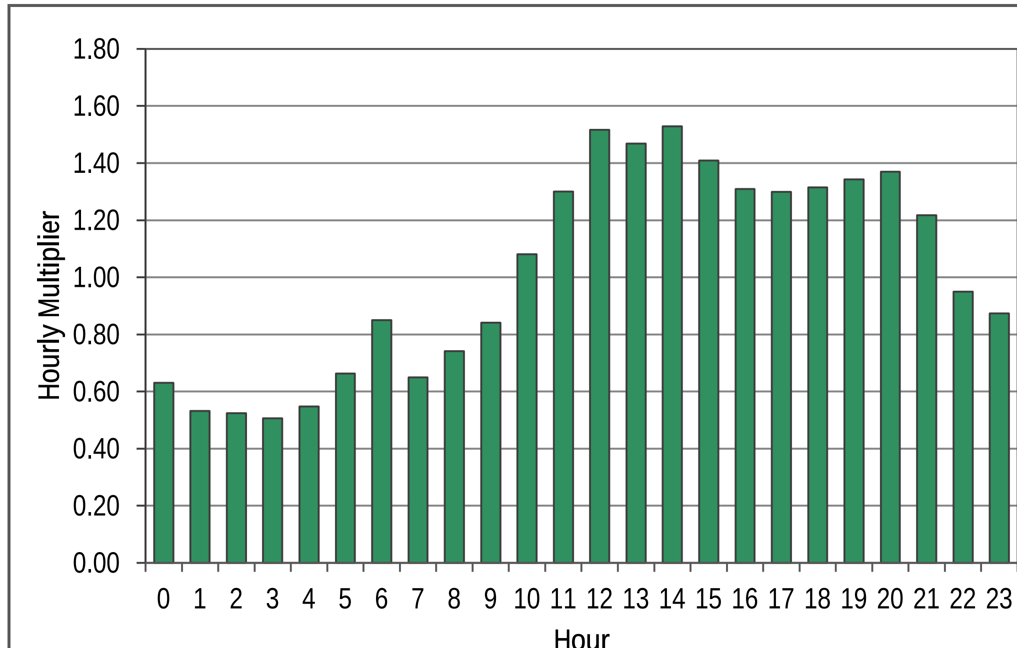
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

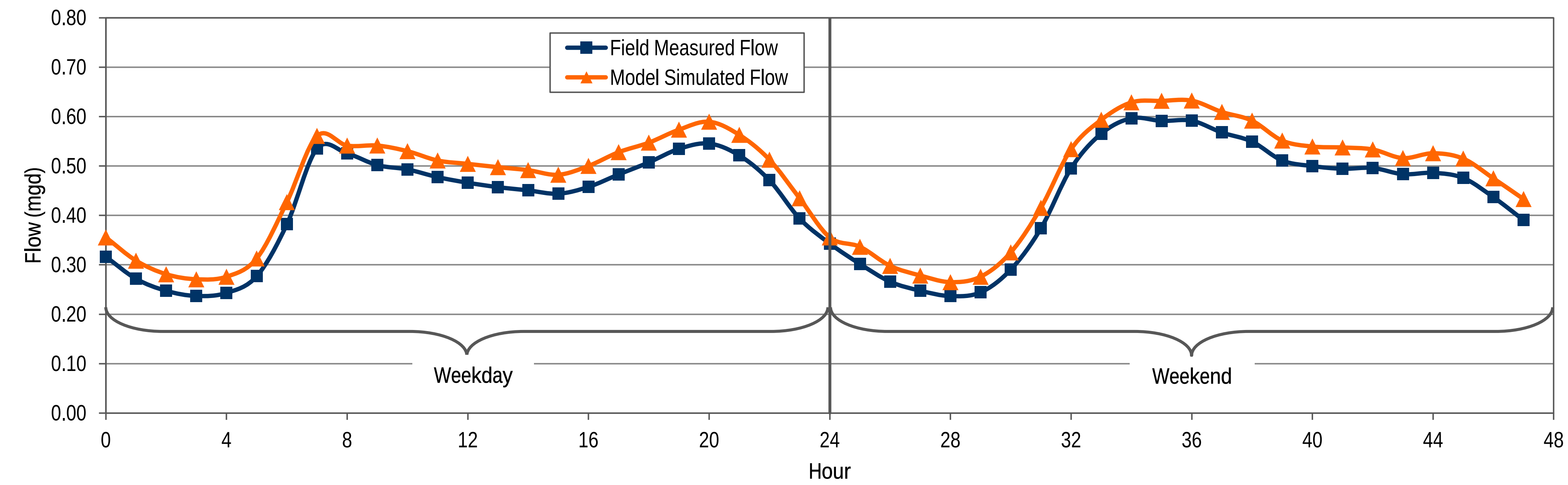
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-3 DRY WEATHER CALIBRATION

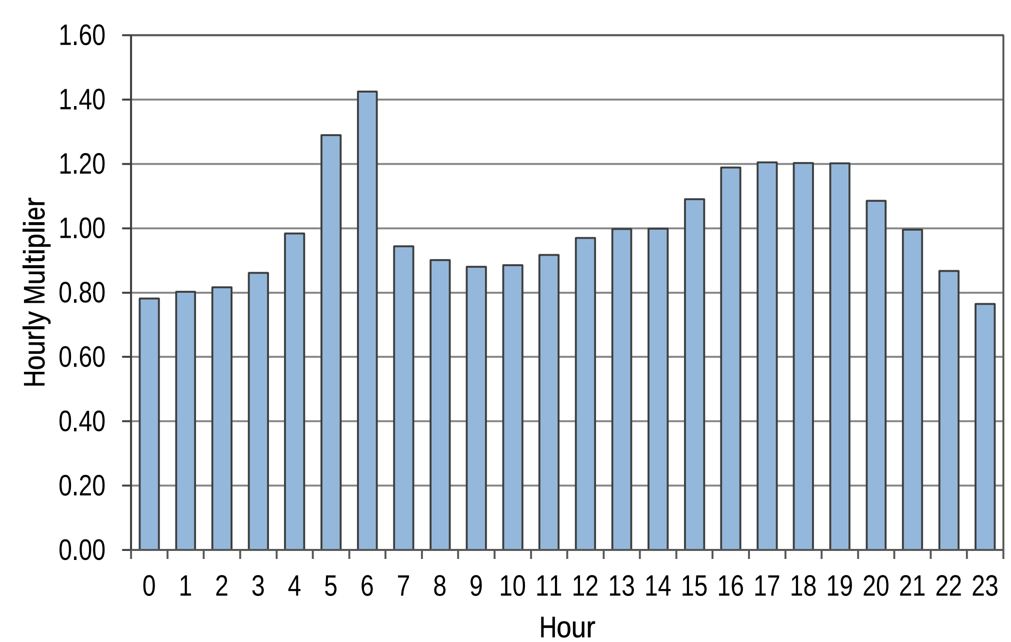
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.316	0.355	0.74	0.63	0.78
	1	0.272	0.308	0.63	0.58	0.80
	2	0.248	0.281	0.58	0.55	0.82
	3	0.237	0.271	0.55	0.57	0.86
	4	0.243	0.276	0.57	0.64	0.98
	5	0.277	0.313	0.64	0.89	1.29
	6	0.382	0.427	0.89	1.24	1.42
	7	0.536	0.561	1.24	1.22	0.94
	8	0.526	0.541	1.22	1.17	0.90
	9	0.502	0.541	1.17	1.15	0.88
	10	0.493	0.530	1.15	1.11	0.88
	11	0.478	0.511	1.11	1.08	0.92
	12	0.466	0.504	1.08	1.06	0.97
	13	0.457	0.498	1.06	1.05	1.00
	14	0.451	0.492	1.05	1.03	1.00
	15	0.444	0.482	1.03	1.06	1.09
	16	0.458	0.500	1.06	1.12	1.19
	17	0.483	0.528	1.12	1.18	1.20
	18	0.507	0.547	1.18	1.24	1.20
	19	0.535	0.574	1.24	1.27	1.20
	20	0.546	0.590	1.27	1.21	1.09
	21	0.522	0.563	1.21	1.10	1.00
	22	0.471	0.513	1.10	0.92	0.87
	23	0.394	0.435	0.92	0.74	0.77
Weekend	24	0.343	0.355	0.80	0.70	0.82
	25	0.302	0.336	0.70	0.62	0.80
	26	0.266	0.298	0.62	0.58	0.76
	27	0.248	0.278	0.58	0.55	0.74
	28	0.237	0.265	0.55	0.57	0.80
	29	0.245	0.276	0.57	0.68	0.96
	30	0.291	0.325	0.68	0.87	1.21
	31	0.374	0.415	0.87	1.15	1.44
	32	0.495	0.534	1.15	1.31	1.29
	33	0.566	0.594	1.31	1.39	1.12
	34	0.597	0.629	1.39	1.37	1.09
	35	0.591	0.632	1.37	1.38	1.07
	36	0.592	0.632	1.38	1.32	1.06
	37	0.568	0.609	1.32	1.28	1.03
	38	0.550	0.592	1.28	1.19	0.98
	39	0.511	0.552	1.19	1.16	0.99
	40	0.500	0.540	1.16	1.15	1.04
	41	0.495	0.538	1.15	1.15	1.04
	42	0.496	0.534	1.15	1.12	0.97
	43	0.484	0.516	1.12	1.13	1.01
	44	0.486	0.526	1.13	1.11	0.98
	45	0.476	0.515	1.11	1.02	0.92
	46	0.437	0.475	1.02	0.91	0.90
	47	0.391	0.433	0.91	0.80	0.86
Average						
Weekday		0.427	0.464	0.99	0.99	1.00
Weekend		0.439	0.475	1.02	1.02	0.99
ADWF[1]		0.430	0.467	1.00	1.00	1.00
% Error						
Weekday			8.8%			
Weekend			8.2%			

Notes:

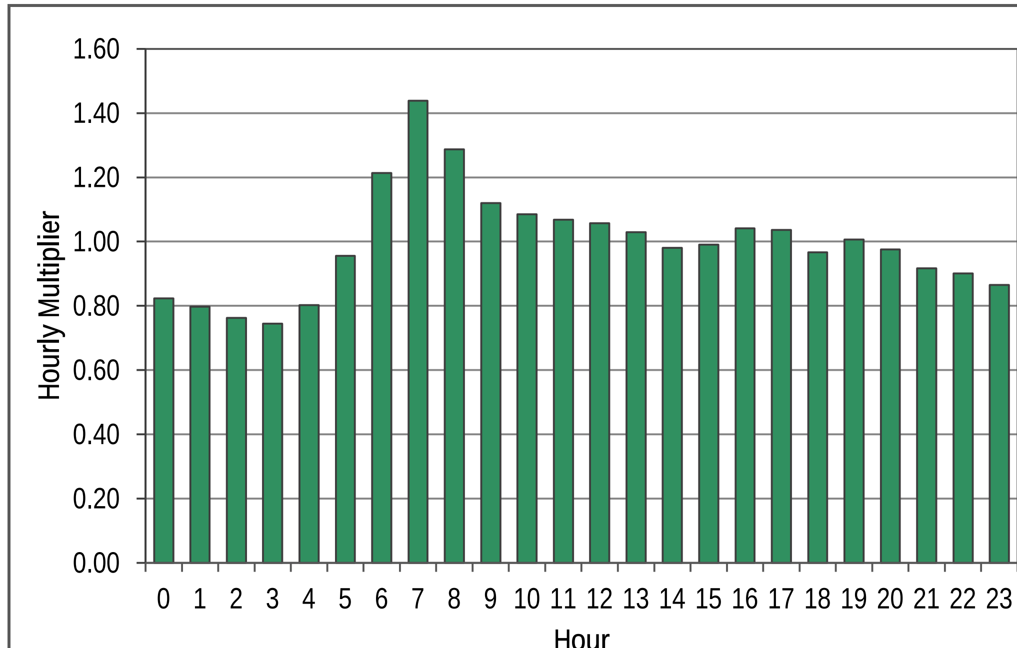
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

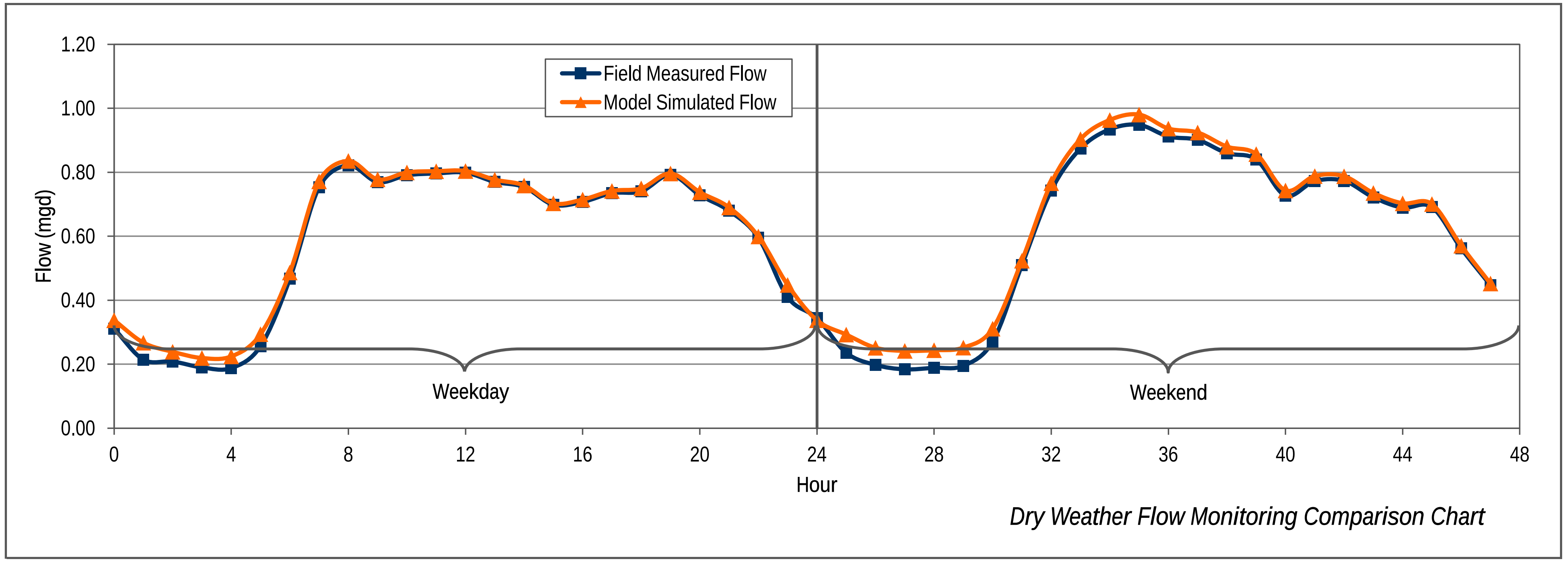
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-1X DRY WEATHER CALIBRATION

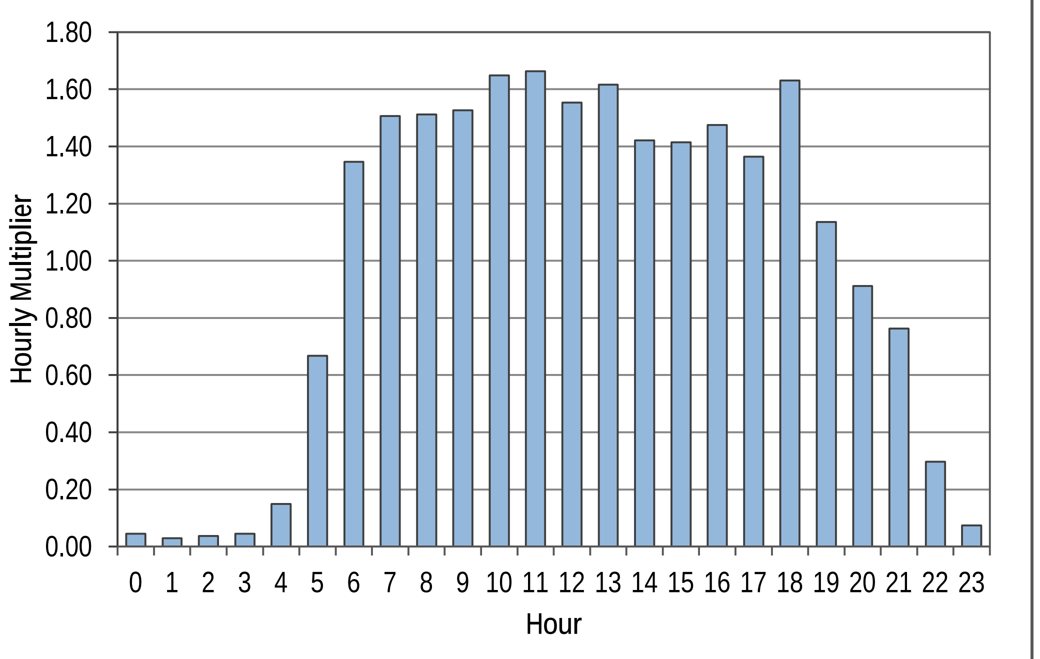
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.311	0.337	0.52	0.36	0.04
	1	0.214	0.267	0.36	0.35	0.03
	2	0.208	0.239	0.35	0.32	0.04
	3	0.190	0.219	0.32	0.32	0.04
	4	0.188	0.224	0.32	0.43	0.15
	5	0.257	0.294	0.43	0.79	0.67
	6	0.467	0.487	0.79	1.27	1.35
	7	0.754	0.771	1.27	1.38	1.51
	8	0.821	0.835	1.38	1.29	1.51
	9	0.769	0.778	1.29	1.33	1.53
	10	0.791	0.799	1.33	1.34	1.65
	11	0.796	0.803	1.34	1.34	1.66
	12	0.799	0.804	1.34	1.29	1.55
	13	0.770	0.777	1.29	1.27	1.62
	14	0.754	0.758	1.27	1.17	1.42
	15	0.698	0.703	1.17	1.19	1.42
	16	0.707	0.715	1.19	1.24	1.48
	17	0.735	0.742	1.24	1.24	1.36
	18	0.740	0.750	1.24	1.33	1.63
	19	0.791	0.796	1.33	1.22	1.14
	20	0.728	0.738	1.22	1.14	0.91
	21	0.679	0.690	1.14	1.00	0.76
	22	0.596	0.599	1.00	0.69	0.30
	23	0.410	0.448	0.69	0.52	0.07
Weekend	24	0.344	0.337	0.58	0.40	0.03
	25	0.236	0.293	0.40	0.33	0.02
	26	0.198	0.251	0.33	0.31	0.03
	27	0.184	0.242	0.31	0.32	0.05
	28	0.189	0.244	0.32	0.33	0.07
	29	0.195	0.252	0.33	0.46	0.16
	30	0.271	0.311	0.46	0.86	0.98
	31	0.510	0.523	0.86	1.25	1.53
	32	0.743	0.766	1.25	1.47	1.56
	33	0.874	0.903	1.47	1.57	1.61
	34	0.934	0.963	1.57	1.59	1.56
	35	0.948	0.980	1.59	1.53	1.55
	36	0.912	0.936	1.53	1.52	1.81
	37	0.901	0.924	1.52	1.45	1.72
	38	0.859	0.880	1.45	1.41	2.01
	39	0.840	0.857	1.41	1.22	1.38
	40	0.727	0.743	1.22	1.30	1.80
	41	0.772	0.788	1.30	1.30	1.79
	42	0.773	0.787	1.30	1.21	1.34
	43	0.722	0.735	1.21	1.16	1.14
	44	0.689	0.703	1.16	1.16	1.28
	45	0.691	0.701	1.16	0.95	0.67
	46	0.562	0.570	0.95	0.75	0.28
	47	0.447	0.452	0.75	0.58	0.05
Average						
Weekday		0.591	0.607	0.99	0.99	0.99
Weekend		0.605	0.631	1.02	1.02	1.02
ADWF[1]		0.595	0.614	1.00	1.00	1.00
% Error						
Weekday			2.8%			
Weekend			4.3%			

Notes:

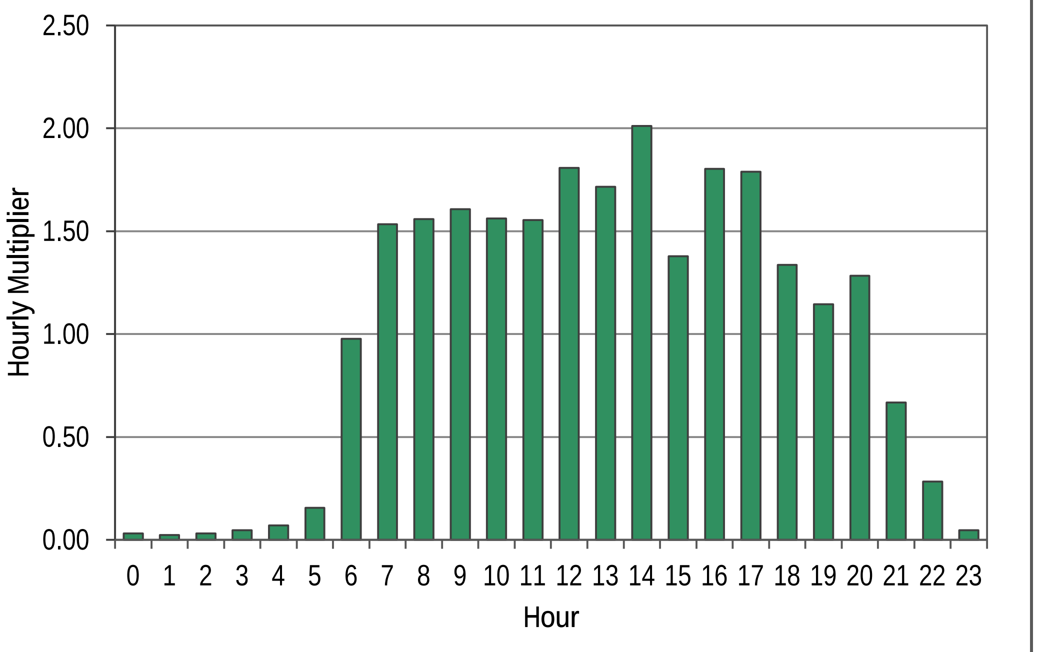
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

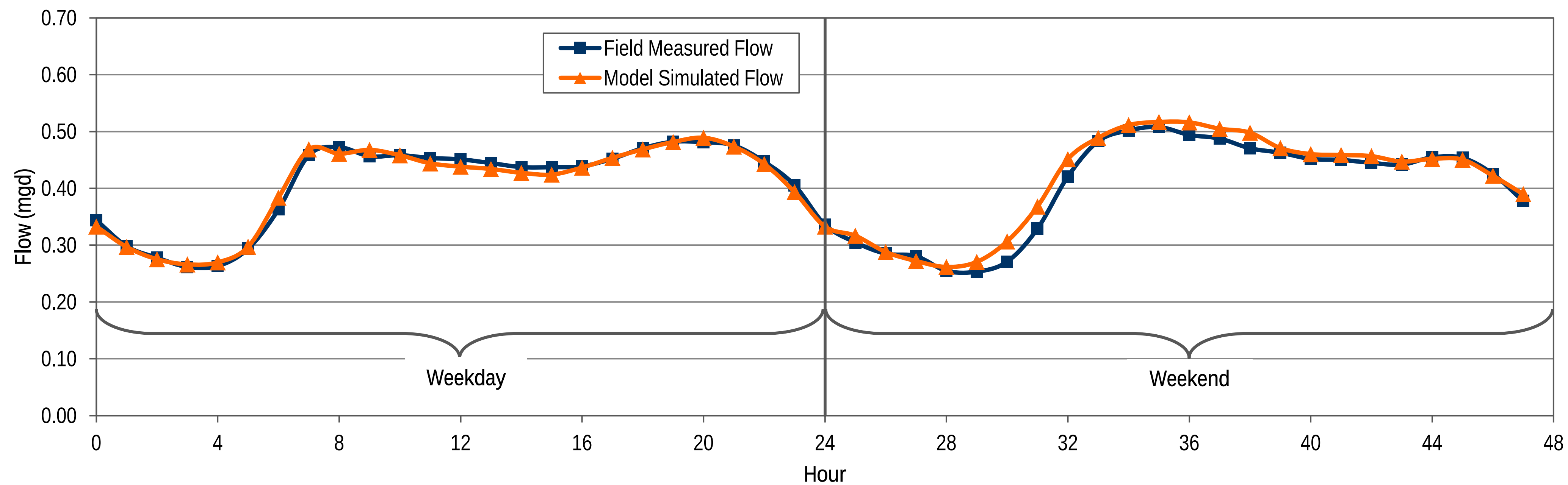
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-3X DRY WEATHER CALIBRATION

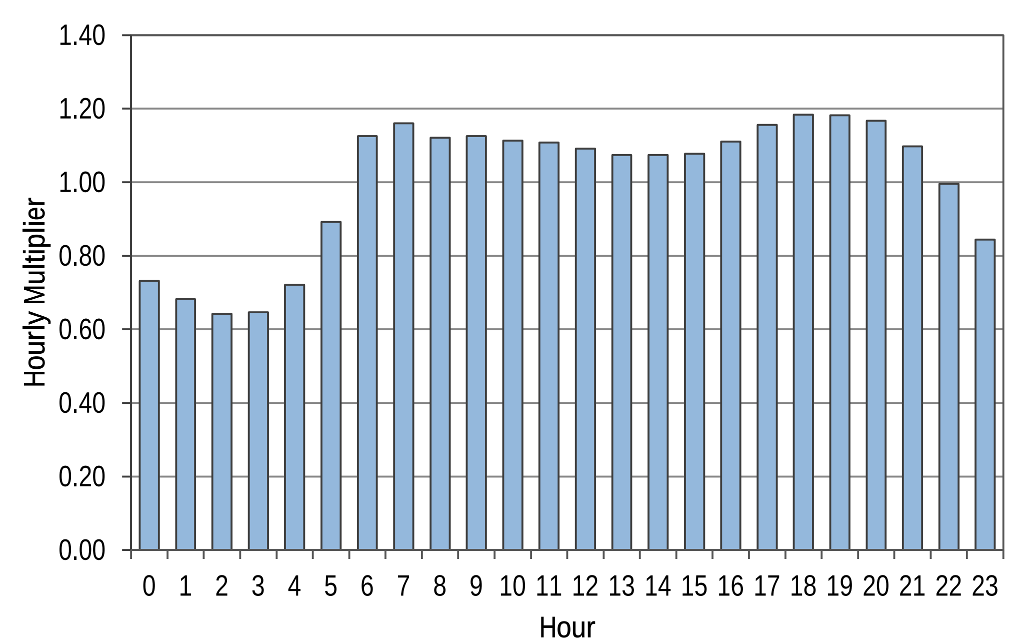
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.344	0.333	0.84	0.73	0.73
	1	0.298	0.297	0.73	0.68	0.68
	2	0.278	0.275	0.68	0.64	0.64
	3	0.262	0.266	0.64	0.65	0.65
	4	0.263	0.270	0.65	0.72	0.72
	5	0.294	0.297	0.72	0.89	0.89
	6	0.363	0.384	0.89	1.13	1.13
	7	0.458	0.469	1.13	1.16	1.16
	8	0.472	0.461	1.16	1.12	1.12
	9	0.457	0.468	1.12	1.13	1.13
	10	0.459	0.458	1.13	1.11	1.11
	11	0.453	0.444	1.11	1.11	1.11
	12	0.451	0.438	1.11	1.09	1.09
	13	0.445	0.434	1.09	1.07	1.07
	14	0.438	0.427	1.07	1.07	1.07
	15	0.437	0.424	1.07	1.08	1.08
	16	0.439	0.437	1.08	1.11	1.11
	17	0.452	0.454	1.11	1.16	1.16
	18	0.471	0.469	1.16	1.18	1.18
	19	0.482	0.482	1.18	1.18	1.18
	20	0.481	0.489	1.18	1.17	1.17
	21	0.476	0.474	1.17	1.10	1.10
	22	0.447	0.443	1.10	1.00	1.00
	23	0.405	0.393	1.00	0.84	0.84
Weekend	24	0.336	0.333	0.83	0.75	0.75
	25	0.305	0.317	0.75	0.70	0.70
	26	0.285	0.288	0.70	0.69	0.69
	27	0.281	0.272	0.69	0.63	0.63
	28	0.255	0.262	0.63	0.62	0.62
	29	0.253	0.271	0.62	0.67	0.67
	30	0.271	0.307	0.67	0.81	0.81
	31	0.329	0.368	0.81	1.03	1.03
	32	0.421	0.451	1.03	1.19	1.19
	33	0.483	0.489	1.19	1.23	1.23
	34	0.502	0.511	1.23	1.25	1.25
	35	0.508	0.517	1.25	1.21	1.21
	36	0.494	0.516	1.21	1.20	1.20
	37	0.488	0.505	1.20	1.16	1.16
	38	0.471	0.498	1.16	1.14	1.14
	39	0.463	0.471	1.14	1.11	1.11
	40	0.452	0.460	1.11	1.11	1.11
	41	0.450	0.459	1.11	1.09	1.09
	42	0.445	0.457	1.09	1.09	1.09
	43	0.442	0.447	1.09	1.12	1.12
	44	0.455	0.452	1.12	1.11	1.11
	45	0.454	0.451	1.11	1.04	1.04
	46	0.426	0.422	1.04	0.93	0.93
	47	0.378	0.390	0.93	0.83	0.83
Average						
	Weekday	0.409	0.408	1.01	1.01	1.01
	Weekend	0.402	0.413	0.99	0.99	0.99
	ADWF[(1)]	0.407	0.409	1.00	1.00	1.00
% Error						
	Weekday		-0.4%			
	Weekend		2.8%			

Notes:

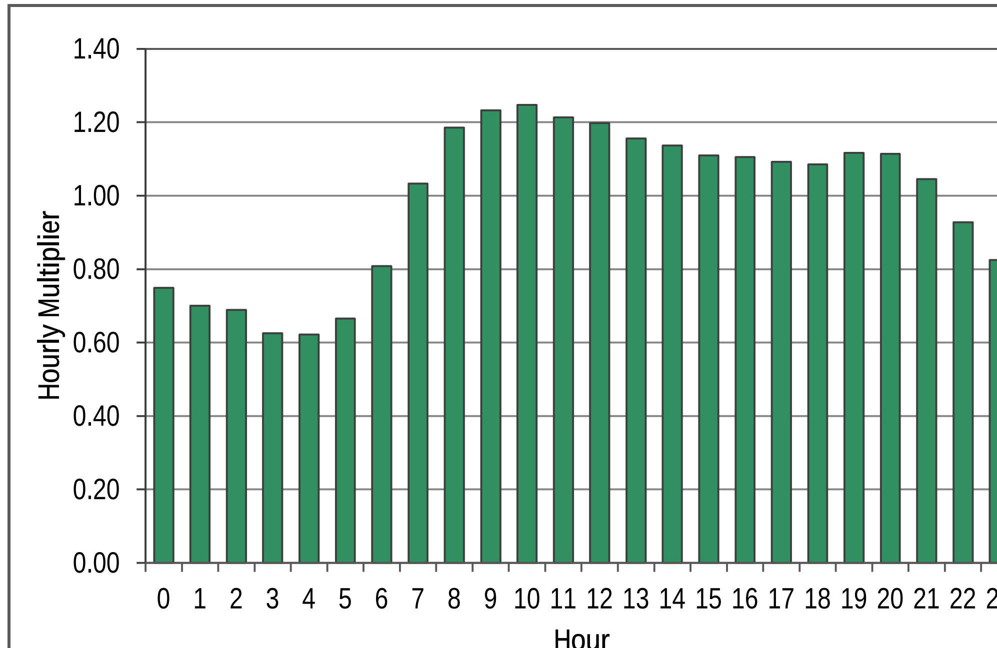
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal

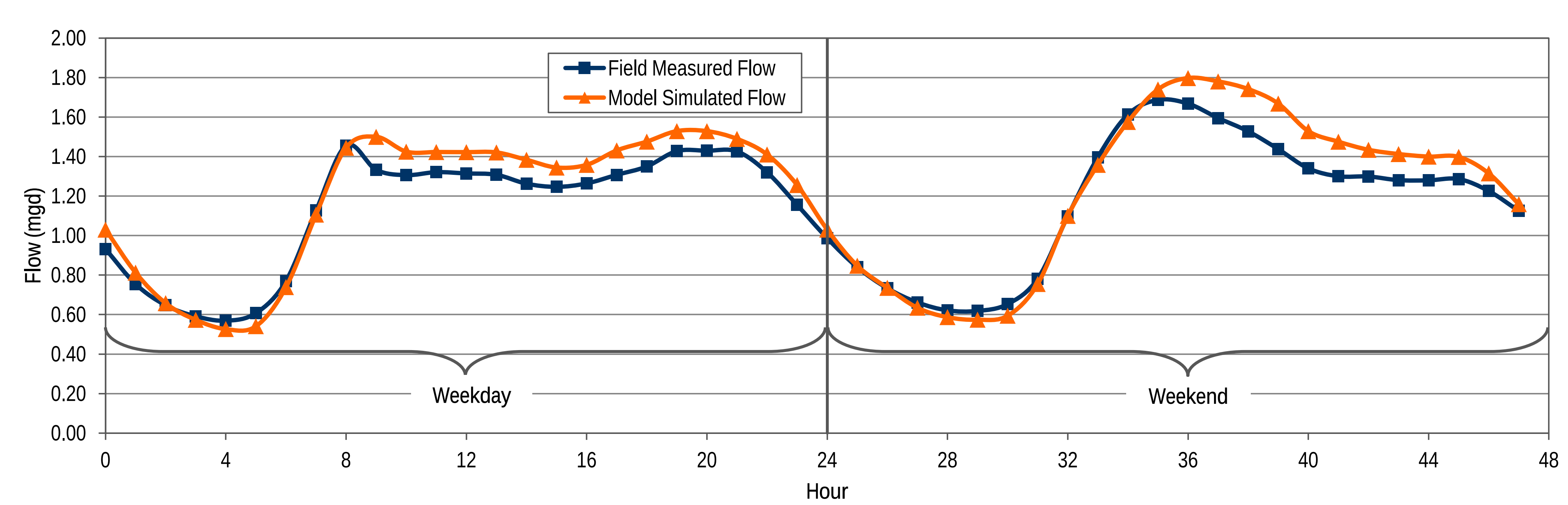


Dry Weather Flow Weekend Diurnal

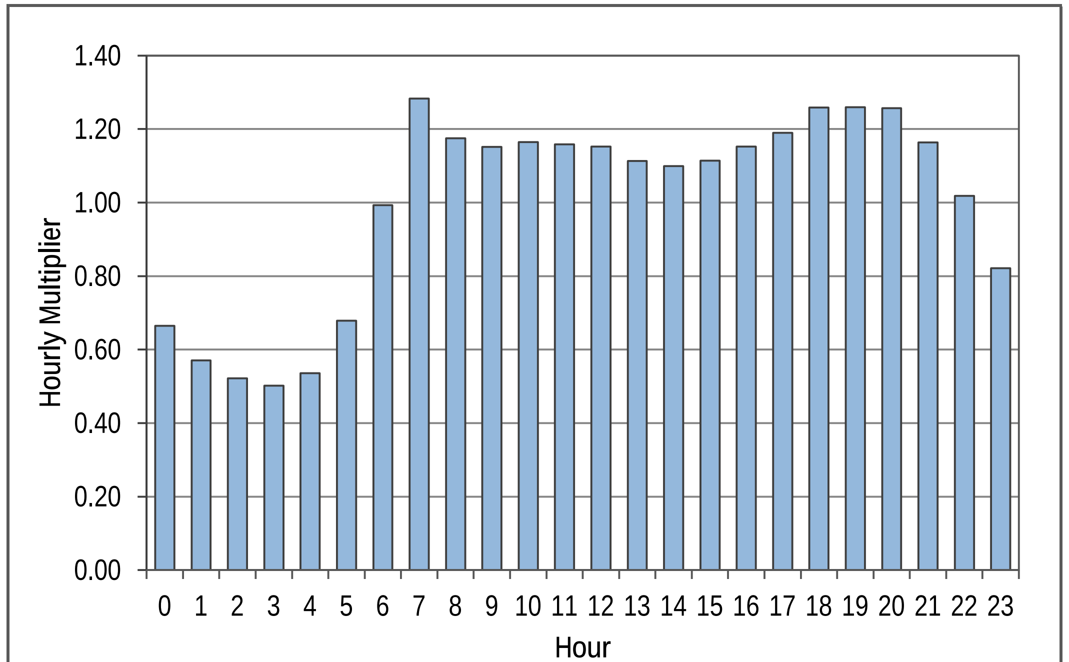
FLOW MONITORING SITE 84L-1 DRY WEATHER CALIBRATION

	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.932	1.030	0.81	0.66	0.67
	1	0.755	0.812	0.66	0.57	0.57
	2	0.647	0.658	0.57	0.52	0.52
	3	0.592	0.574	0.52	0.50	0.50
	4	0.570	0.527	0.50	0.53	0.54
	5	0.608	0.541	0.53	0.67	0.68
	6	0.770	0.739	0.67	0.98	0.99
	7	1.127	1.106	0.98	1.27	1.28
	8	1.455	1.445	1.27	1.16	1.17
	9	1.333	1.500	1.16	1.14	1.15
	10	1.306	1.425	1.14	1.15	1.16
	11	1.321	1.423	1.15	1.15	1.16
	12	1.315	1.422	1.15	1.14	1.15
	13	1.308	1.421	1.14	1.10	1.11
	14	1.263	1.384	1.10	1.09	1.10
	15	1.247	1.344	1.09	1.10	1.11
	16	1.264	1.358	1.10	1.14	1.15
	17	1.307	1.431	1.14	1.18	1.19
	18	1.350	1.476	1.18	1.25	1.26
	19	1.427	1.529	1.25	1.25	1.26
	20	1.429	1.529	1.25	1.25	1.26
	21	1.426	1.489	1.25	1.15	1.16
	22	1.320	1.410	1.15	1.01	1.02
	23	1.155	1.256	1.01	0.81	0.82
Weekend	24	0.987	1.030	0.86	0.73	0.72
	25	0.840	0.847	0.73	0.64	0.63
	26	0.734	0.735	0.64	0.58	0.57
	27	0.662	0.635	0.58	0.54	0.53
	28	0.622	0.587	0.54	0.54	0.53
	29	0.619	0.574	0.54	0.57	0.56
	30	0.653	0.594	0.57	0.68	0.67
	31	0.781	0.755	0.68	0.96	0.94
	32	1.098	1.100	0.96	1.22	1.19
	33	1.396	1.358	1.22	1.41	1.38
	34	1.612	1.575	1.41	1.47	1.44
	35	1.687	1.740	1.47	1.46	1.43
	36	1.668	1.797	1.46	1.39	1.36
	37	1.595	1.780	1.39	1.33	1.31
	38	1.528	1.741	1.33	1.26	1.23
	39	1.438	1.668	1.26	1.17	1.15
	40	1.340	1.529	1.17	1.14	1.11
	41	1.300	1.475	1.14	1.14	1.11
	42	1.299	1.434	1.14	1.12	1.10
	43	1.281	1.413	1.12	1.12	1.09
	44	1.280	1.400	1.12	1.12	1.10
	45	1.286	1.398	1.12	1.07	1.05
	46	1.226	1.315	1.07	0.98	0.96
	47	1.125	1.159	0.98	0.86	0.86
Average						
Weekday		1.134	1.201	0.99	0.99	1.00
Weekend		1.169	1.235	1.02	1.02	1.00
ADWF[(1)]		1.144	1.211	1.00	1.00	1.00
% Error						
Weekday			5.9%			
Weekend			5.7%			

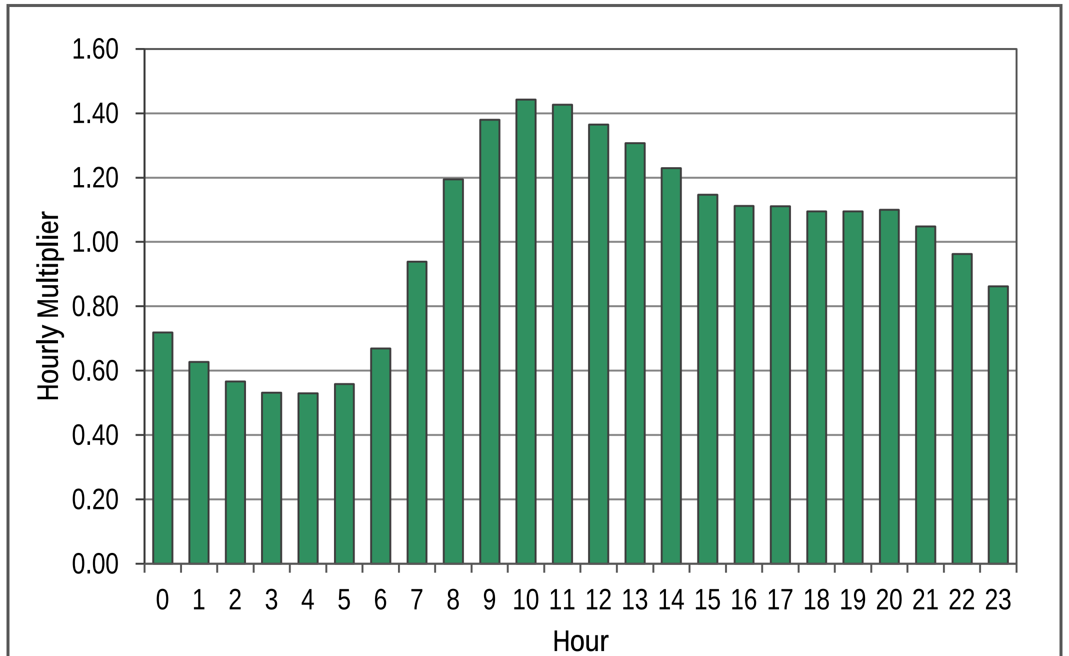
Notes:
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

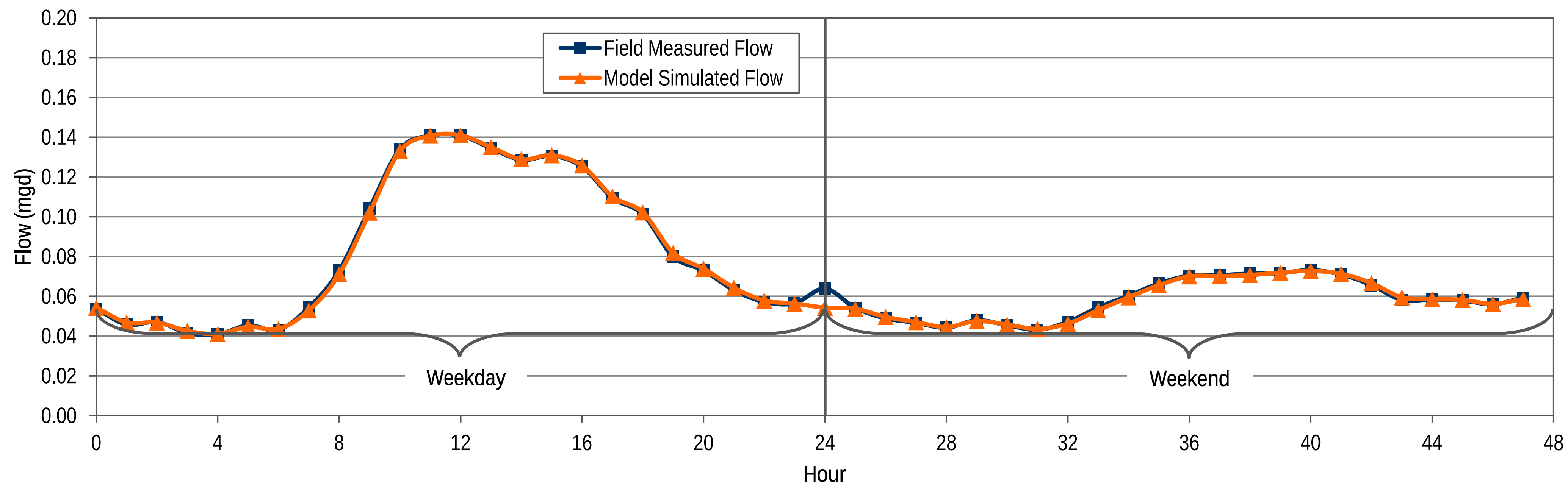
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84L-2 DRY WEATHER CALIBRATION

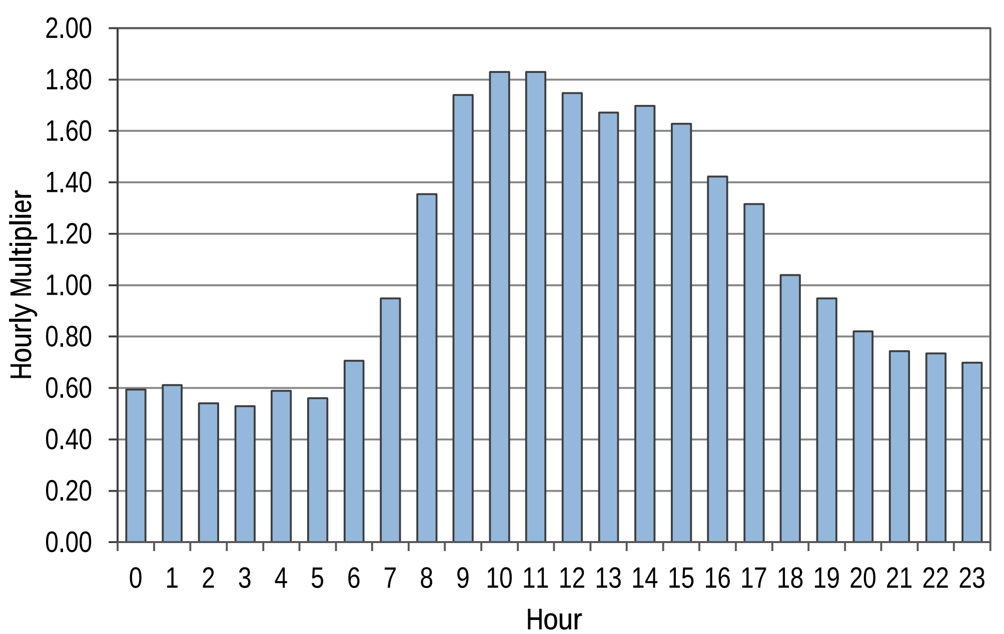
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.054	0.054	0.70	0.59	0.59
	1	0.046	0.047	0.59	0.61	0.61
	2	0.047	0.047	0.61	0.54	0.54
	3	0.042	0.043	0.54	0.53	0.53
	4	0.041	0.041	0.53	0.59	0.59
	5	0.045	0.045	0.59	0.56	0.56
	6	0.043	0.044	0.56	0.71	0.71
	7	0.054	0.053	0.71	0.95	0.95
	8	0.073	0.071	0.95	1.35	1.35
	9	0.104	0.102	1.35	1.74	1.74
	10	0.134	0.133	1.74	1.83	1.83
	11	0.141	0.141	1.83	1.83	1.83
	12	0.141	0.141	1.83	1.75	1.75
	13	0.135	0.135	1.75	1.67	1.67
	14	0.129	0.129	1.67	1.70	1.70
	15	0.131	0.131	1.70	1.63	1.63
	16	0.125	0.126	1.63	1.42	1.42
	17	0.109	0.110	1.42	1.32	1.32
	18	0.101	0.102	1.32	1.04	1.04
	19	0.080	0.082	1.04	0.95	0.95
	20	0.073	0.074	0.95	0.82	0.82
	21	0.063	0.064	0.82	0.74	0.74
	22	0.057	0.058	0.74	0.73	0.73
	23	0.056	0.056	0.73	0.70	0.70
Weekend	24	0.064	0.054	0.83	0.70	0.70
	25	0.054	0.054	0.70	0.64	0.64
	26	0.049	0.050	0.64	0.61	0.61
	27	0.047	0.047	0.61	0.57	0.57
	28	0.044	0.045	0.57	0.62	0.62
	29	0.048	0.048	0.62	0.59	0.59
	30	0.045	0.046	0.59	0.56	0.56
	31	0.043	0.044	0.56	0.61	0.61
	32	0.047	0.046	0.61	0.71	0.71
	33	0.054	0.053	0.71	0.78	0.78
	34	0.060	0.059	0.78	0.86	0.86
	35	0.066	0.066	0.86	0.91	0.91
	36	0.070	0.070	0.91	0.92	0.92
	37	0.071	0.070	0.92	0.93	0.93
	38	0.071	0.071	0.93	0.93	0.93
	39	0.072	0.072	0.93	0.95	0.95
	40	0.073	0.073	0.95	0.92	0.92
	41	0.071	0.071	0.92	0.85	0.85
	42	0.066	0.067	0.85	0.76	0.76
	43	0.058	0.059	0.76	0.76	0.76
	44	0.058	0.059	0.76	0.75	0.75
	45	0.058	0.058	0.75	0.73	0.73
	46	0.056	0.056	0.73	0.77	0.77
	47	0.059	0.059	0.77	0.83	0.83
Average						
	Weekday	0.084	0.085	1.10	1.10	1.10
	Weekend	0.059	0.058	0.76	0.76	0.76
	ADWF[1]	0.077	0.077	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		-0.8%			

Notes:

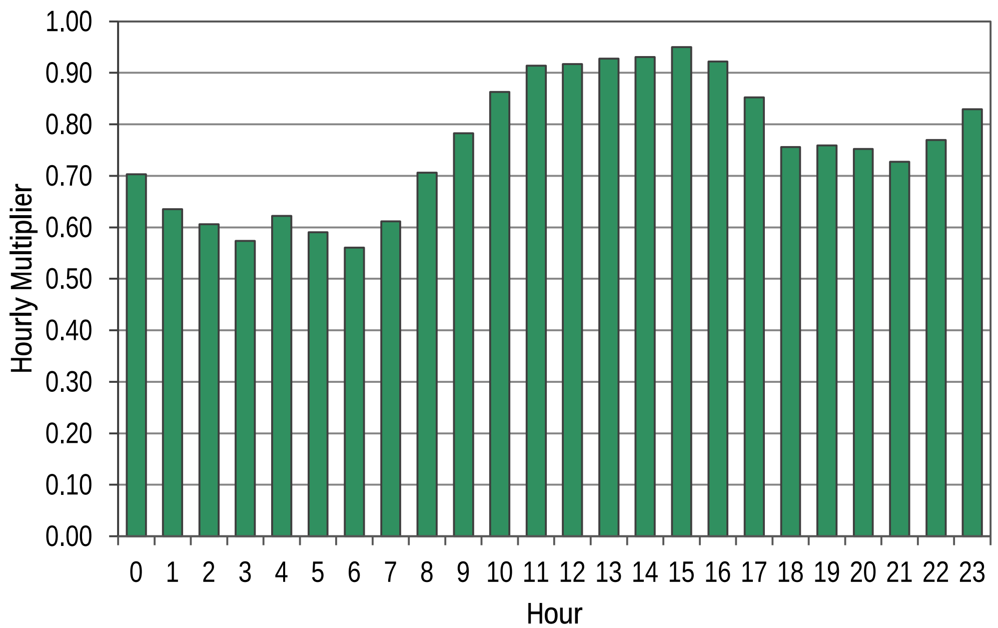
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_84.xlsx

City of Oakland

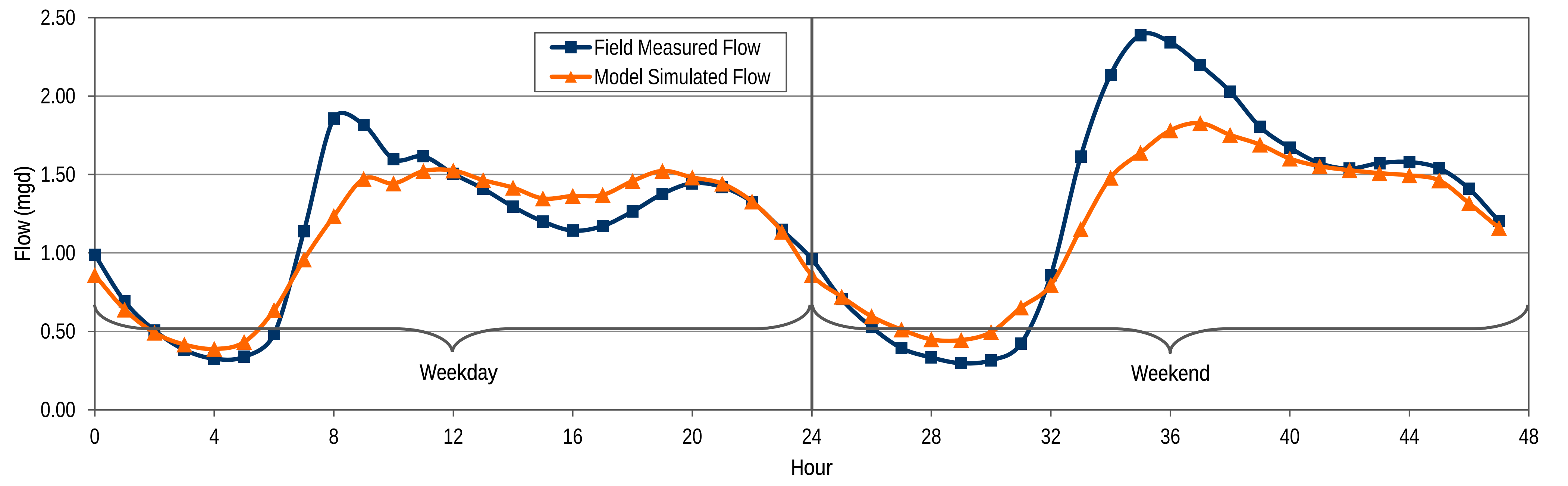
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-F DRY WEATHER CALIBRATION

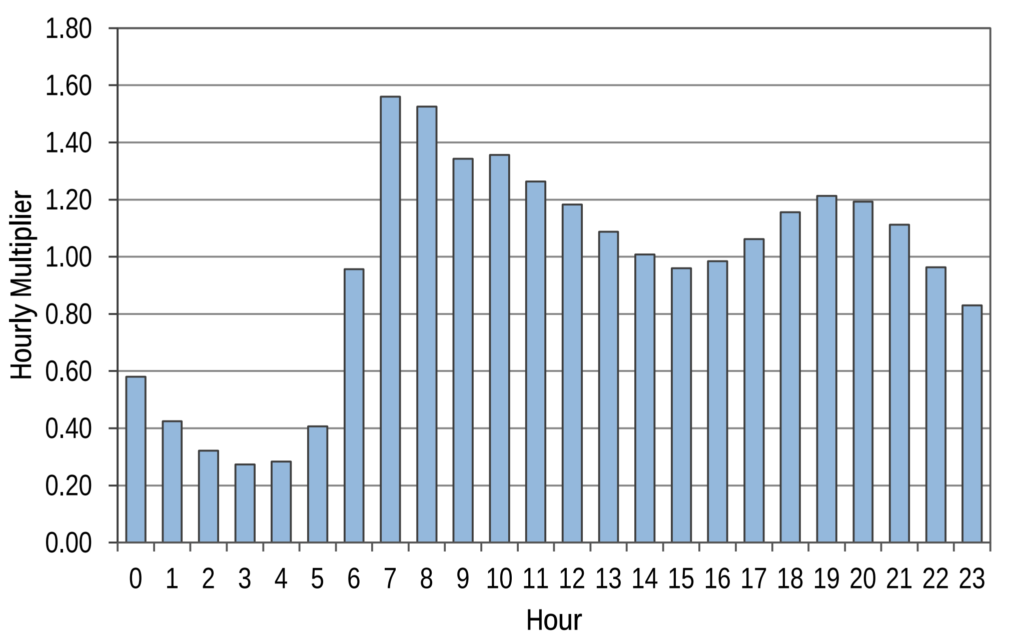
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.988	0.859	0.83	0.58	0.58
	1	0.691	0.639	0.58	0.43	0.43
	2	0.506	0.492	0.43	0.32	0.32
	3	0.382	0.416	0.32	0.27	0.27
	4	0.326	0.389	0.27	0.28	0.28
	5	0.338	0.433	0.28	0.41	0.41
	6	0.484	0.636	0.41	0.96	0.96
	7	1.139	0.959	0.96	1.56	1.56
	8	1.857	1.235	1.56	1.53	1.53
	9	1.817	1.472	1.53	1.34	1.34
	10	1.598	1.443	1.34	1.36	1.36
	11	1.615	1.522	1.36	1.26	1.26
	12	1.504	1.525	1.26	1.18	1.18
	13	1.409	1.464	1.18	1.09	1.09
	14	1.294	1.416	1.09	1.01	1.01
	15	1.200	1.347	1.01	0.96	0.96
	16	1.142	1.363	0.96	0.98	0.98
	17	1.172	1.370	0.98	1.06	1.06
	18	1.264	1.459	1.06	1.16	1.16
	19	1.376	1.523	1.16	1.21	1.21
	20	1.444	1.481	1.21	1.19	1.19
	21	1.420	1.442	1.19	1.11	1.11
	22	1.324	1.328	1.11	0.96	0.96
	23	1.147	1.136	0.96	0.83	0.83
Weekend	24	0.960	0.859	0.81	0.59	0.59
	25	0.705	0.721	0.59	0.44	0.44
	26	0.527	0.596	0.44	0.33	0.33
	27	0.393	0.512	0.33	0.28	0.28
	28	0.334	0.449	0.28	0.25	0.25
	29	0.297	0.445	0.25	0.27	0.27
	30	0.316	0.496	0.27	0.35	0.35
	31	0.423	0.652	0.35	0.72	0.72
	32	0.858	0.796	0.72	1.36	1.36
	33	1.613	1.152	1.36	1.79	1.79
	34	2.136	1.479	1.79	2.01	2.01
	35	2.389	1.638	2.01	1.97	1.97
	36	2.342	1.782	1.97	1.85	1.85
	37	2.197	1.827	1.85	1.70	1.70
	38	2.029	1.752	1.70	1.52	1.52
	39	1.804	1.691	1.52	1.40	1.40
	40	1.671	1.601	1.40	1.32	1.32
	41	1.572	1.553	1.32	1.29	1.29
	42	1.538	1.527	1.29	1.32	1.32
	43	1.572	1.509	1.32	1.33	1.33
	44	1.579	1.495	1.33	1.29	1.29
	45	1.539	1.462	1.29	1.18	1.18
	46	1.409	1.317	1.18	1.01	1.01
	47	1.202	1.160	1.01	0.81	0.81
Average						
	Weekday	1.143	1.139	0.96	0.96	0.96
	Weekend	1.308	1.186	1.10	1.10	1.10
	ADWF[(1)]	1.190	1.153	1.00	1.00	1.00
% Error						
	Weekday		-0.3%			
	Weekend		-9.3%			

Notes:

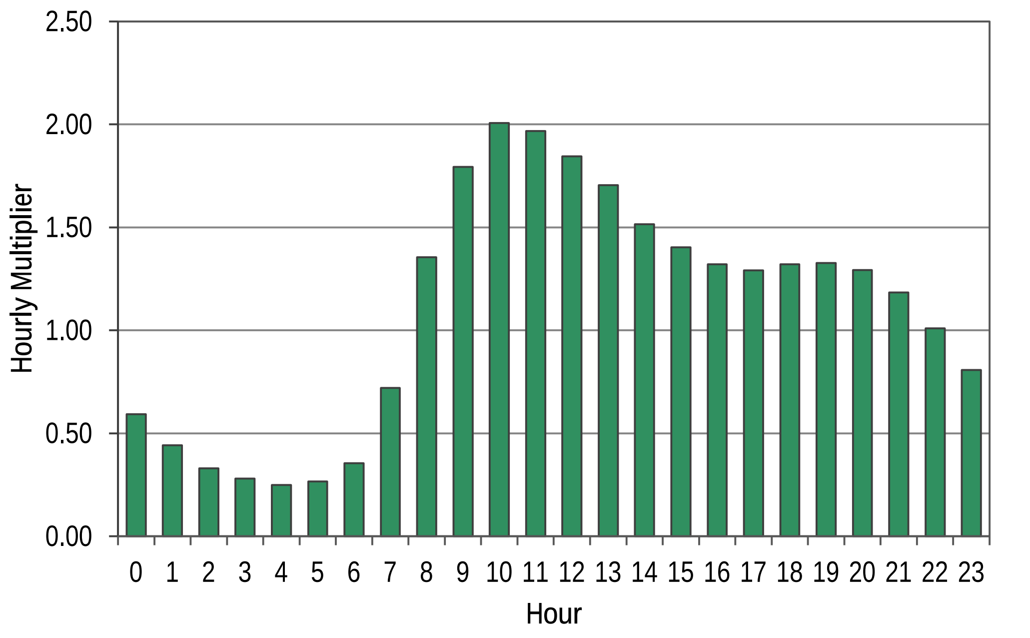
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

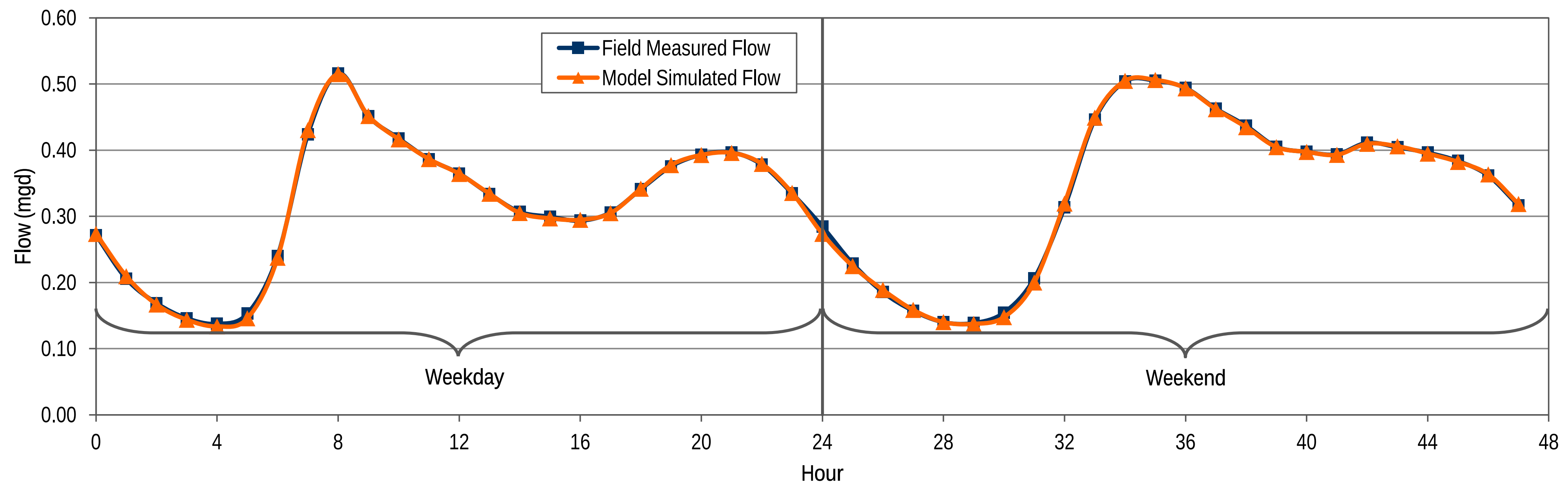
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85D DRY WEATHER CALIBRATION

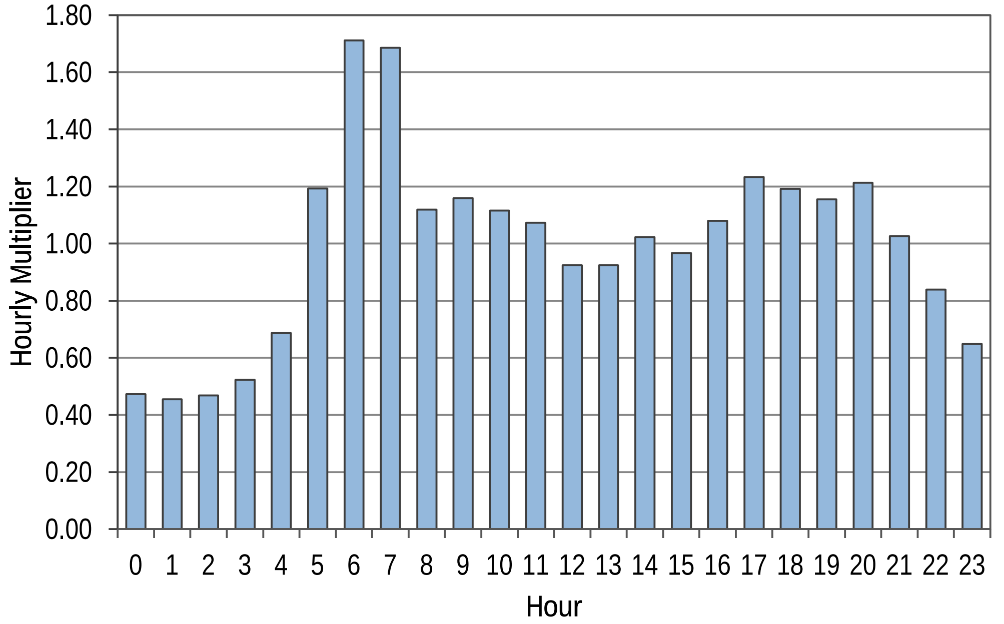
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.272	0.273	0.84	0.63	0.47
	1	0.206	0.209	0.63	0.52	0.46
	2	0.169	0.167	0.52	0.45	0.47
	3	0.146	0.144	0.45	0.42	0.52
	4	0.138	0.134	0.42	0.47	0.69
	5	0.153	0.146	0.47	0.74	1.19
	6	0.240	0.237	0.74	1.31	1.71
	7	0.424	0.430	1.31	1.59	1.69
	8	0.516	0.515	1.59	1.39	1.12
	9	0.451	0.452	1.39	1.29	1.16
	10	0.418	0.416	1.29	1.19	1.12
	11	0.386	0.387	1.19	1.12	1.07
	12	0.365	0.364	1.12	1.03	0.92
	13	0.334	0.334	1.03	0.95	0.92
	14	0.307	0.305	0.95	0.92	1.02
	15	0.300	0.297	0.92	0.91	0.97
	16	0.294	0.295	0.91	0.94	1.08
	17	0.306	0.305	0.94	1.05	1.23
	18	0.341	0.342	1.05	1.16	1.19
	19	0.376	0.377	1.16	1.21	1.15
	20	0.393	0.393	1.21	1.22	1.21
	21	0.397	0.396	1.22	1.17	1.03
	22	0.378	0.379	1.17	1.03	0.84
	23	0.335	0.335	1.03	0.84	0.65
Weekend	24	0.285	0.274	0.88	0.71	0.67
	25	0.229	0.225	0.71	0.57	0.53
	26	0.186	0.189	0.57	0.49	0.46
	27	0.157	0.159	0.49	0.43	0.44
	28	0.140	0.140	0.43	0.43	0.47
	29	0.139	0.137	0.43	0.48	0.63
	30	0.155	0.148	0.48	0.64	0.93
	31	0.206	0.200	0.64	0.97	1.19
	32	0.314	0.319	0.97	1.38	1.55
	33	0.446	0.449	1.38	1.55	1.52
	34	0.504	0.505	1.55	1.56	1.37
	35	0.505	0.506	1.56	1.52	1.30
	36	0.494	0.493	1.52	1.43	1.08
	37	0.463	0.462	1.43	1.35	1.08
	38	0.437	0.435	1.35	1.25	1.10
	39	0.405	0.405	1.25	1.23	1.19
	40	0.398	0.397	1.23	1.21	1.18
	41	0.394	0.393	1.21	1.27	1.42
	42	0.411	0.410	1.27	1.25	1.26
	43	0.404	0.406	1.25	1.22	1.16
	44	0.396	0.395	1.22	1.18	1.19
	45	0.384	0.382	1.18	1.12	1.01
	46	0.362	0.363	1.12	0.98	0.80
	47	0.316	0.319	0.98	0.88	0.76
Average						
	Weekday	0.318	0.318	0.98	0.98	1.00
	Weekend	0.339	0.338	1.04	1.04	1.01
	ADWF[1]	0.324	0.324	1.00	1.00	1.00
% Error						
	Weekday		-0.1%			
	Weekend		-0.2%			

Notes:

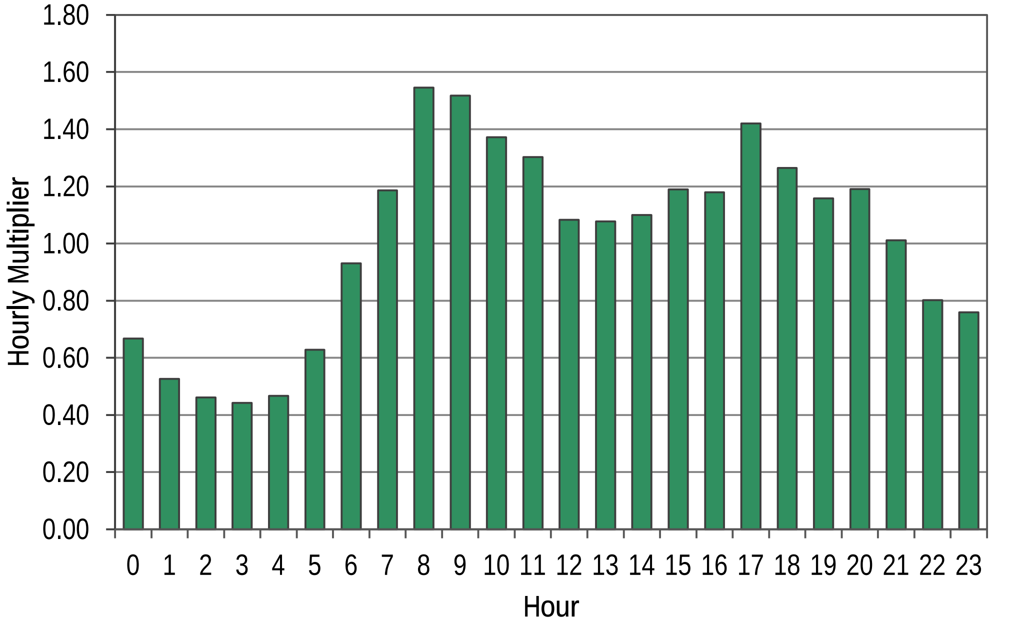
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

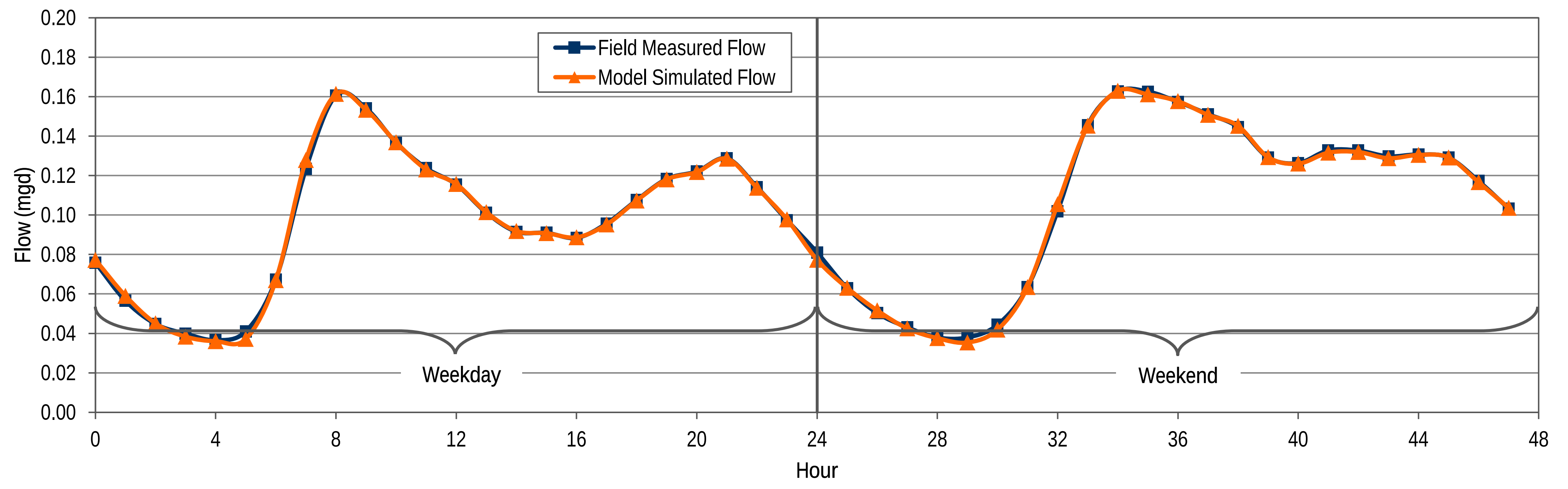
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85D.1 DRY WEATHER CALIBRATION

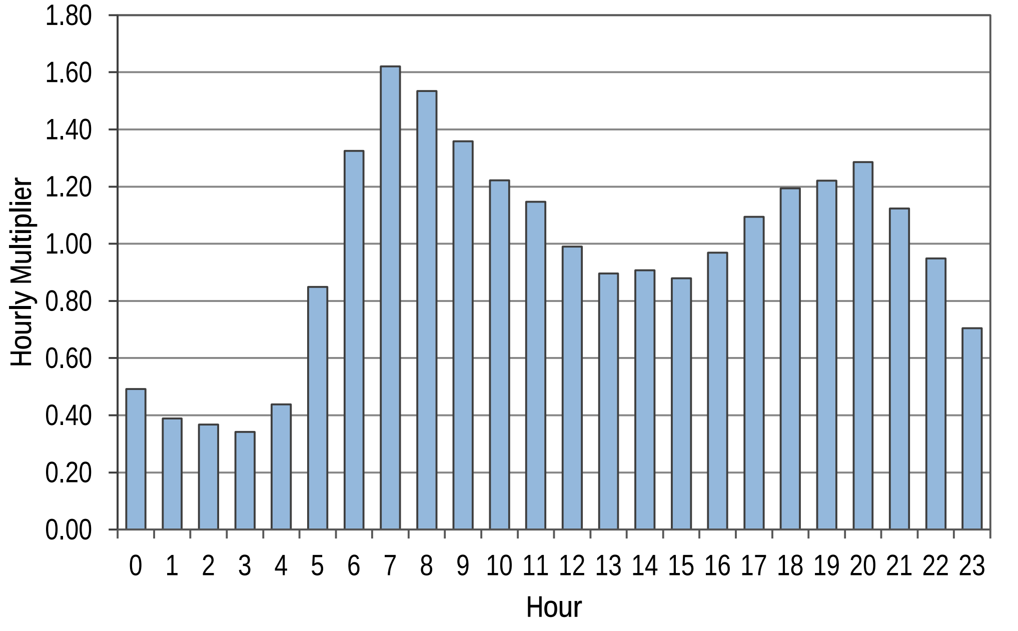
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.076	0.077	0.76	0.57	0.49
	1	0.057	0.059	0.57	0.45	0.39
	2	0.045	0.045	0.45	0.40	0.37
	3	0.040	0.038	0.40	0.37	0.34
	4	0.037	0.036	0.37	0.41	0.44
	5	0.041	0.037	0.41	0.67	0.85
	6	0.067	0.067	0.67	1.23	1.32
	7	0.123	0.128	1.23	1.60	1.62
	8	0.161	0.161	1.60	1.54	1.53
	9	0.154	0.153	1.54	1.36	1.36
	10	0.137	0.137	1.36	1.24	1.22
	11	0.124	0.123	1.24	1.15	1.15
	12	0.115	0.116	1.15	1.01	0.99
	13	0.101	0.101	1.01	0.91	0.90
	14	0.092	0.092	0.91	0.91	0.91
	15	0.091	0.091	0.91	0.88	0.88
	16	0.088	0.089	0.88	0.96	0.97
	17	0.096	0.095	0.96	1.07	1.09
	18	0.108	0.107	1.07	1.18	1.19
	19	0.118	0.118	1.18	1.22	1.22
	20	0.122	0.122	1.22	1.29	1.29
	21	0.129	0.129	1.29	1.14	1.12
	22	0.114	0.114	1.14	0.97	0.95
	23	0.097	0.098	0.97	0.76	0.70
Weekend	24	0.081	0.077	0.81	0.63	0.58
	25	0.063	0.063	0.63	0.50	0.44
	26	0.050	0.052	0.50	0.43	0.39
	27	0.043	0.043	0.43	0.38	0.35
	28	0.038	0.038	0.38	0.38	0.37
	29	0.038	0.035	0.38	0.44	0.49
	30	0.044	0.042	0.44	0.63	0.76
	31	0.063	0.064	0.63	1.02	1.11
	32	0.102	0.106	1.02	1.45	1.47
	33	0.146	0.145	1.45	1.62	1.63
	34	0.163	0.163	1.62	1.62	1.62
	35	0.163	0.161	1.62	1.57	1.57
	36	0.157	0.158	1.57	1.51	1.51
	37	0.151	0.151	1.51	1.44	1.44
	38	0.145	0.145	1.44	1.29	1.28
	39	0.129	0.129	1.29	1.26	1.26
	40	0.126	0.126	1.26	1.33	1.32
	41	0.133	0.132	1.33	1.33	1.33
	42	0.133	0.132	1.33	1.30	1.29
	43	0.130	0.129	1.30	1.31	1.30
	44	0.131	0.131	1.31	1.29	1.28
	45	0.129	0.129	1.29	1.17	1.15
	46	0.117	0.117	1.17	1.03	1.01
	47	0.103	0.104	1.03	0.81	0.80
Average						
Weekday		0.097	0.097	0.97	0.97	0.97
Weekend		0.107	0.107	1.07	1.07	1.07
ADWF[1]		0.100	0.100	1.00	1.00	1.00
% Error						
Weekday			0.1%			
Weekend			-0.3%			

Notes:

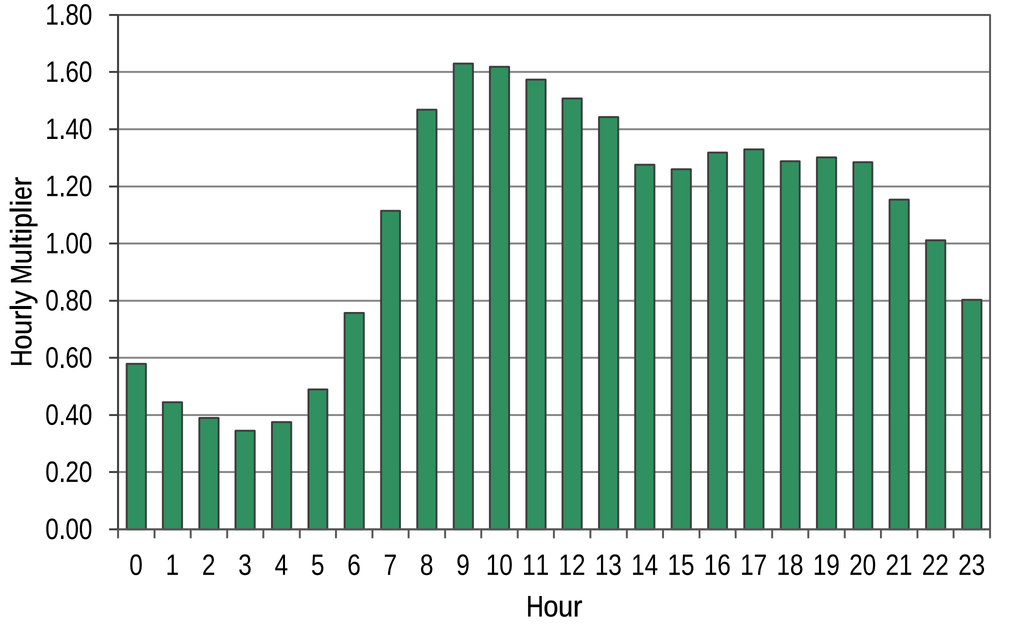
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

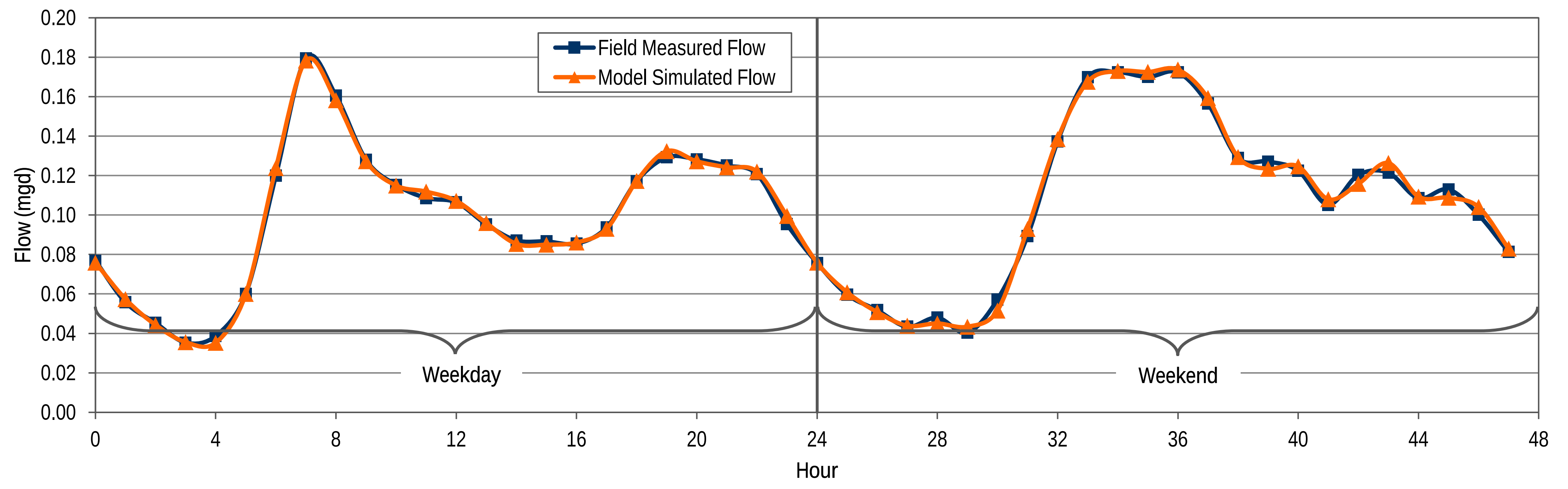
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85D.2 DRY WEATHER CALIBRATION

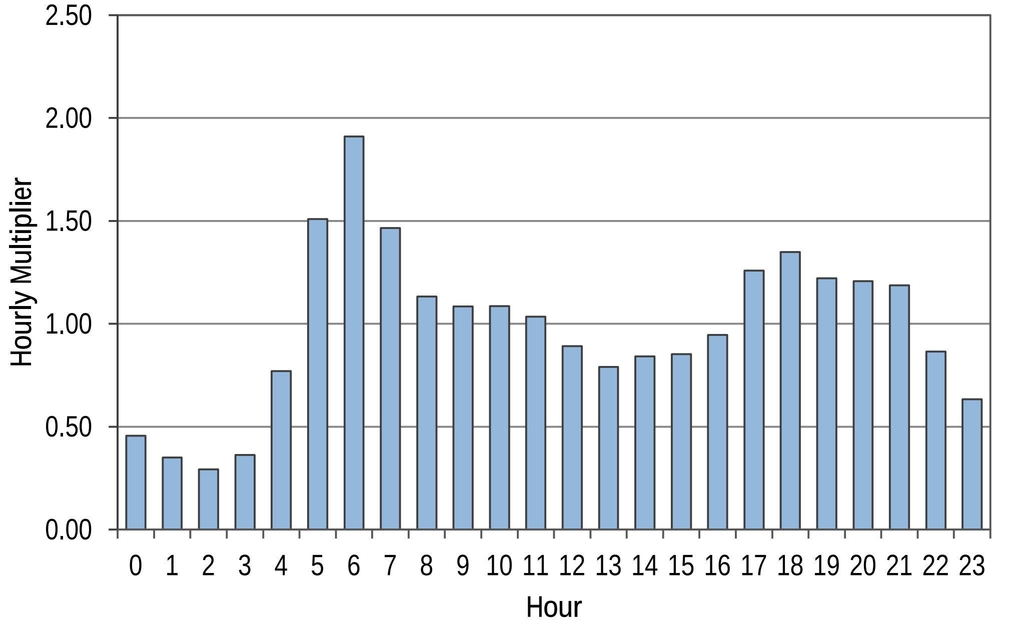
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.077	0.076	0.75	0.55	0.46
	1	0.056	0.057	0.55	0.44	0.35
	2	0.045	0.044	0.44	0.35	0.29
	3	0.035	0.036	0.35	0.38	0.36
	4	0.039	0.035	0.38	0.59	0.77
	5	0.060	0.060	0.59	1.18	1.51
	6	0.120	0.124	1.18	1.76	1.91
	7	0.179	0.178	1.76	1.58	1.47
	8	0.160	0.158	1.58	1.26	1.13
	9	0.128	0.127	1.26	1.13	1.09
	10	0.115	0.115	1.13	1.07	1.09
	11	0.109	0.112	1.07	1.04	1.03
	12	0.106	0.107	1.04	0.94	0.89
	13	0.095	0.096	0.94	0.86	0.79
	14	0.087	0.085	0.86	0.85	0.84
	15	0.087	0.085	0.85	0.84	0.85
	16	0.086	0.086	0.84	0.92	0.95
	17	0.094	0.093	0.92	1.15	1.26
	18	0.117	0.117	1.15	1.27	1.35
	19	0.129	0.132	1.27	1.26	1.22
	20	0.128	0.127	1.26	1.23	1.21
	21	0.125	0.124	1.23	1.18	1.19
	22	0.121	0.122	1.18	0.94	0.87
	23	0.095	0.100	0.94	0.75	0.63
Weekend	24	0.076	0.076	0.74	0.59	0.52
	25	0.060	0.061	0.59	0.51	0.44
	26	0.052	0.051	0.51	0.43	0.39
	27	0.043	0.044	0.43	0.47	0.47
	28	0.048	0.045	0.47	0.40	0.41
	29	0.040	0.043	0.40	0.56	0.58
	30	0.057	0.052	0.56	0.88	1.15
	31	0.089	0.093	0.88	1.35	1.52
	32	0.137	0.138	1.35	1.67	1.74
	33	0.170	0.168	1.67	1.69	1.71
	34	0.172	0.173	1.69	1.67	1.68
	35	0.170	0.173	1.67	1.69	1.71
	36	0.172	0.174	1.69	1.54	1.51
	37	0.156	0.159	1.54	1.27	1.16
	38	0.129	0.129	1.27	1.25	1.20
	39	0.127	0.123	1.25	1.20	1.23
	40	0.123	0.125	1.20	1.03	0.97
	41	0.105	0.108	1.03	1.18	1.18
	42	0.120	0.116	1.18	1.19	1.29
	43	0.121	0.126	1.19	1.07	0.99
	44	0.109	0.109	1.07	1.11	1.08
	45	0.113	0.109	1.11	0.98	1.00
	46	0.100	0.104	0.98	0.80	0.70
	47	0.081	0.083	0.80	0.74	0.62
Average						
	Weekday	0.100	0.100	0.98	0.98	0.98
	Weekend	0.107	0.108	1.05	1.05	1.05
	ADWF[(1)]	0.102	0.102	1.00	1.00	1.00
% Error						
	Weekday		0.2%			
	Weekend		0.4%			

Notes:

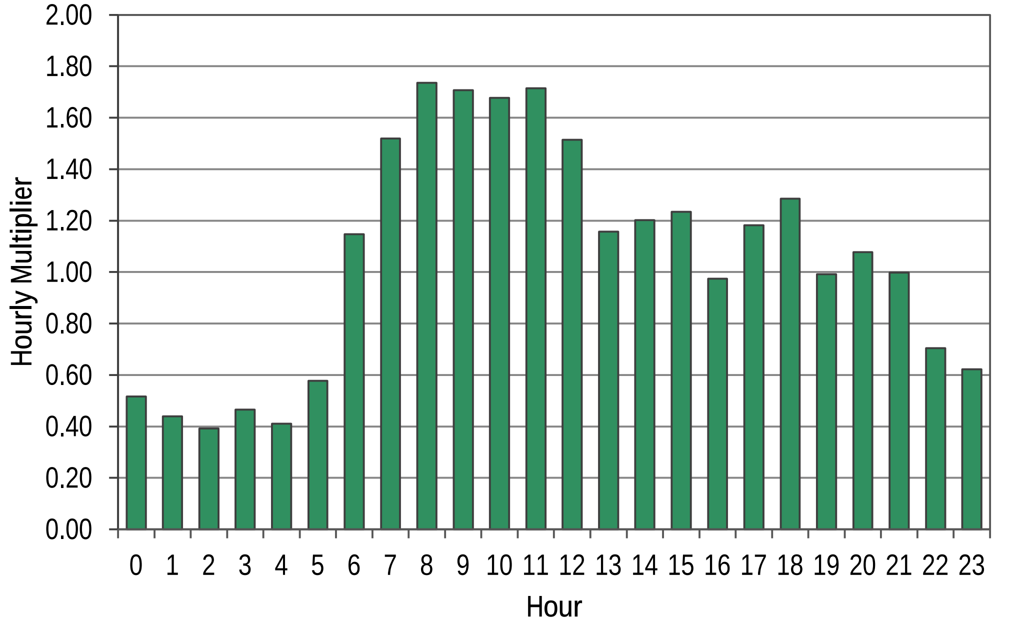
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

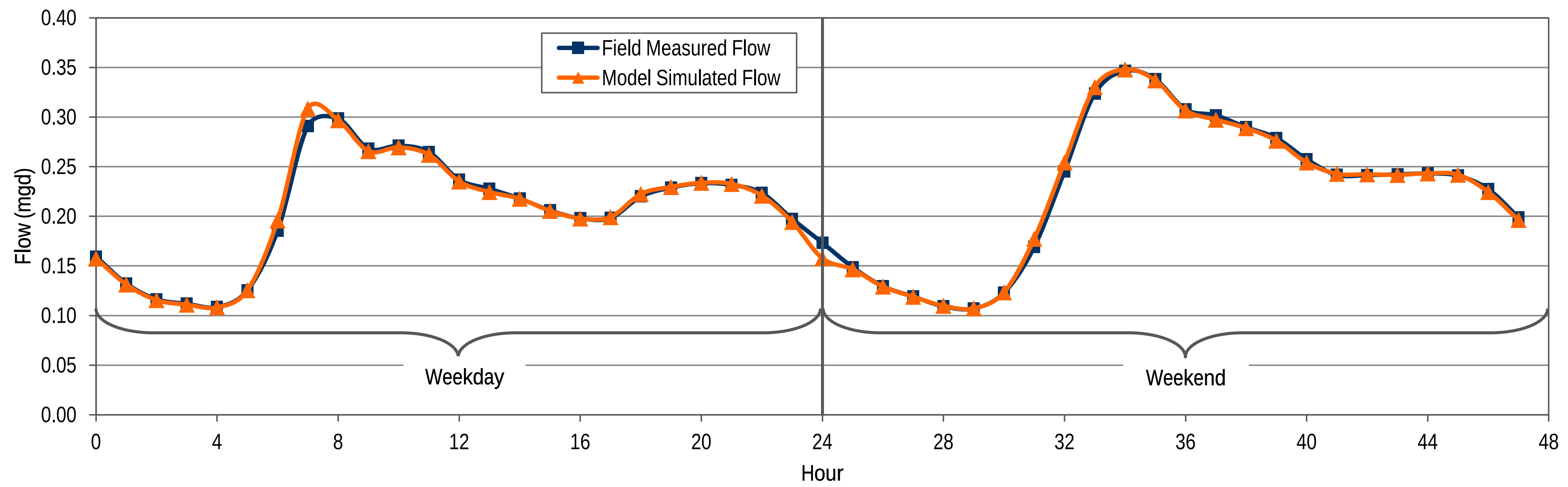
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85E DRY WEATHER CALIBRATION

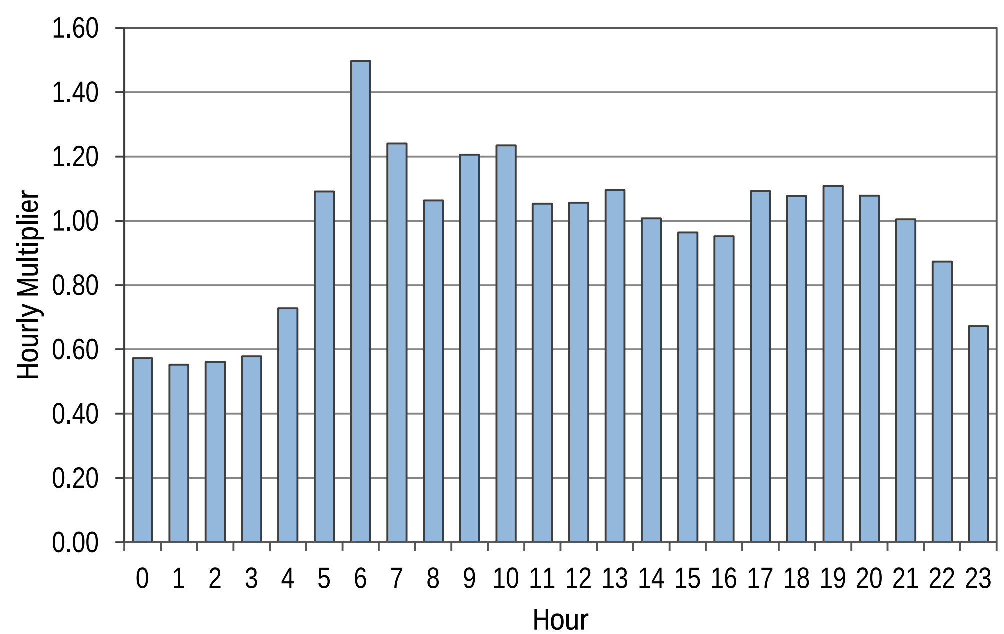
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.159	0.158	0.75	0.62	0.57
	1	0.132	0.131	0.62	0.55	0.55
	2	0.116	0.116	0.55	0.53	0.56
	3	0.112	0.111	0.53	0.51	0.58
	4	0.109	0.108	0.51	0.59	0.73
	5	0.125	0.126	0.59	0.88	1.09
	6	0.186	0.196	0.88	1.37	1.50
	7	0.291	0.308	1.37	1.41	1.24
	8	0.299	0.297	1.41	1.27	1.06
	9	0.268	0.266	1.27	1.28	1.21
	10	0.271	0.270	1.28	1.25	1.23
	11	0.265	0.262	1.25	1.12	1.05
	12	0.237	0.235	1.12	1.08	1.06
	13	0.228	0.224	1.08	1.03	1.10
	14	0.218	0.218	1.03	0.97	1.01
	15	0.206	0.206	0.97	0.93	0.96
	16	0.198	0.198	0.93	0.94	0.95
	17	0.198	0.199	0.94	1.04	1.09
	18	0.220	0.222	1.04	1.08	1.08
	19	0.229	0.230	1.08	1.10	1.11
	20	0.233	0.234	1.10	1.09	1.08
	21	0.232	0.233	1.09	1.06	1.00
	22	0.223	0.221	1.06	0.93	0.87
	23	0.198	0.194	0.93	0.75	0.67
Weekend	24	0.173	0.158	0.82	0.70	0.72
	25	0.149	0.147	0.70	0.61	0.65
	26	0.130	0.129	0.61	0.56	0.61
	27	0.119	0.119	0.56	0.52	0.56
	28	0.109	0.110	0.52	0.51	0.56
	29	0.107	0.107	0.51	0.58	0.68
	30	0.123	0.123	0.58	0.80	0.89
	31	0.169	0.177	0.80	1.16	1.17
	32	0.245	0.254	1.16	1.53	1.55
	33	0.324	0.330	1.53	1.64	1.61
	34	0.347	0.348	1.64	1.60	1.54
	35	0.338	0.337	1.60	1.45	1.29
	36	0.308	0.307	1.45	1.43	1.35
	37	0.302	0.297	1.43	1.37	1.39
	38	0.290	0.289	1.37	1.32	1.35
	39	0.279	0.276	1.32	1.22	1.25
	40	0.258	0.254	1.22	1.14	1.15
	41	0.242	0.243	1.14	1.14	1.10
	42	0.242	0.242	1.14	1.14	1.10
	43	0.242	0.242	1.14	1.15	1.16
	44	0.243	0.243	1.15	1.14	1.15
	45	0.241	0.242	1.14	1.07	1.04
	46	0.228	0.225	1.07	0.94	0.89
	47	0.199	0.196	0.94	0.82	0.80
Average						
Weekday		0.206	0.207	0.97	0.97	0.97
Weekend		0.225	0.225	1.06	1.06	1.07
ADWF[(1)]		0.212	0.212	1.00	1.00	1.00
% Error						
Weekday			0.2%			
Weekend			-0.2%			

Notes:

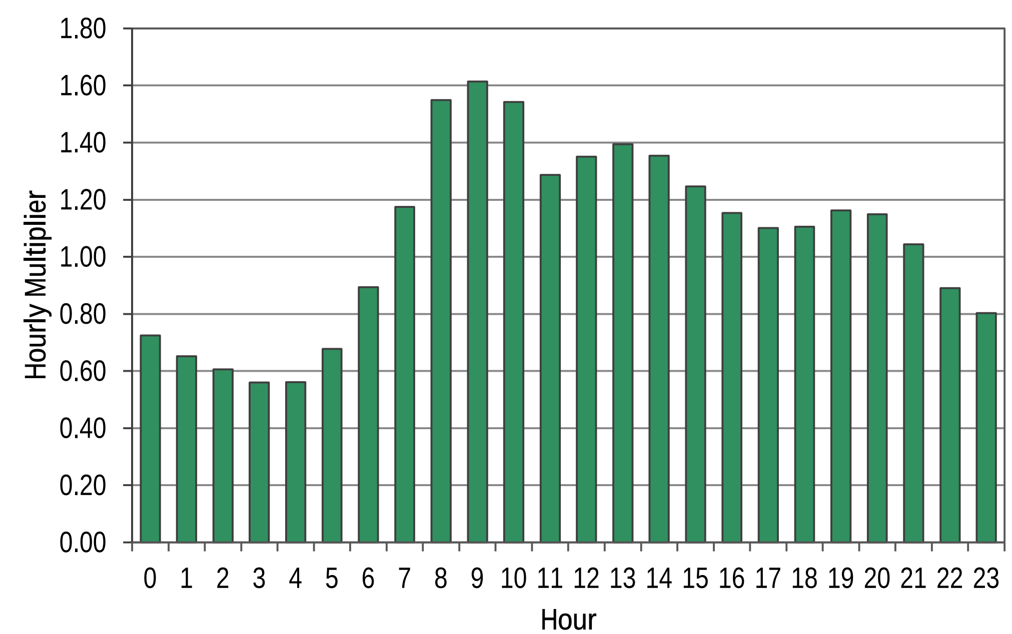
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

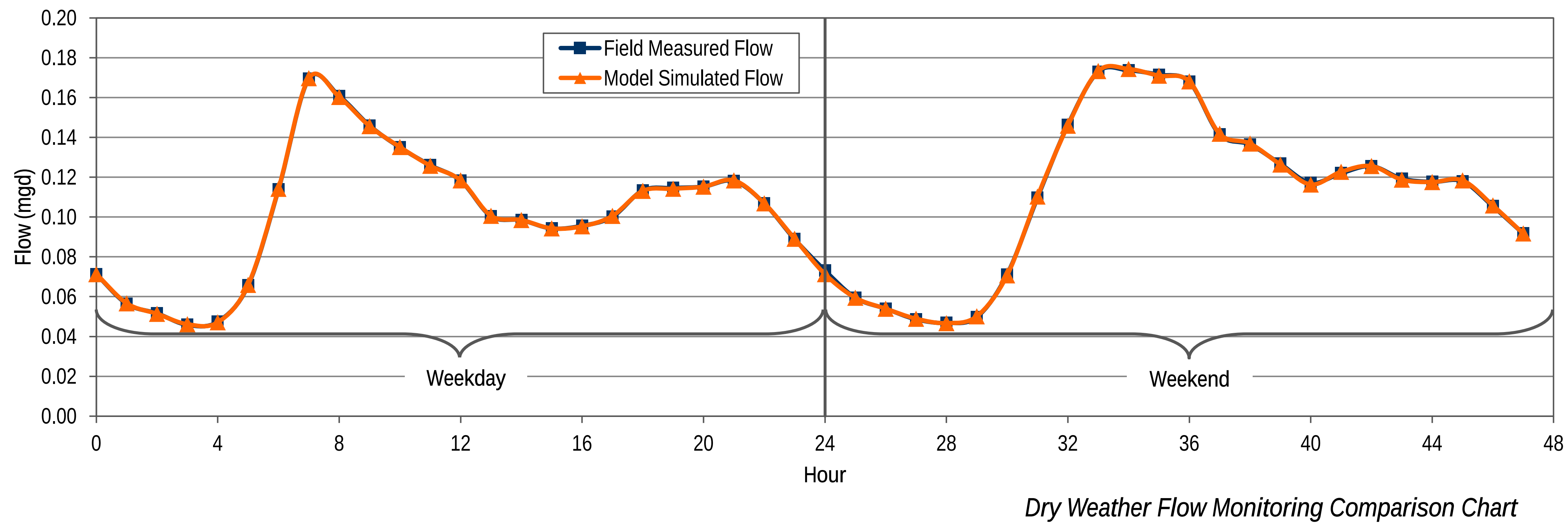
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85E.1 DRY WEATHER CALIBRATION

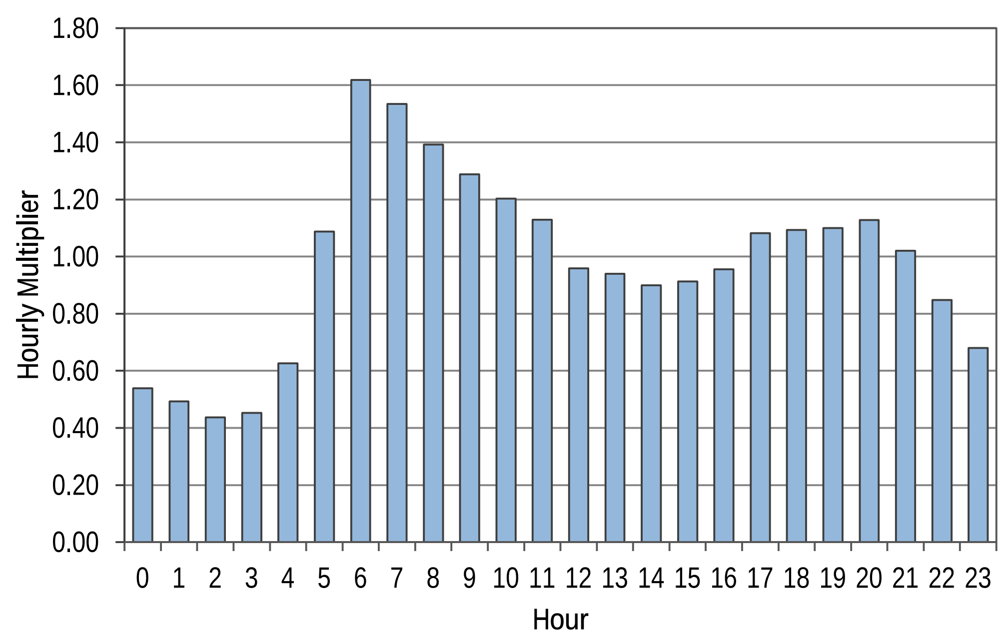
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.071	0.071	0.68	0.54	0.54
	1	0.056	0.057	0.54	0.49	0.49
	2	0.052	0.051	0.49	0.44	0.44
	3	0.046	0.046	0.44	0.45	0.45
	4	0.047	0.047	0.45	0.63	0.63
	5	0.066	0.066	0.63	1.09	1.09
	6	0.114	0.114	1.09	1.62	1.62
	7	0.170	0.170	1.62	1.53	1.53
	8	0.161	0.160	1.53	1.39	1.39
	9	0.146	0.146	1.39	1.29	1.29
	10	0.135	0.135	1.29	1.20	1.20
	11	0.126	0.126	1.20	1.13	1.13
	12	0.118	0.118	1.13	0.96	0.96
	13	0.100	0.101	0.96	0.94	0.94
	14	0.098	0.098	0.94	0.90	0.90
	15	0.094	0.094	0.90	0.91	0.91
	16	0.096	0.095	0.91	0.96	0.96
	17	0.100	0.101	0.96	1.08	1.08
	18	0.113	0.113	1.08	1.09	1.09
	19	0.115	0.114	1.09	1.10	1.10
	20	0.115	0.115	1.10	1.13	1.13
	21	0.118	0.118	1.13	1.02	1.02
	22	0.107	0.107	1.02	0.85	0.85
	23	0.089	0.089	0.85	0.68	0.68
Weekend	24	0.073	0.071	0.70	0.57	0.57
	25	0.059	0.059	0.57	0.52	0.52
	26	0.054	0.054	0.52	0.46	0.46
	27	0.049	0.049	0.46	0.45	0.45
	28	0.047	0.047	0.45	0.48	0.48
	29	0.050	0.050	0.48	0.68	0.68
	30	0.071	0.071	0.68	1.05	1.05
	31	0.110	0.110	1.05	1.40	1.40
	32	0.146	0.146	1.40	1.65	1.65
	33	0.173	0.173	1.65	1.66	1.66
	34	0.174	0.174	1.66	1.64	1.64
	35	0.171	0.171	1.64	1.60	1.60
	36	0.168	0.168	1.60	1.35	1.35
	37	0.141	0.142	1.35	1.30	1.30
	38	0.136	0.137	1.30	1.21	1.21
	39	0.127	0.126	1.21	1.12	1.12
	40	0.117	0.116	1.12	1.16	1.16
	41	0.122	0.123	1.16	1.20	1.20
	42	0.126	0.126	1.20	1.14	1.14
	43	0.119	0.119	1.14	1.12	1.12
	44	0.118	0.118	1.12	1.13	1.13
	45	0.118	0.118	1.13	1.01	1.01
	46	0.105	0.106	1.01	0.88	0.88
	47	0.092	0.092	0.88	0.70	0.70
Average						
	Weekday	0.102	0.102	0.98	0.98	0.98
	Weekend	0.111	0.111	1.06	1.06	1.06
	ADWF[1]	0.105	0.105	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

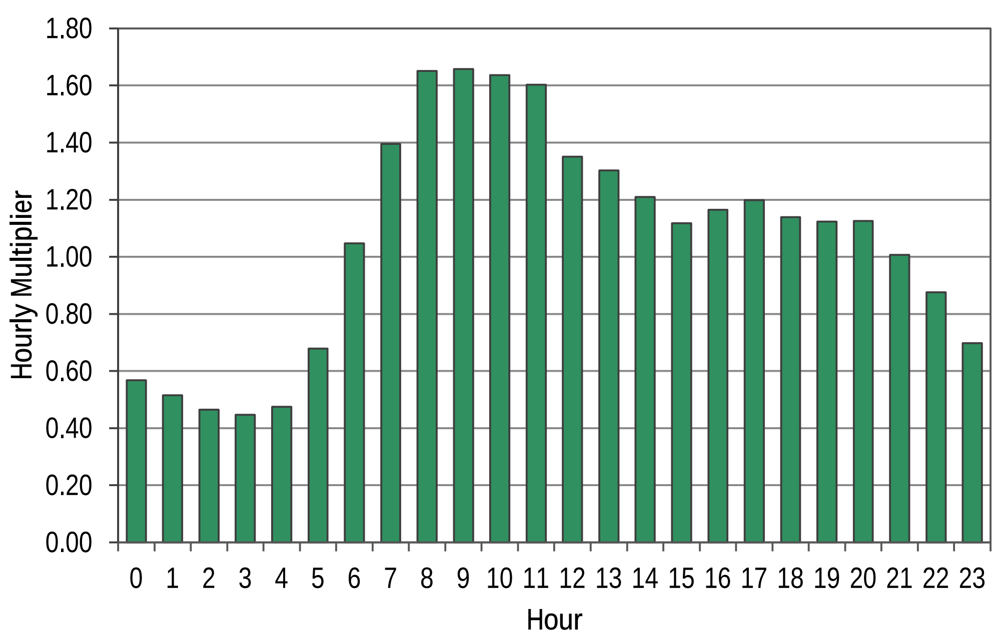
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

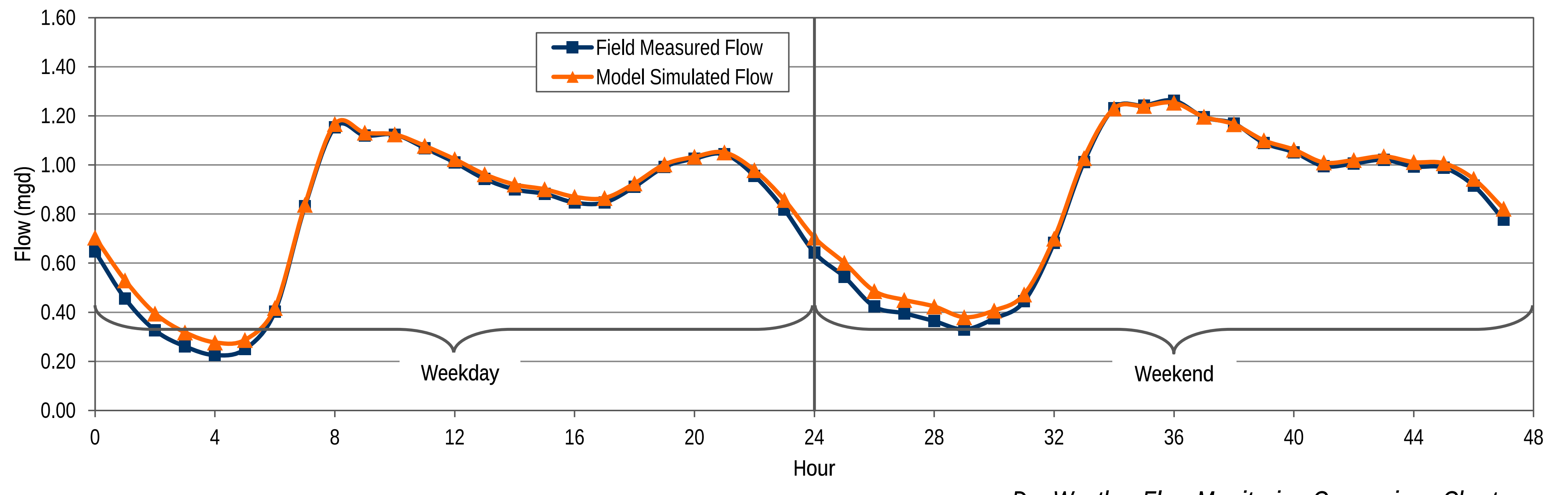
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-1 DRY WEATHER CALIBRATION

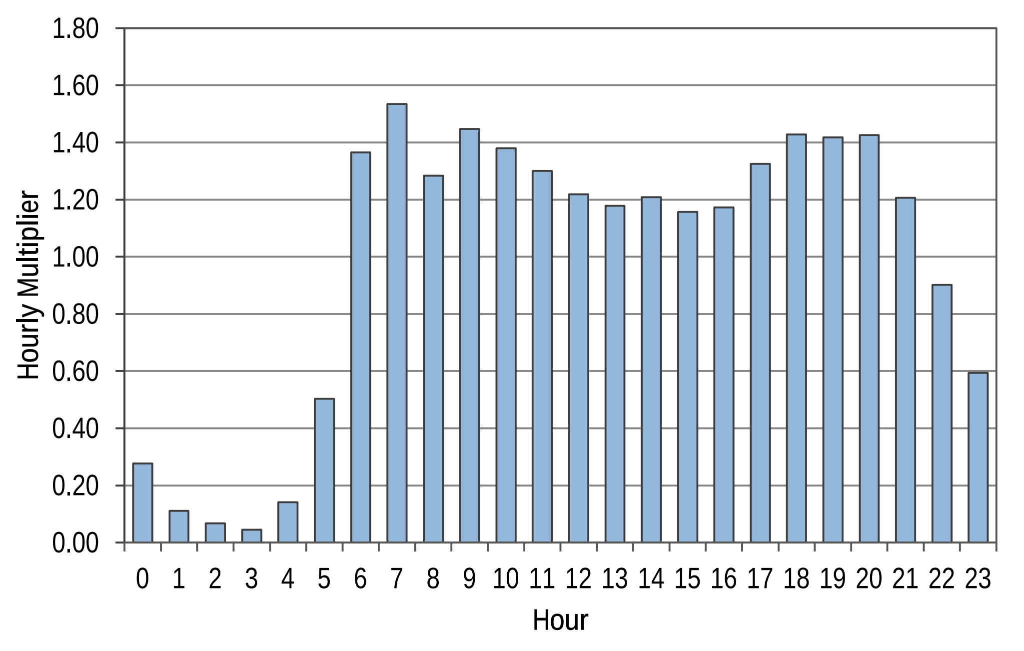
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.647	0.704	0.80	0.57	0.28
	1	0.456	0.530	0.57	0.40	0.11
	2	0.326	0.395	0.40	0.32	0.07
	3	0.261	0.318	0.32	0.28	0.05
	4	0.225	0.277	0.28	0.31	0.14
	5	0.250	0.287	0.31	0.50	0.50
	6	0.403	0.417	0.50	1.03	1.36
	7	0.832	0.838	1.03	1.43	1.53
	8	1.154	1.167	1.43	1.39	1.28
	9	1.120	1.132	1.39	1.39	1.45
	10	1.123	1.125	1.39	1.32	1.38
	11	1.069	1.078	1.32	1.25	1.30
	12	1.010	1.024	1.25	1.17	1.22
	13	0.943	0.962	1.17	1.12	1.18
	14	0.900	0.920	1.12	1.09	1.21
	15	0.882	0.901	1.09	1.05	1.16
	16	0.847	0.870	1.05	1.05	1.17
	17	0.847	0.865	1.05	1.13	1.33
	18	0.911	0.925	1.13	1.23	1.43
	19	0.992	1.002	1.23	1.27	1.42
	20	1.026	1.033	1.27	1.29	1.43
	21	1.044	1.051	1.29	1.18	1.21
	22	0.956	0.979	1.18	1.01	0.90
	23	0.818	0.857	1.01	0.80	0.59
Weekend	24	0.643	0.704	0.80	0.67	0.50
	25	0.544	0.601	0.67	0.52	0.32
	26	0.423	0.486	0.52	0.49	0.34
	27	0.396	0.450	0.49	0.45	0.34
	28	0.364	0.423	0.45	0.41	0.32
	29	0.330	0.380	0.41	0.46	0.46
	30	0.374	0.407	0.46	0.55	0.61
	31	0.444	0.473	0.55	0.85	1.06
	32	0.683	0.700	0.85	1.25	1.50
	33	1.012	1.028	1.25	1.53	1.63
	34	1.231	1.230	1.53	1.54	1.51
	35	1.242	1.241	1.54	1.56	1.58
	36	1.262	1.254	1.56	1.48	1.48
	37	1.194	1.196	1.48	1.45	1.49
	38	1.169	1.166	1.45	1.35	1.36
	39	1.090	1.100	1.35	1.30	1.35
	40	1.052	1.063	1.30	1.23	1.26
	41	0.995	1.010	1.23	1.25	1.31
	42	1.006	1.020	1.25	1.27	1.33
	43	1.021	1.035	1.27	1.23	1.26
	44	0.993	1.012	1.23	1.23	1.26
	45	0.989	1.007	1.23	1.14	1.11
	46	0.916	0.944	1.14	0.96	0.82
	47	0.777	0.822	0.96	0.80	0.58
Average						
	Weekday	0.793	0.819	0.98	0.98	0.99
	Weekend	0.840	0.865	1.04	1.04	1.03
	ADWF[1]	0.807	0.832	1.00	1.00	1.00
% Error						
	Weekday		3.2%			
	Weekend		3.0%			

Notes:

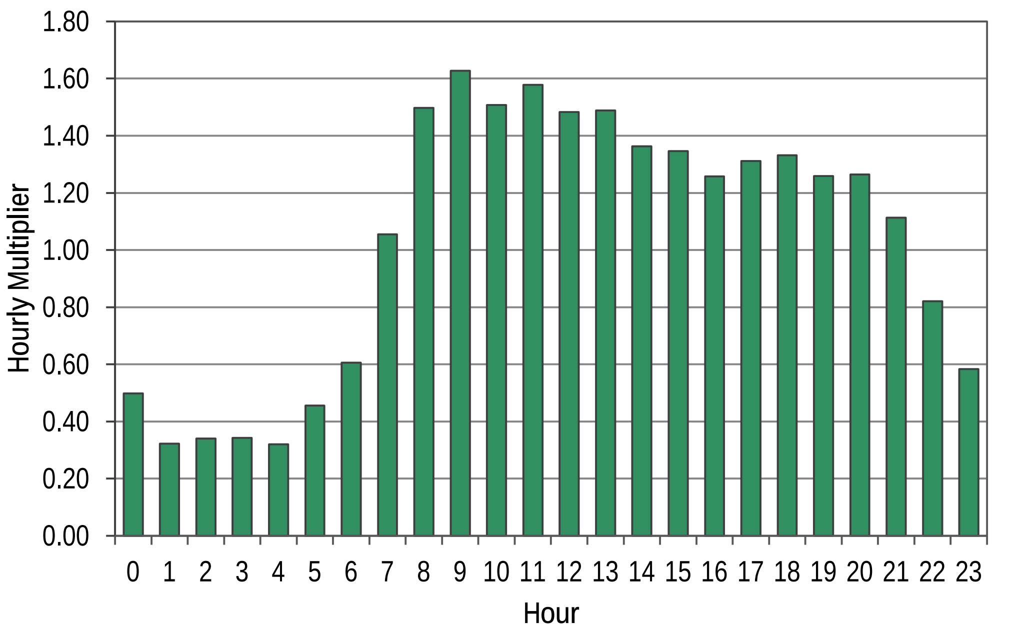
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

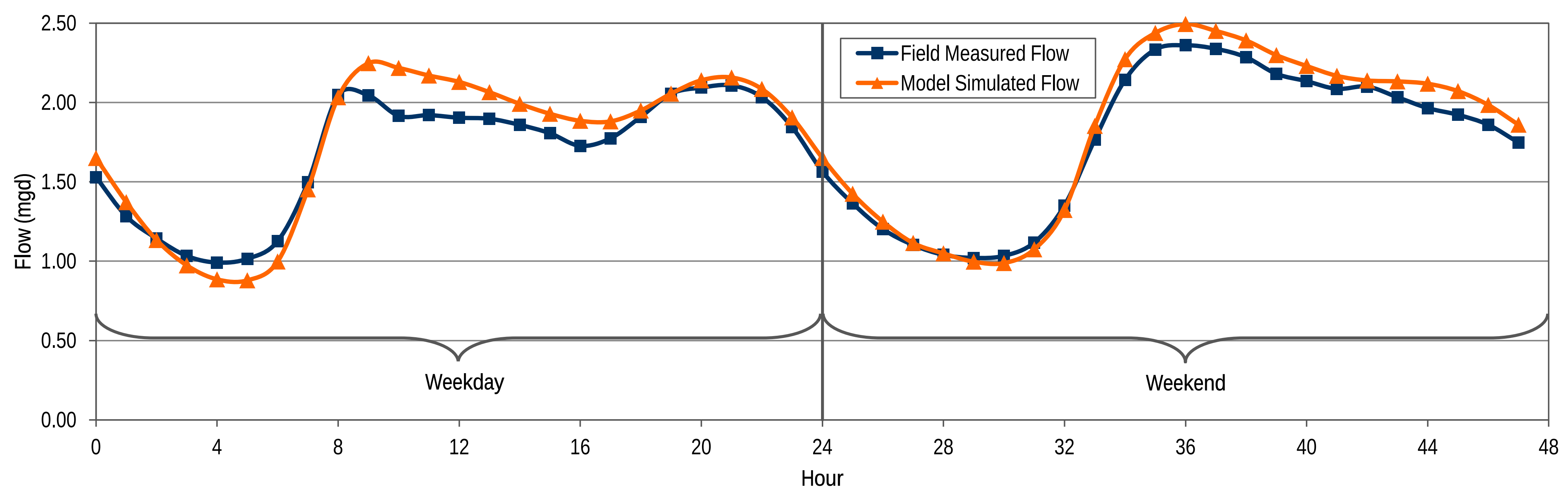
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85A DRY WEATHER CALIBRATION

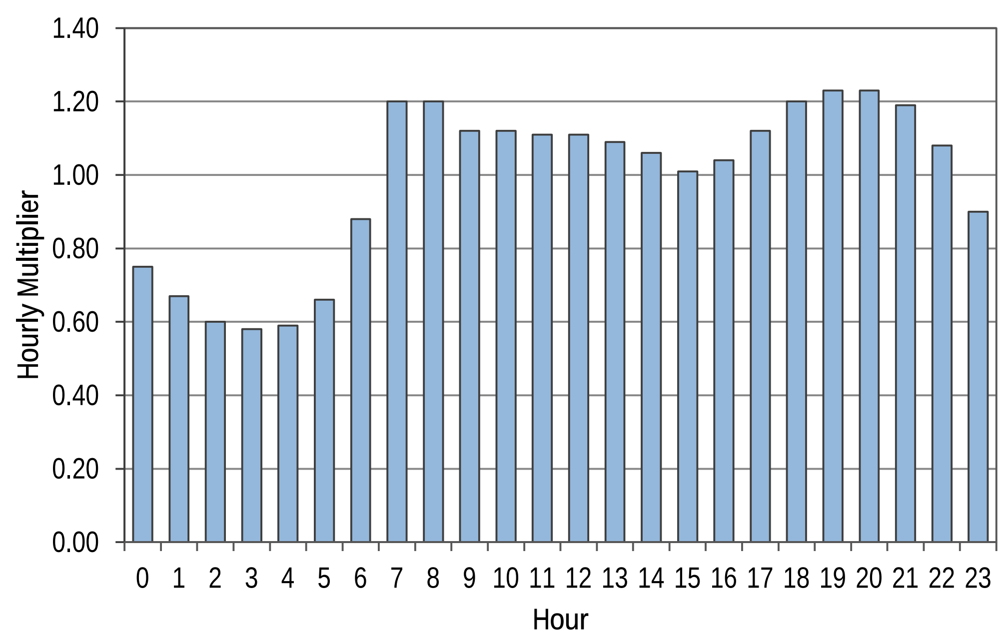
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.529	1.650	0.90	0.75	0.75
	1	1.282	1.372	0.75	0.67	0.67
	2	1.142	1.133	0.67	0.60	0.60
	3	1.032	0.974	0.60	0.58	0.58
	4	0.991	0.886	0.58	0.59	0.59
	5	1.015	0.880	0.59	0.66	0.66
	6	1.126	0.998	0.66	0.88	0.88
	7	1.496	1.453	0.88	1.20	1.20
	8	2.046	2.033	1.20	1.20	1.20
	9	2.044	2.248	1.20	1.12	1.12
	10	1.915	2.218	1.12	1.12	1.12
	11	1.920	2.170	1.12	1.11	1.11
	12	1.904	2.130	1.11	1.11	1.11
	13	1.897	2.065	1.11	1.09	1.09
	14	1.859	1.992	1.09	1.06	1.06
	15	1.806	1.929	1.06	1.01	1.01
	16	1.726	1.885	1.01	1.04	1.04
	17	1.774	1.881	1.04	1.12	1.12
	18	1.910	1.949	1.12	1.20	1.20
	19	2.055	2.056	1.20	1.23	1.23
	20	2.094	2.140	1.23	1.23	1.23
	21	2.107	2.157	1.23	1.19	1.19
	22	2.033	2.085	1.19	1.08	1.08
	23	1.844	1.906	1.08	0.90	0.90
Weekend	24	1.565	1.650	0.92	0.80	0.80
	25	1.364	1.425	0.80	0.70	0.70
	26	1.202	1.249	0.70	0.65	0.64
	27	1.102	1.115	0.65	0.61	0.61
	28	1.040	1.049	0.61	0.60	0.60
	29	1.020	0.997	0.60	0.60	0.61
	30	1.033	0.988	0.60	0.65	0.66
	31	1.117	1.075	0.65	0.79	0.79
	32	1.350	1.323	0.79	1.03	1.03
	33	1.766	1.853	1.03	1.25	1.25
	34	2.142	2.273	1.25	1.37	1.37
	35	2.334	2.438	1.37	1.38	1.38
	36	2.360	2.494	1.38	1.37	1.37
	37	2.338	2.451	1.37	1.34	1.34
	38	2.285	2.391	1.34	1.28	1.28
	39	2.181	2.299	1.28	1.25	1.25
	40	2.134	2.230	1.25	1.22	1.23
	41	2.086	2.168	1.22	1.23	1.23
	42	2.100	2.139	1.23	1.19	1.19
	43	2.033	2.133	1.19	1.15	1.16
	44	1.965	2.118	1.15	1.13	1.12
	45	1.922	2.072	1.13	1.09	1.08
	46	1.860	1.985	1.09	1.02	1.03
	47	1.747	1.860	1.02	0.92	0.92
Average						
	Weekday	1.690	1.758	0.99	0.99	0.99
	Weekend	1.752	1.824	1.03	1.03	1.03
	ADWF[(1)]	1.707	1.777	1.00	1.00	1.00
% Error						
	Weekday		4.0%			
	Weekend		4.1%			

Notes:

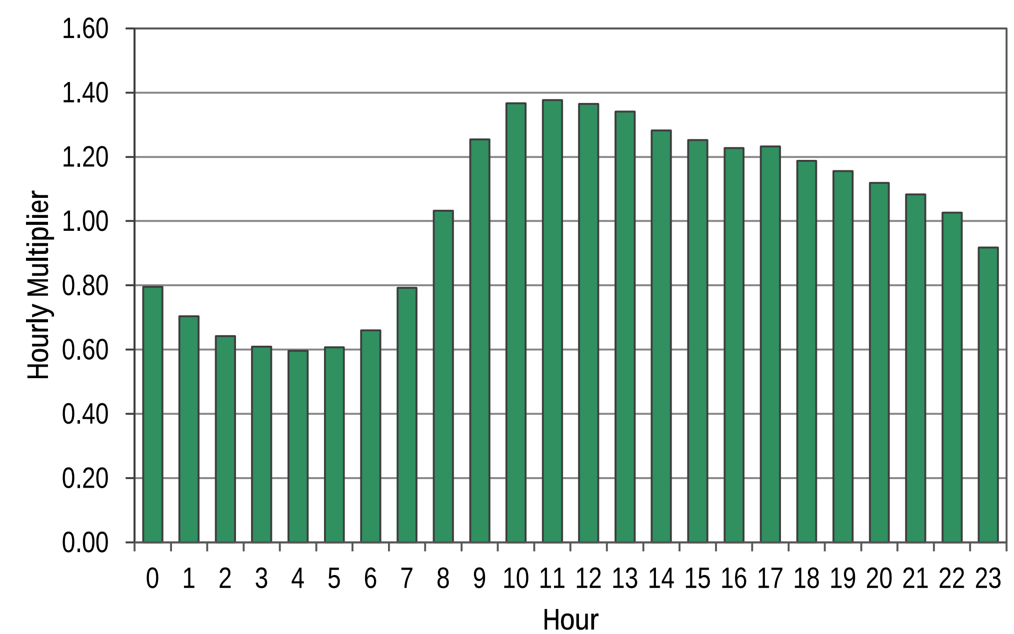
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

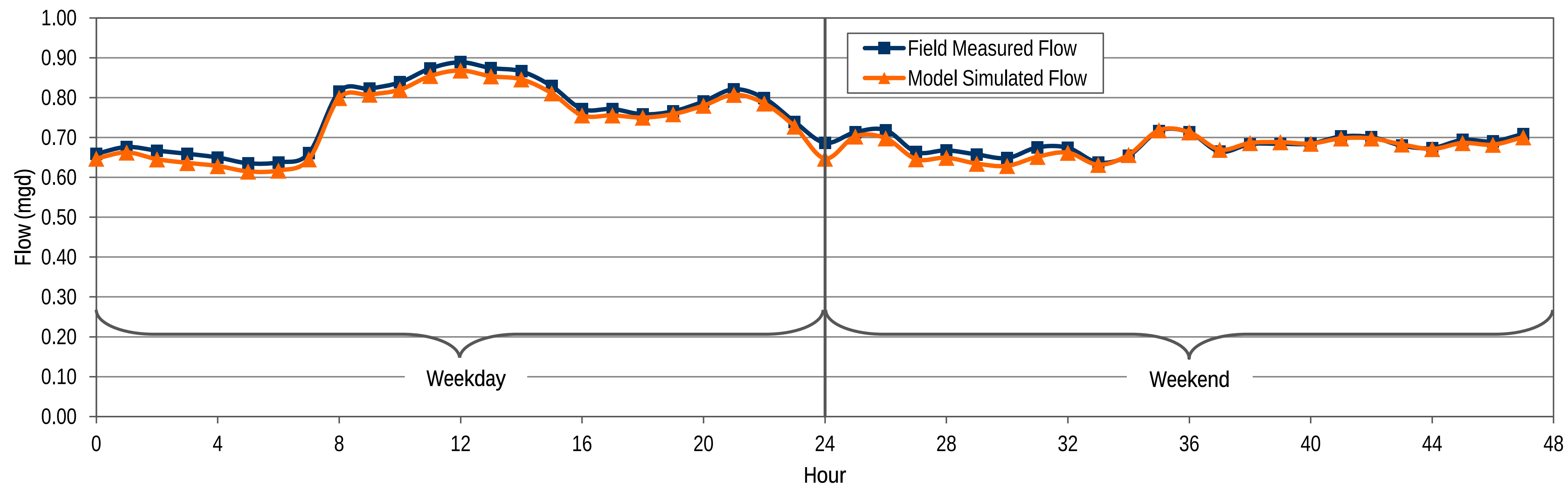
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85B DRY WEATHER CALIBRATION

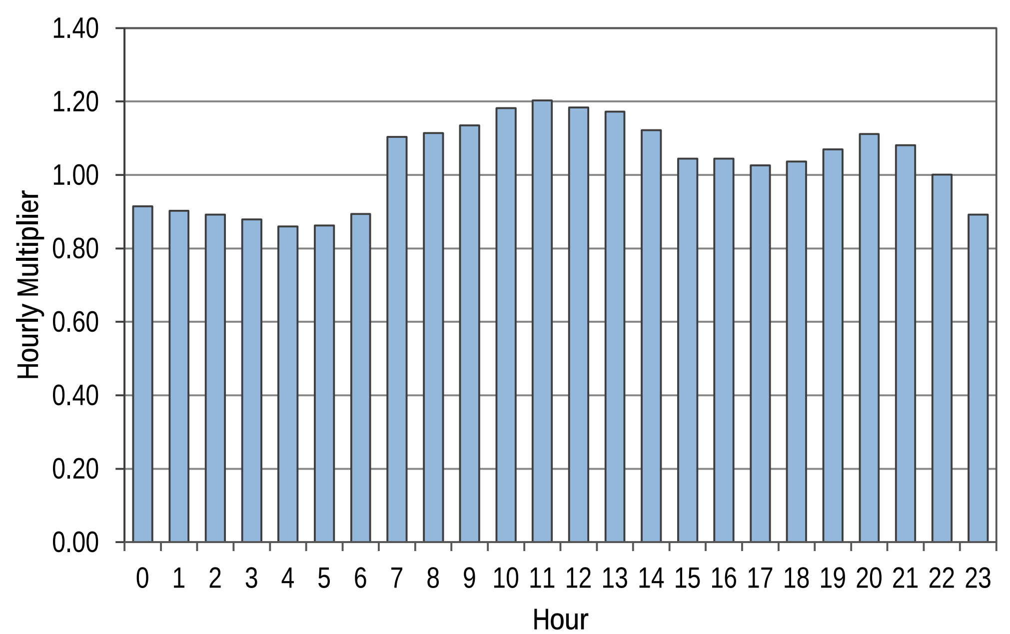
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.659	0.647	0.89	0.92	0.92
	1	0.676	0.662	0.92	0.90	0.90
	2	0.667	0.645	0.90	0.89	0.89
	3	0.659	0.636	0.89	0.88	0.88
	4	0.650	0.628	0.88	0.86	0.86
	5	0.635	0.615	0.86	0.86	0.86
	6	0.637	0.617	0.86	0.89	0.89
	7	0.661	0.645	0.89	1.10	1.10
	8	0.815	0.799	1.10	1.11	1.11
	9	0.823	0.808	1.11	1.13	1.13
	10	0.838	0.820	1.13	1.18	1.18
	11	0.873	0.854	1.18	1.20	1.20
	12	0.889	0.868	1.20	1.18	1.18
	13	0.874	0.854	1.18	1.17	1.17
	14	0.866	0.846	1.17	1.12	1.12
	15	0.829	0.811	1.12	1.04	1.04
	16	0.771	0.756	1.04	1.04	1.04
	17	0.772	0.755	1.04	1.03	1.03
	18	0.758	0.750	1.03	1.04	1.04
	19	0.766	0.759	1.04	1.07	1.07
	20	0.790	0.780	1.07	1.11	1.11
	21	0.821	0.807	1.11	1.08	1.08
	22	0.799	0.785	1.08	1.00	1.00
	23	0.739	0.727	1.00	0.89	0.89
Weekend	24	0.687	0.647	0.93	0.97	0.97
	25	0.713	0.703	0.97	0.97	0.97
	26	0.718	0.698	0.97	0.90	0.90
	27	0.663	0.645	0.90	0.90	0.90
	28	0.668	0.649	0.90	0.89	0.89
	29	0.657	0.634	0.89	0.88	0.88
	30	0.648	0.629	0.88	0.91	0.91
	31	0.675	0.651	0.91	0.91	0.91
	32	0.674	0.662	0.91	0.86	0.86
	33	0.637	0.631	0.86	0.88	0.88
	34	0.654	0.656	0.88	0.97	0.97
	35	0.716	0.718	0.97	0.97	0.97
	36	0.713	0.713	0.97	0.90	0.90
	37	0.664	0.669	0.90	0.92	0.92
	38	0.683	0.686	0.92	0.93	0.93
	39	0.684	0.688	0.93	0.93	0.93
	40	0.684	0.684	0.93	0.95	0.95
	41	0.702	0.698	0.95	0.95	0.95
	42	0.701	0.698	0.95	0.92	0.92
	43	0.680	0.683	0.92	0.91	0.91
	44	0.673	0.671	0.91	0.94	0.94
	45	0.694	0.686	0.94	0.93	0.93
	46	0.690	0.682	0.93	0.96	0.96
	47	0.709	0.701	0.96	0.93	0.93
Average						
	Weekday	0.761	0.745	1.03	1.03	1.03
	Weekend	0.683	0.674	0.92	0.92	0.92
	ADWF[1]	0.739	0.725	1.00	1.00	1.00
% Error						
	Weekday		-2.2%			
	Weekend		-1.3%			

Notes:

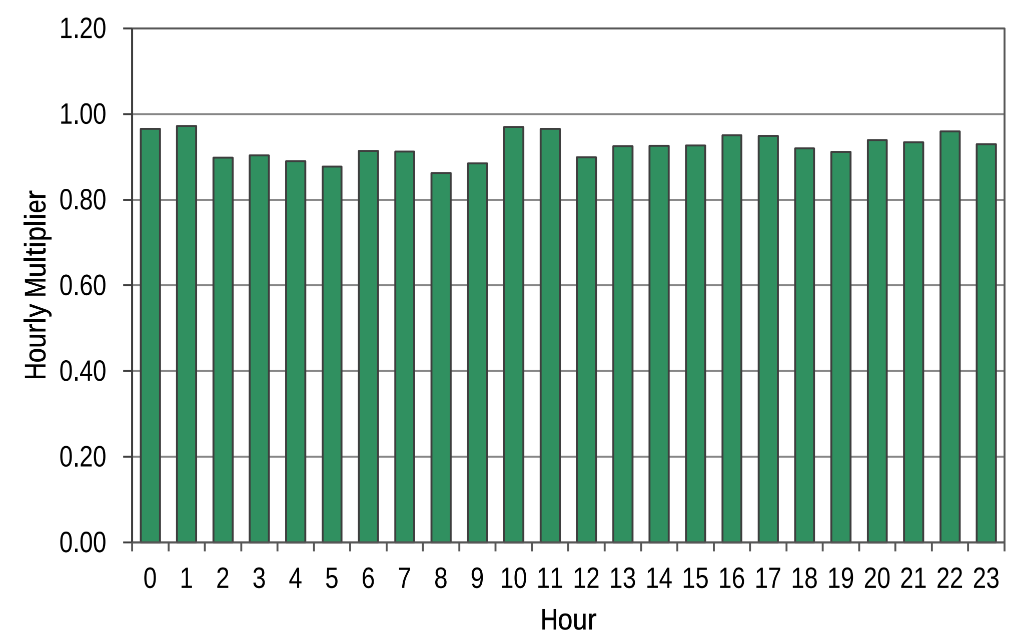
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

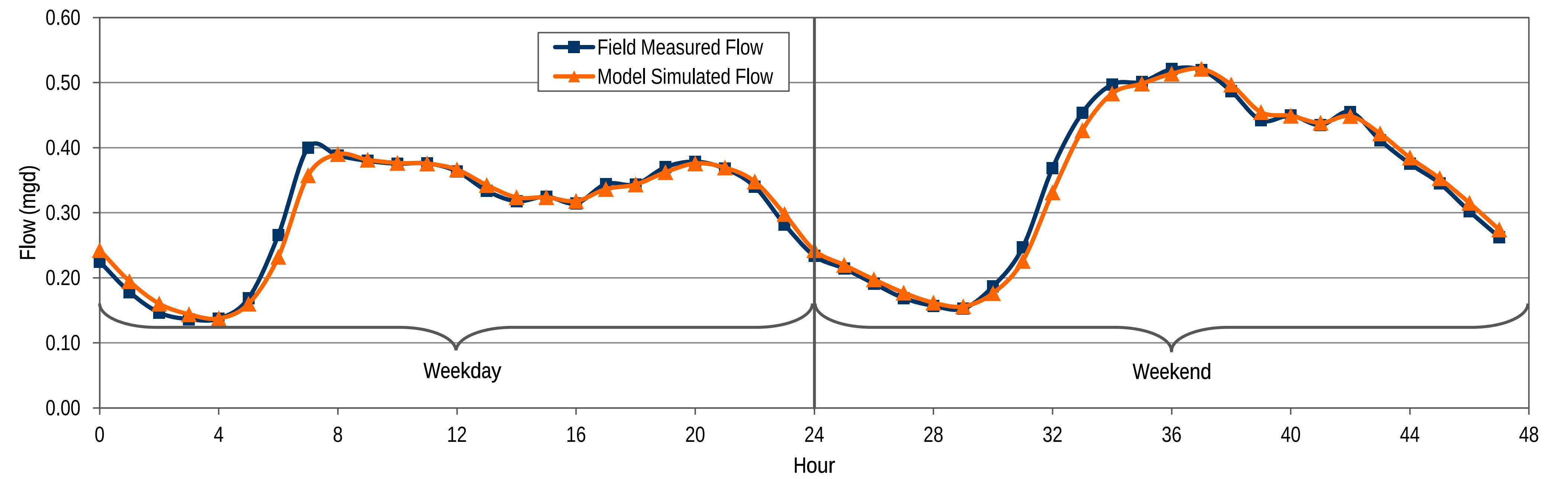
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85C DRY WEATHER CALIBRATION

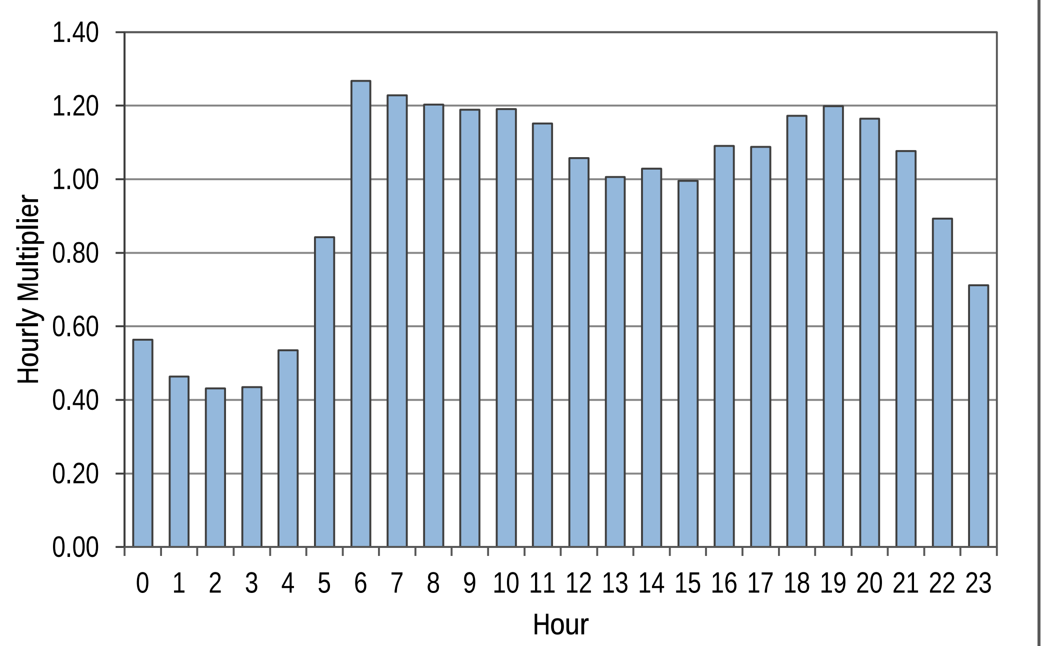
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.225	0.243	0.71	0.56	0.56
	1	0.178	0.195	0.56	0.46	0.46
	2	0.146	0.160	0.46	0.43	0.43
	3	0.136	0.144	0.43	0.43	0.43
	4	0.137	0.138	0.43	0.54	0.54
	5	0.169	0.160	0.54	0.84	0.84
	6	0.266	0.232	0.84	1.27	1.27
	7	0.400	0.358	1.27	1.23	1.23
	8	0.388	0.390	1.23	1.20	1.20
	9	0.380	0.382	1.20	1.19	1.19
	10	0.375	0.377	1.19	1.19	1.19
	11	0.376	0.376	1.19	1.15	1.15
	12	0.364	0.366	1.15	1.06	1.06
	13	0.334	0.343	1.06	1.01	1.01
	14	0.318	0.324	1.01	1.03	1.03
	15	0.325	0.324	1.03	1.00	1.00
	16	0.314	0.318	1.00	1.09	1.09
	17	0.344	0.337	1.09	1.09	1.09
	18	0.344	0.344	1.09	1.17	1.17
	19	0.370	0.362	1.17	1.20	1.20
	20	0.379	0.376	1.20	1.16	1.16
	21	0.368	0.370	1.16	1.08	1.08
	22	0.340	0.348	1.08	0.89	0.89
	23	0.282	0.298	0.89	0.71	0.71
Weekend	24	0.234	0.243	0.74	0.68	0.68
	25	0.214	0.220	0.68	0.61	0.61
	26	0.191	0.198	0.61	0.53	0.53
	27	0.169	0.177	0.53	0.50	0.50
	28	0.157	0.162	0.50	0.48	0.48
	29	0.152	0.156	0.48	0.59	0.59
	30	0.187	0.176	0.59	0.78	0.78
	31	0.247	0.226	0.78	1.17	1.17
	32	0.368	0.331	1.17	1.44	1.44
	33	0.454	0.427	1.44	1.58	1.58
	34	0.497	0.483	1.58	1.59	1.59
	35	0.501	0.499	1.59	1.65	1.65
	36	0.521	0.514	1.65	1.65	1.65
	37	0.519	0.521	1.65	1.54	1.54
	38	0.487	0.497	1.54	1.40	1.40
	39	0.442	0.455	1.40	1.42	1.42
	40	0.449	0.449	1.42	1.38	1.38
	41	0.435	0.438	1.38	1.44	1.44
	42	0.455	0.449	1.44	1.30	1.30
	43	0.412	0.422	1.30	1.19	1.19
	44	0.375	0.385	1.19	1.09	1.09
	45	0.345	0.353	1.09	0.96	0.96
	46	0.302	0.315	0.96	0.83	0.83
	47	0.263	0.274	0.83	0.74	0.74
Average						
	Weekday	0.302	0.303	0.96	0.96	0.96
	Weekend	0.349	0.349	1.11	1.11	1.11
	ADWF[(1)]	0.316	0.316	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.1%			

Notes:

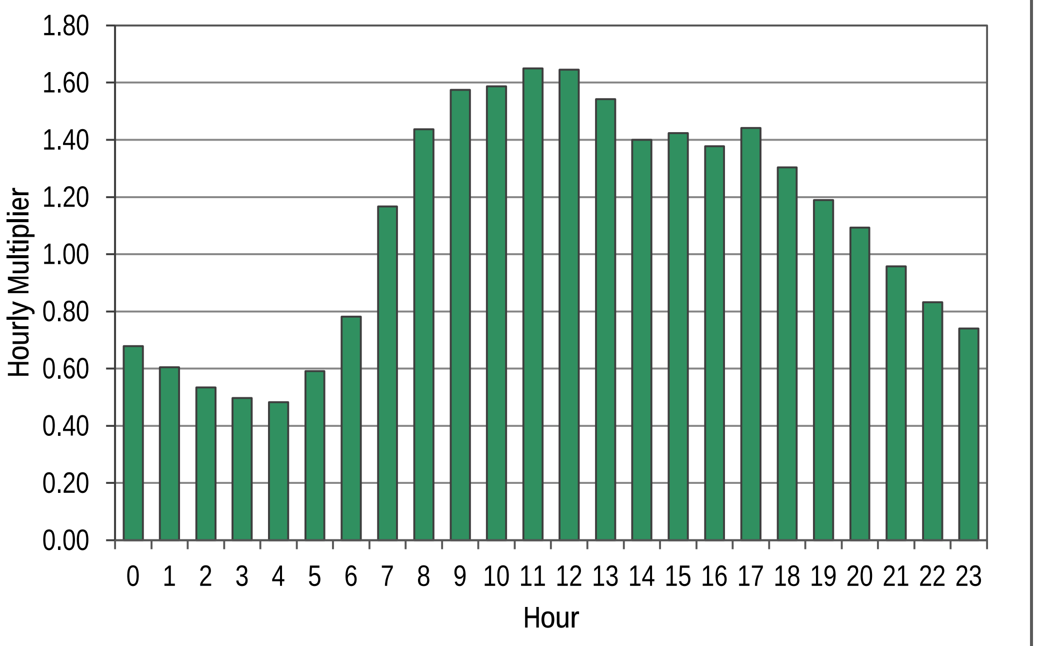
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

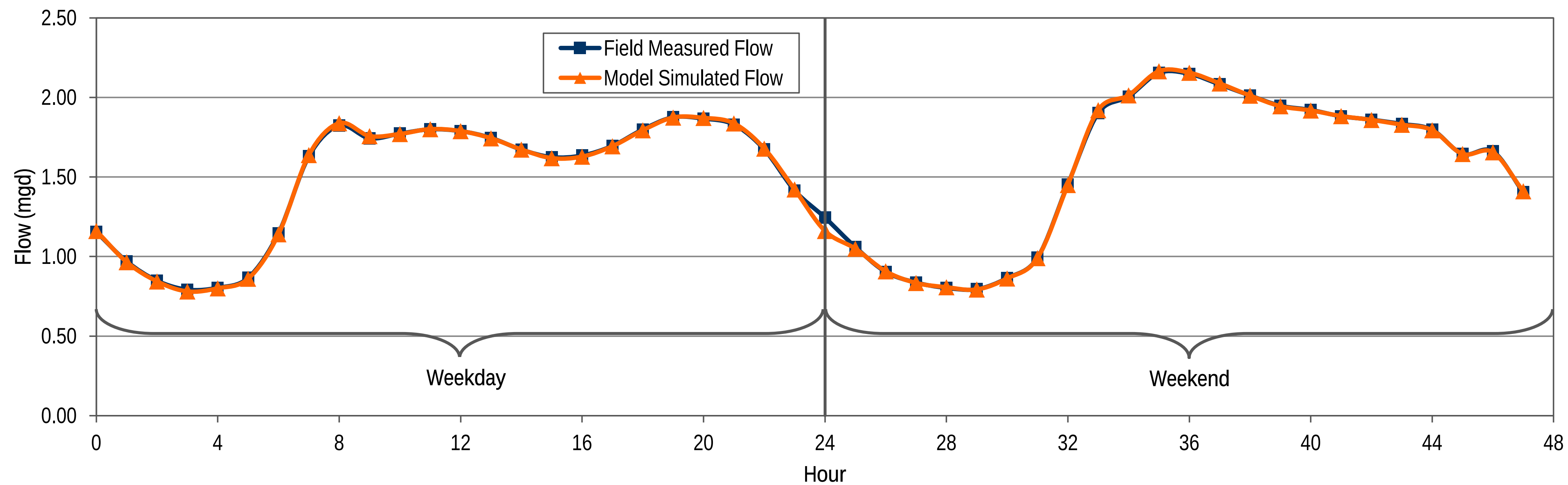
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-2 DRY WEATHER CALIBRATION

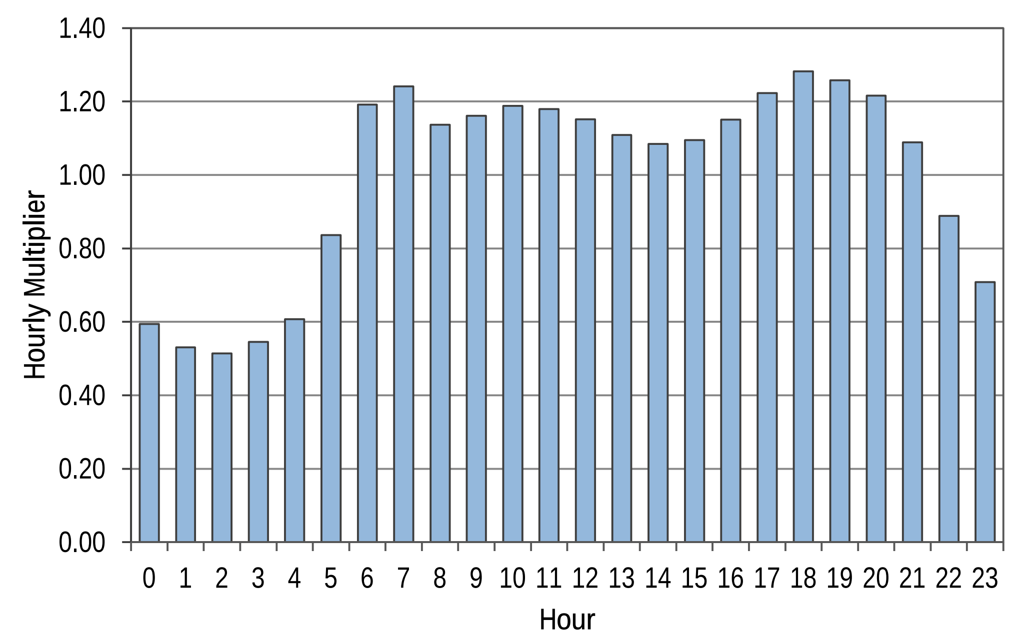
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	1.154	1.160	0.76	0.64	0.59
	1	0.969	0.964	0.64	0.56	0.53
	2	0.848	0.843	0.56	0.52	0.51
	3	0.792	0.780	0.52	0.53	0.55
	4	0.804	0.800	0.53	0.57	0.61
	5	0.866	0.860	0.57	0.76	0.84
	6	1.146	1.140	0.76	1.08	1.19
	7	1.630	1.638	1.08	1.20	1.24
	8	1.823	1.838	1.20	1.15	1.14
	9	1.743	1.757	1.15	1.17	1.16
	10	1.773	1.770	1.17	1.19	1.19
	11	1.799	1.800	1.19	1.18	1.18
	12	1.788	1.788	1.18	1.15	1.15
	13	1.745	1.743	1.15	1.10	1.11
	14	1.672	1.672	1.10	1.07	1.08
	15	1.625	1.618	1.07	1.08	1.09
	16	1.635	1.628	1.08	1.12	1.15
	17	1.695	1.693	1.12	1.19	1.22
	18	1.798	1.793	1.19	1.24	1.28
	19	1.875	1.873	1.24	1.23	1.26
	20	1.866	1.871	1.23	1.21	1.22
	21	1.829	1.836	1.21	1.11	1.09
	22	1.673	1.678	1.11	0.94	0.89
	23	1.415	1.422	0.94	0.76	0.71
Weekend	24	1.245	1.161	0.82	0.70	0.67
	25	1.059	1.049	0.70	0.60	0.56
	26	0.904	0.907	0.60	0.55	0.53
	27	0.837	0.834	0.55	0.53	0.52
	28	0.803	0.807	0.53	0.53	0.52
	29	0.795	0.793	0.53	0.57	0.59
	30	0.864	0.862	0.57	0.66	0.69
	31	0.992	0.990	0.66	0.96	1.04
	32	1.453	1.449	0.96	1.26	1.33
	33	1.901	1.920	1.26	1.33	1.33
	34	2.005	2.013	1.33	1.42	1.40
	35	2.154	2.164	1.42	1.42	1.38
	36	2.148	2.155	1.42	1.38	1.31
	37	2.082	2.088	1.38	1.33	1.24
	38	2.012	2.011	1.33	1.29	1.21
	39	1.948	1.944	1.29	1.27	1.22
	40	1.921	1.918	1.27	1.24	1.19
	41	1.882	1.882	1.24	1.23	1.19
	42	1.860	1.858	1.23	1.21	1.15
	43	1.833	1.828	1.21	1.19	1.15
	44	1.797	1.794	1.19	1.09	1.05
	45	1.645	1.644	1.09	1.10	1.09
	46	1.661	1.655	1.10	0.93	0.91
	47	1.405	1.410	0.93	0.82	0.78
Average						
	Weekday	1.499	1.499	0.99	0.99	1.00
	Weekend	1.550	1.547	1.02	1.02	1.00
	ADWF(1)	1.513	1.513	1.00	1.00	1.00
% Error						
	Weekday		0.0%			
	Weekend		-0.2%			

Notes:

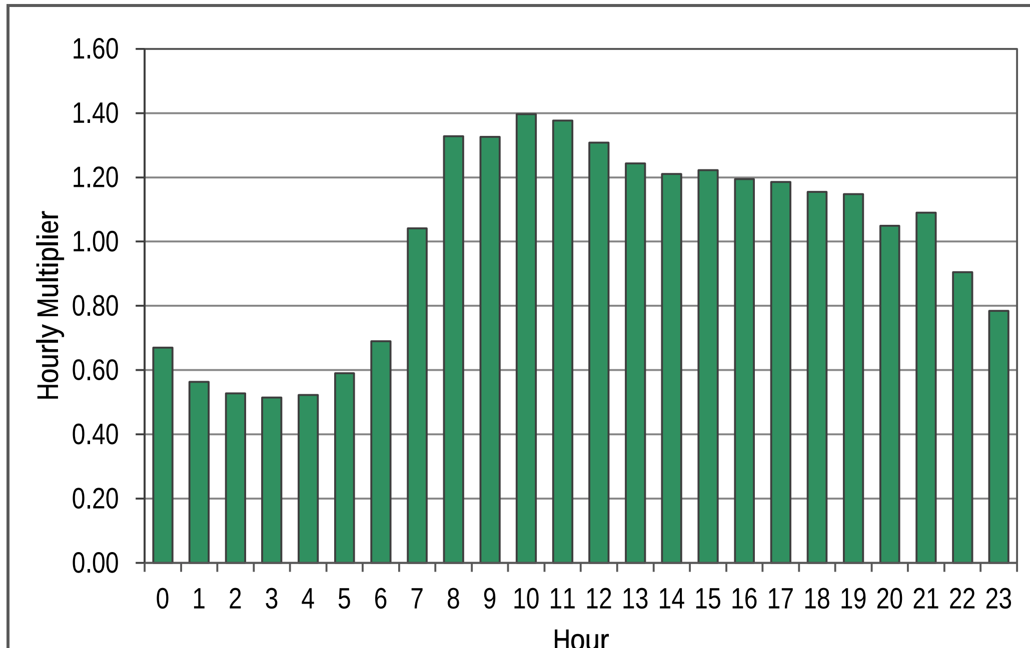
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

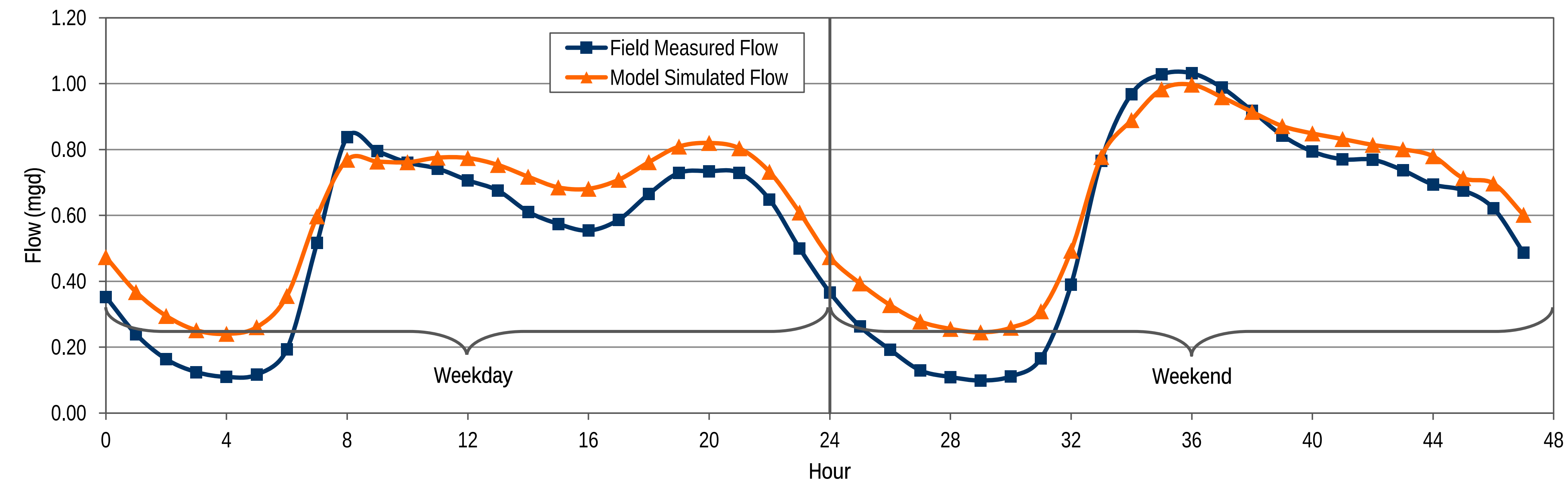
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-F DRY WEATHER CALIBRATION

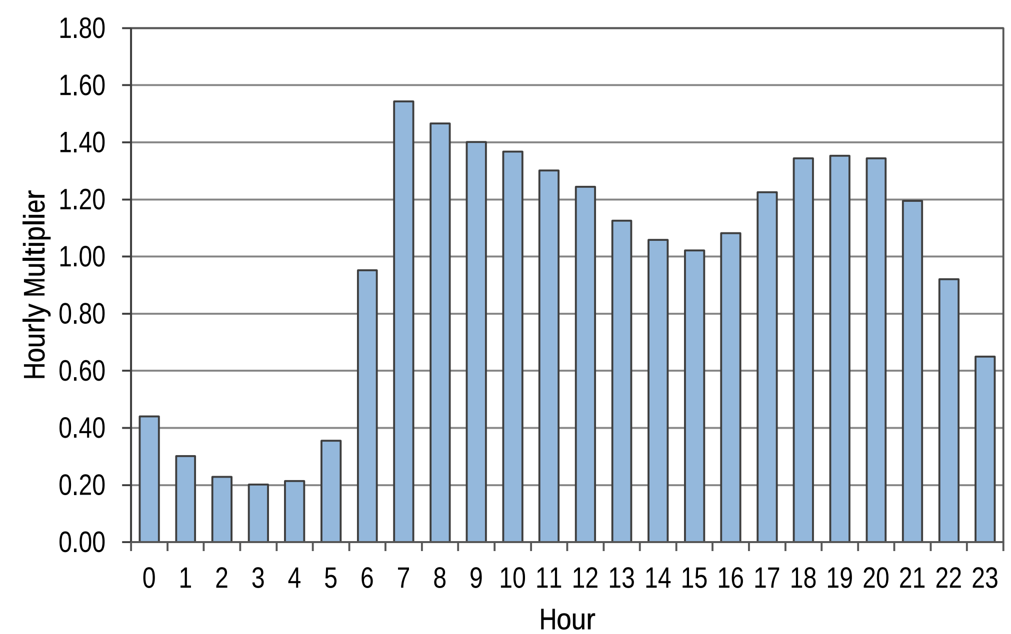
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.352	0.473	0.65	0.44	0.44
	1	0.239	0.367	0.44	0.30	0.30
	2	0.163	0.295	0.30	0.23	0.23
	3	0.124	0.251	0.23	0.20	0.20
	4	0.109	0.241	0.20	0.21	0.21
	5	0.116	0.261	0.21	0.36	0.36
	6	0.193	0.355	0.36	0.95	0.95
	7	0.517	0.597	0.95	1.54	1.54
	8	0.837	0.769	1.54	1.47	1.47
	9	0.795	0.763	1.47	1.40	1.40
	10	0.760	0.761	1.40	1.37	1.37
	11	0.742	0.775	1.37	1.30	1.30
	12	0.706	0.774	1.30	1.24	1.24
	13	0.675	0.753	1.24	1.13	1.13
	14	0.611	0.717	1.13	1.06	1.06
	15	0.574	0.685	1.06	1.02	1.02
	16	0.554	0.681	1.02	1.08	1.08
	17	0.587	0.708	1.08	1.23	1.23
	18	0.665	0.762	1.23	1.34	1.34
	19	0.729	0.809	1.34	1.35	1.35
	20	0.734	0.820	1.35	1.34	1.34
	21	0.729	0.804	1.34	1.20	1.20
	22	0.648	0.732	1.20	0.92	0.92
	23	0.499	0.609	0.92	0.65	0.65
Weekend	24	0.366	0.473	0.67	0.48	0.48
	25	0.263	0.394	0.48	0.35	0.35
	26	0.192	0.328	0.35	0.24	0.24
	27	0.129	0.278	0.24	0.20	0.20
	28	0.109	0.256	0.20	0.18	0.18
	29	0.099	0.245	0.18	0.20	0.20
	30	0.111	0.259	0.20	0.31	0.31
	31	0.166	0.309	0.31	0.72	0.72
	32	0.389	0.493	0.72	1.41	1.41
	33	0.766	0.777	1.41	1.78	1.78
	34	0.968	0.889	1.78	1.90	1.90
	35	1.028	0.983	1.90	1.90	1.90
	36	1.031	0.997	1.90	1.82	1.82
	37	0.988	0.959	1.82	1.69	1.69
	38	0.917	0.914	1.69	1.55	1.55
	39	0.843	0.871	1.55	1.46	1.46
	40	0.794	0.849	1.46	1.42	1.42
	41	0.770	0.832	1.42	1.42	1.42
	42	0.769	0.814	1.42	1.36	1.36
	43	0.737	0.801	1.36	1.28	1.28
	44	0.694	0.780	1.28	1.25	1.25
	45	0.676	0.713	1.25	1.15	1.15
	46	0.622	0.697	1.15	0.90	0.90
	47	0.487	0.602	0.90	0.67	0.67
Average						
	Weekday	0.527	0.615	0.97	0.97	0.97
	Weekend	0.580	0.646	1.07	1.07	1.07
	ADWF[(1)]	0.542	0.624	1.00	1.00	1.00
% Error						
	Weekday		16.6%			
	Weekend		11.5%			

Notes:

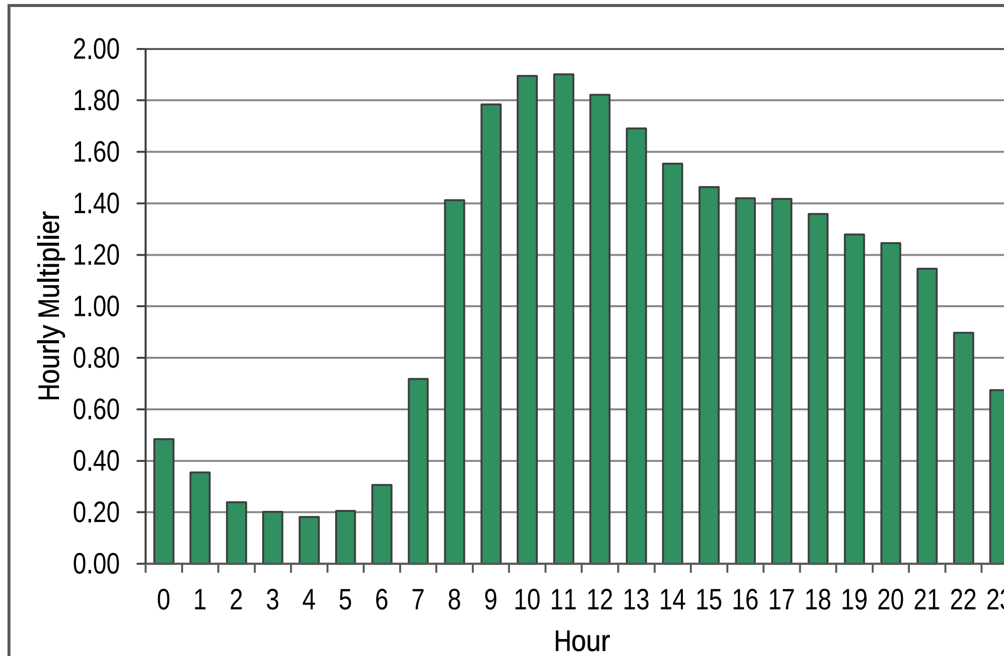
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_85.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

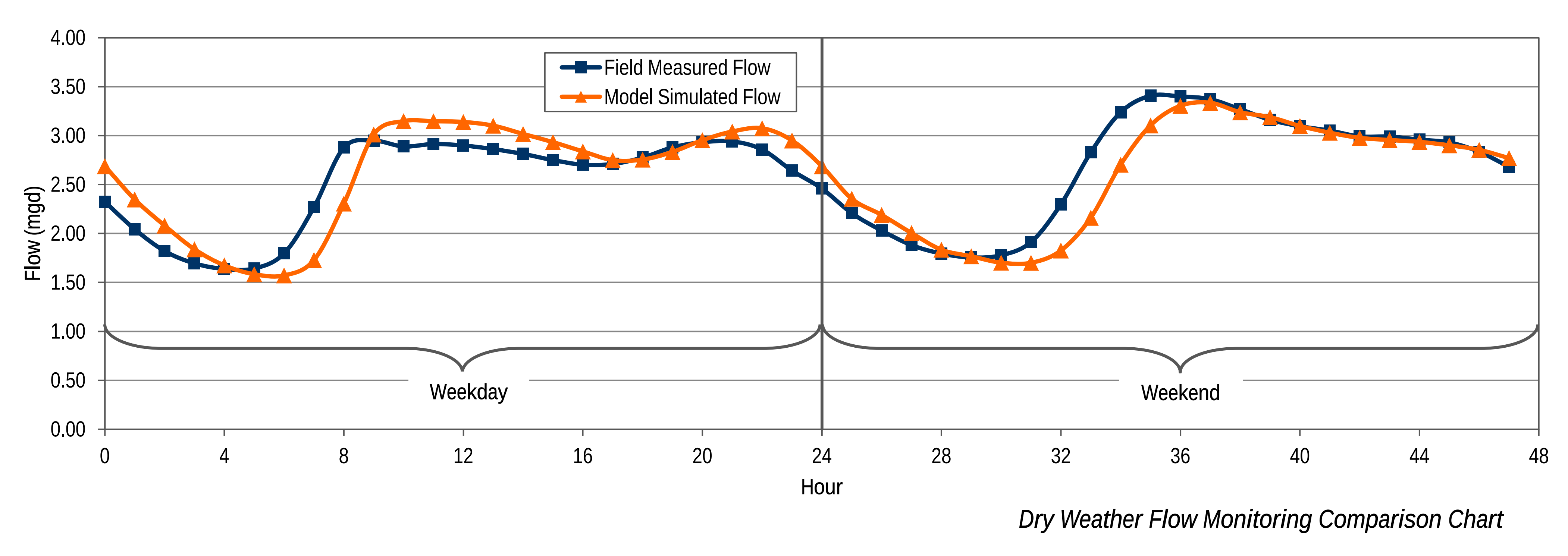
FLOW MONITORING SITE 85L-1 DRY WEATHER CALIBRATION

carollo

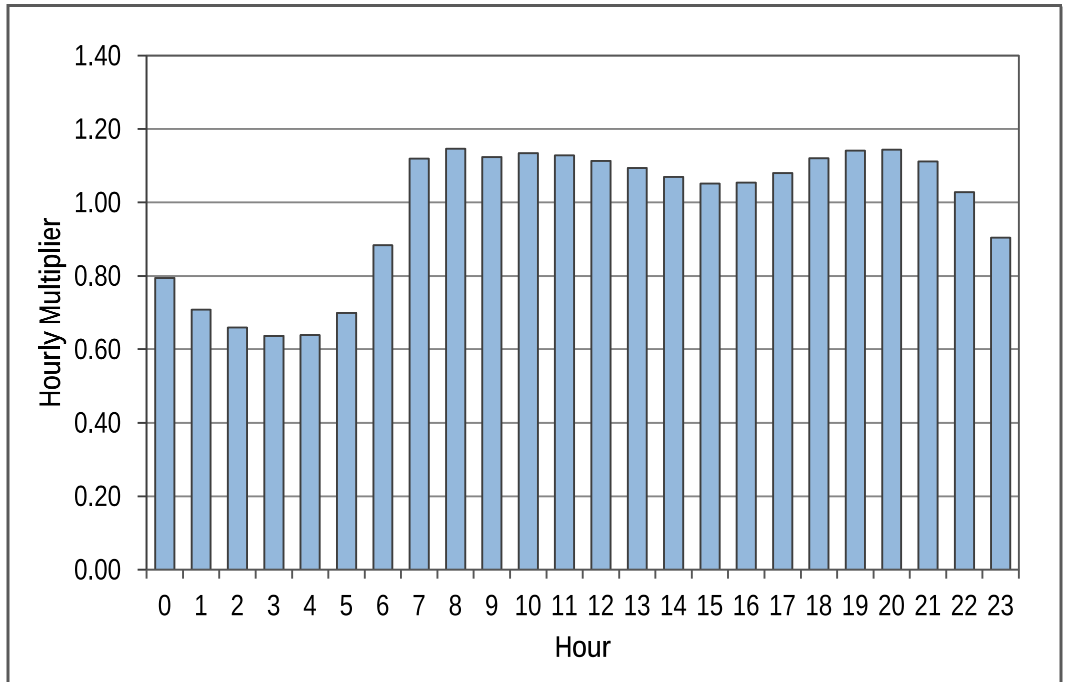
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	2.324	2.687	0.90	0.79	0.79
	1	2.043	2.347	0.79	0.71	0.71
	2	1.821	2.080	0.71	0.66	0.66
	3	1.695	1.838	0.66	0.64	0.64
	4	1.638	1.674	0.64	0.64	0.64
	5	1.643	1.583	0.64	0.70	0.70
	6	1.797	1.571	0.70	0.88	0.88
	7	2.270	1.729	0.88	1.12	1.12
	8	2.878	2.306	1.12	1.15	1.15
	9	2.948	3.011	1.15	1.12	1.12
	10	2.889	3.148	1.12	1.13	1.13
	11	2.915	3.146	1.13	1.13	1.13
	12	2.899	3.139	1.13	1.11	1.11
	13	2.863	3.101	1.11	1.09	1.09
	14	2.813	3.016	1.09	1.07	1.07
	15	2.750	2.933	1.07	1.05	1.05
	16	2.703	2.838	1.05	1.05	1.05
	17	2.710	2.749	1.05	1.08	1.08
	18	2.776	2.755	1.08	1.12	1.12
	19	2.880	2.833	1.12	1.14	1.14
	20	2.933	2.953	1.14	1.14	1.14
	21	2.941	3.041	1.14	1.11	1.11
	22	2.858	3.074	1.11	1.03	1.03
	23	2.643	2.950	1.03	0.90	0.90
Weekend	24	2.459	2.687	0.96	0.86	0.86
	25	2.208	2.355	0.86	0.79	0.79
	26	2.030	2.189	0.79	0.73	0.73
	27	1.881	2.005	0.73	0.70	0.70
	28	1.795	1.834	0.70	0.68	0.68
	29	1.756	1.767	0.68	0.69	0.69
	30	1.778	1.702	0.69	0.74	0.74
	31	1.912	1.700	0.74	0.89	0.89
	32	2.298	1.826	0.89	1.10	1.10
	33	2.829	2.160	1.10	1.26	1.26
	34	3.239	2.702	1.26	1.33	1.33
	35	3.408	3.103	1.33	1.32	1.32
	36	3.401	3.304	1.32	1.31	1.31
	37	3.372	3.334	1.31	1.27	1.27
	38	3.270	3.238	1.27	1.23	1.23
	39	3.162	3.188	1.23	1.20	1.20
	40	3.096	3.098	1.20	1.19	1.19
	41	3.052	3.029	1.19	1.16	1.16
	42	2.993	2.976	1.16	1.16	1.16
	43	2.991	2.954	1.16	1.15	1.15
	44	2.959	2.935	1.15	1.14	1.14
	45	2.931	2.901	1.14	1.10	1.10
	46	2.836	2.854	1.10	1.04	1.04
	47	2.682	2.770	1.04	0.96	0.96
Average						
	Weekday	2.526	2.604	0.98	0.98	0.98
	Weekend	2.681	2.609	1.04	1.04	1.04
	ADWF[1]	2.570	2.606	1.00	1.00	1.00
% Error						
	Weekday		3.1%			
	Weekend		-2.7%			

Notes:

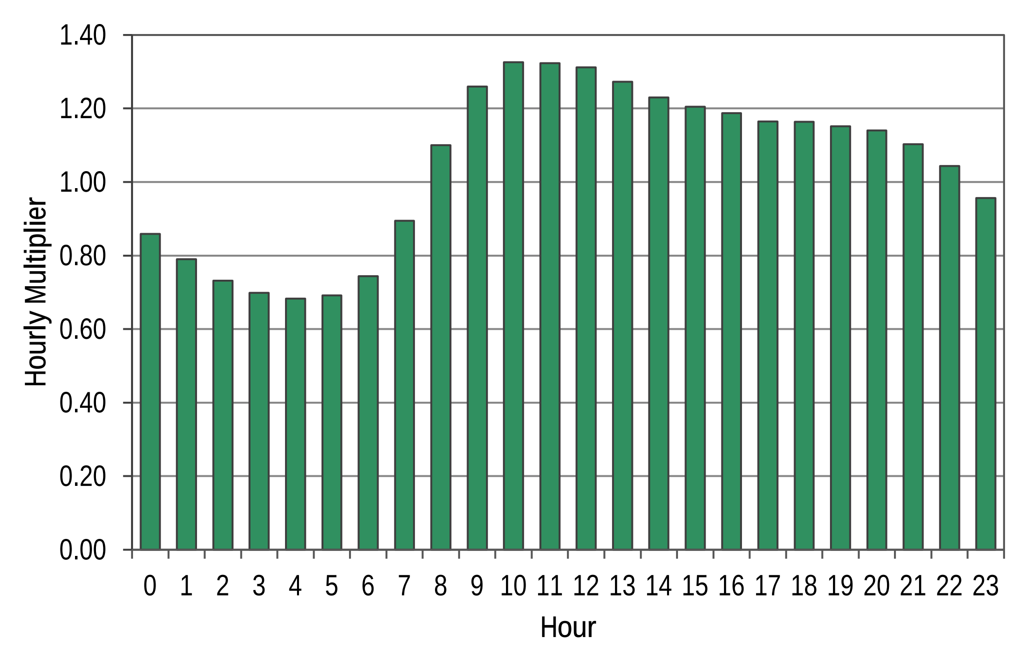
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

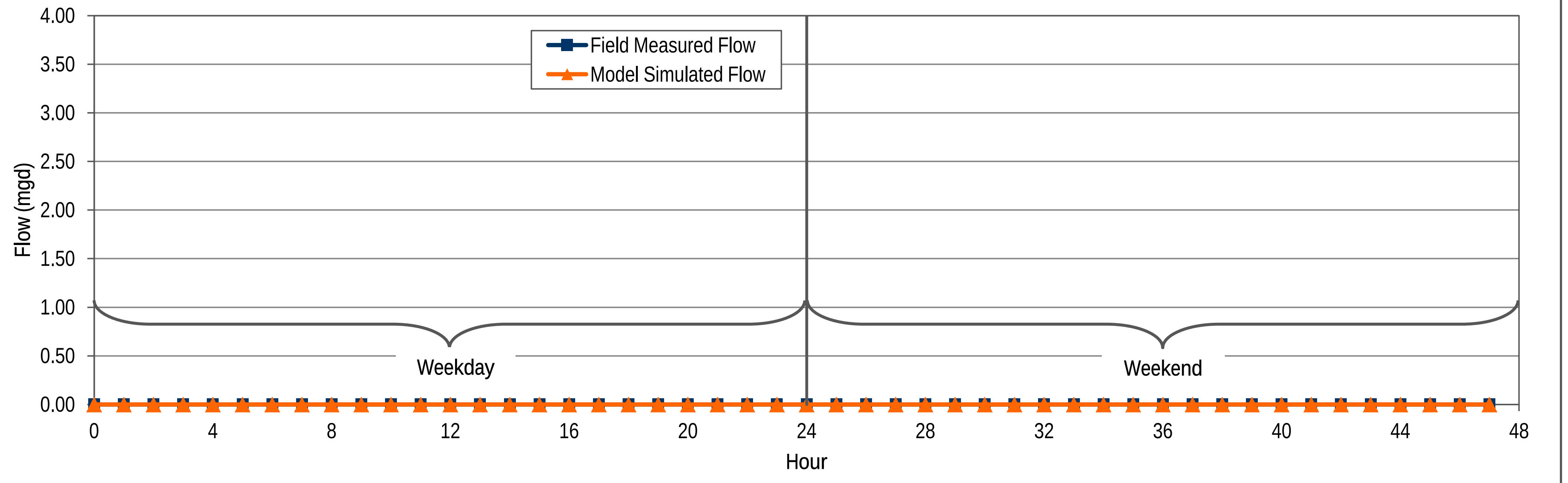
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-2BX DRY WEATHER CALIBRATION

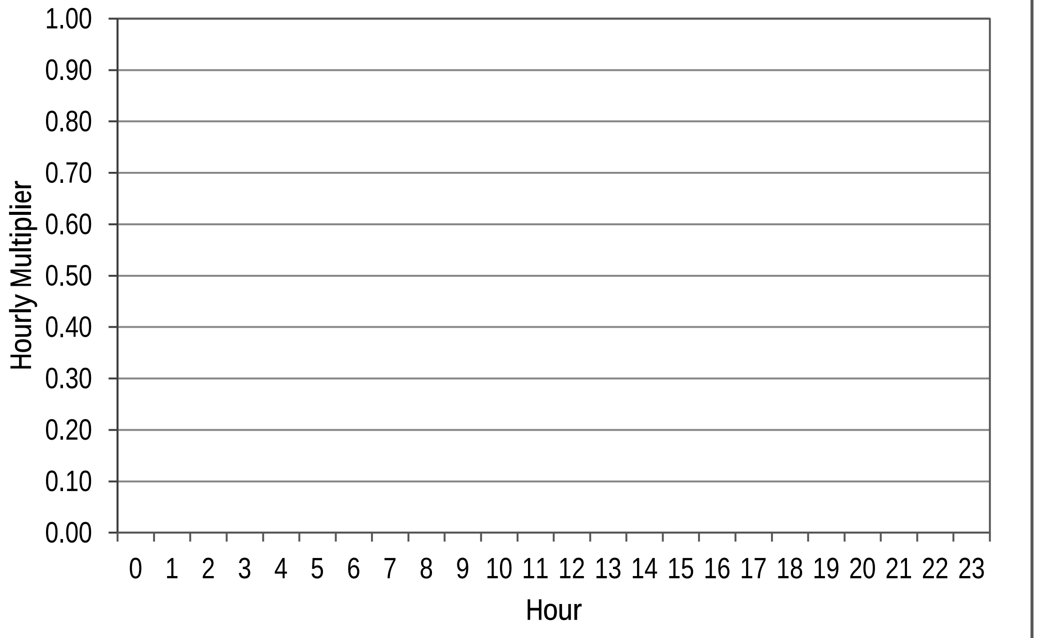
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.000	0.000	0.00	0.00	0.00
	1	0.000	0.000	0.00	0.00	0.00
	2	0.000	0.000	0.00	0.00	0.00
	3	0.000	0.000	0.00	0.00	0.00
	4	0.000	0.000	0.00	0.00	0.00
	5	0.000	0.000	0.00	0.00	0.00
	6	0.000	0.000	0.00	0.00	0.00
	7	0.000	0.000	0.00	0.00	0.00
	8	0.000	0.000	0.00	0.00	0.00
	9	0.000	0.000	0.00	0.00	0.00
	10	0.000	0.000	0.00	0.00	0.00
	11	0.000	0.000	0.00	0.00	0.00
	12	0.000	0.000	0.00	0.00	0.00
	13	0.000	0.000	0.00	0.00	0.00
	14	0.000	0.000	0.00	0.00	0.00
	15	0.000	0.000	0.00	0.00	0.00
	16	0.000	0.000	0.00	0.00	0.00
	17	0.000	0.000	0.00	0.00	0.00
	18	0.000	0.000	0.00	0.00	0.00
	19	0.000	0.000	0.00	0.00	0.00
	20	0.000	0.000	0.00	0.00	0.00
	21	0.000	0.000	0.00	0.00	0.00
	22	0.000	0.000	0.00	0.00	0.00
	23	0.000	0.000	0.00	0.00	0.00
Weekend	24	0.000	0.000	0.00	0.00	0.00
	25	0.000	0.000	0.00	0.00	0.00
	26	0.000	0.000	0.00	0.00	0.00
	27	0.000	0.000	0.00	0.00	0.00
	28	0.000	0.000	0.00	0.00	0.00
	29	0.000	0.000	0.00	0.00	0.00
	30	0.000	0.000	0.00	0.00	0.00
	31	0.000	0.000	0.00	0.00	0.00
	32	0.000	0.000	0.00	0.00	0.00
	33	0.000	0.000	0.00	0.00	0.00
	34	0.000	0.000	0.00	0.00	0.00
	35	0.000	0.000	0.00	0.00	0.00
	36	0.000	0.000	0.00	0.00	0.00
	37	0.000	0.000	0.00	0.00	0.00
	38	0.000	0.000	0.00	0.00	0.00
	39	0.000	0.000	0.00	0.00	0.00
	40	0.000	0.000	0.00	0.00	0.00
	41	0.000	0.000	0.00	0.00	0.00
	42	0.000	0.000	0.00	0.00	0.00
	43	0.000	0.000	0.00	0.00	0.00
	44	0.000	0.000	0.00	0.00	0.00
	45	0.000	0.000	0.00	0.00	0.00
	46	0.000	0.000	0.00	0.00	0.00
	47	0.000	0.000	0.00	0.00	0.00
Average						
	Weekday	0.000	0.000	0.00	0.00	0.00
	Weekend	0.000	0.000	0.00	0.00	0.00
	ADWF[1]	0.000	0.000	0.00	0.00	0.00
% Error						
	Weekday		0.0%			
	Weekend		0.0%			

Notes:

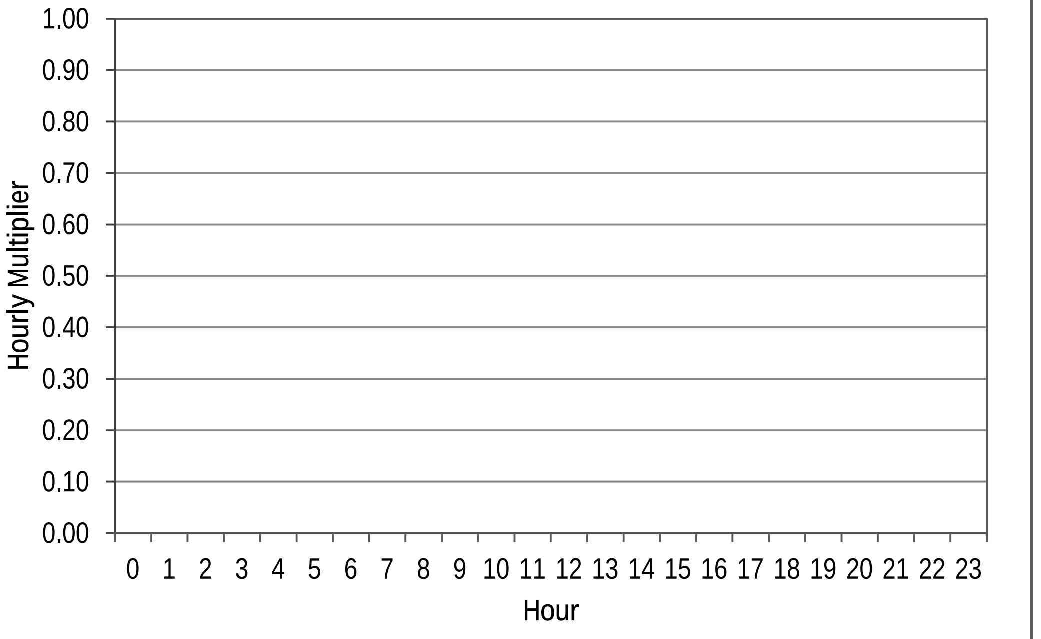
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

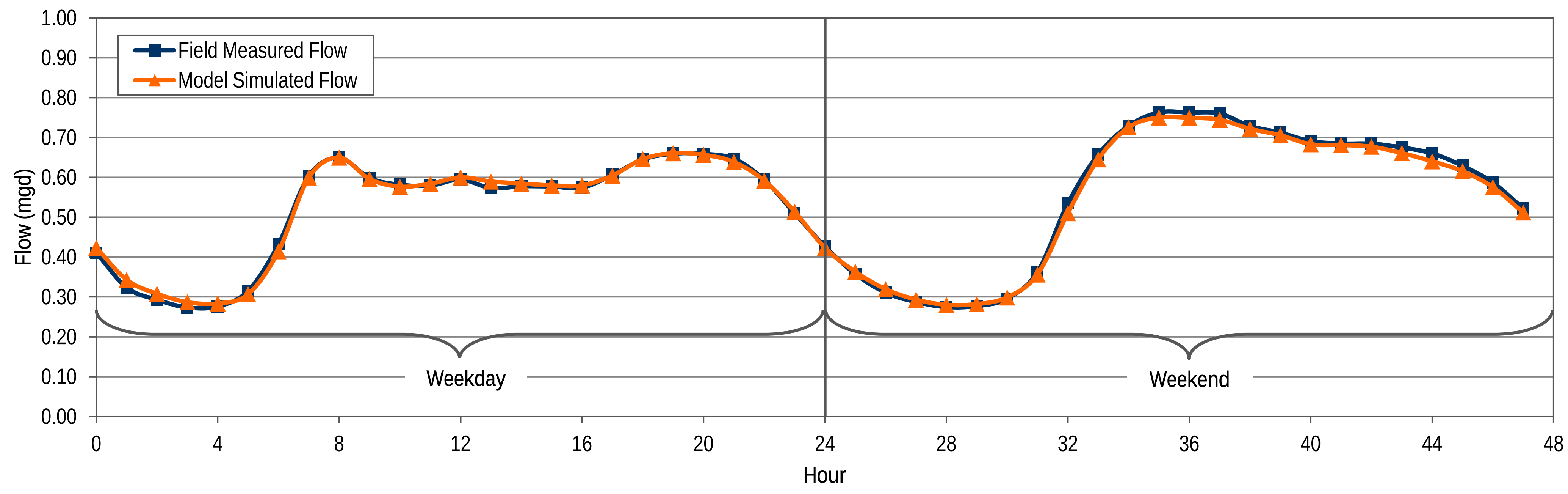
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 86A DRY WEATHER CALIBRATION

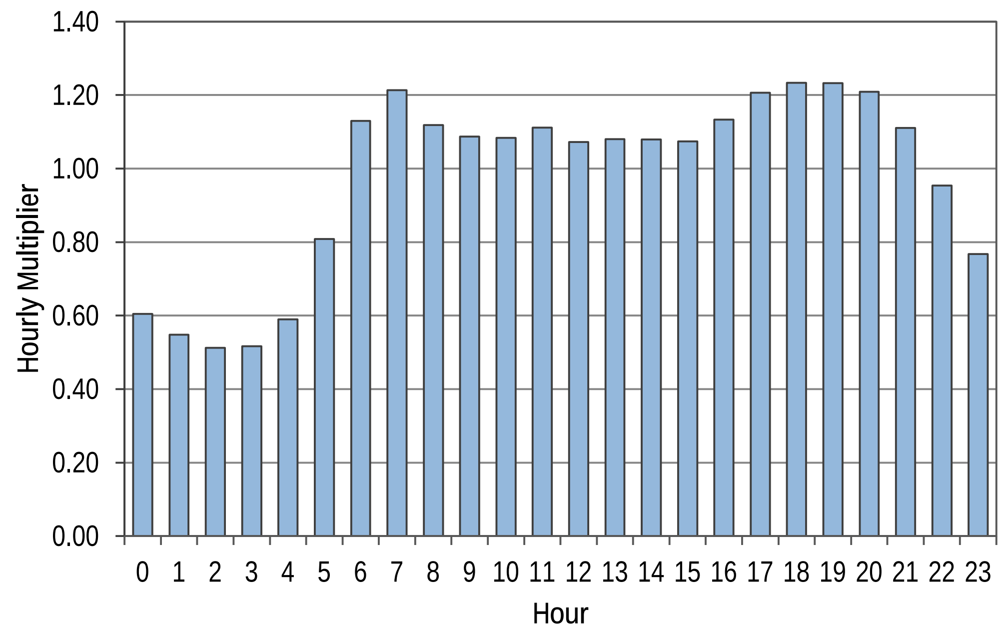
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.411	0.423	0.77	0.61	0.60
	1	0.323	0.343	0.61	0.55	0.55
	2	0.293	0.308	0.55	0.51	0.51
	3	0.274	0.287	0.51	0.52	0.52
	4	0.276	0.284	0.52	0.59	0.59
	5	0.315	0.307	0.59	0.81	0.81
	6	0.432	0.415	0.81	1.13	1.13
	7	0.604	0.600	1.13	1.22	1.21
	8	0.649	0.650	1.22	1.12	1.12
	9	0.598	0.596	1.12	1.09	1.09
	10	0.582	0.577	1.09	1.09	1.08
	11	0.580	0.584	1.09	1.12	1.11
	12	0.595	0.600	1.12	1.08	1.07
	13	0.573	0.590	1.08	1.08	1.08
	14	0.578	0.584	1.08	1.08	1.08
	15	0.577	0.580	1.08	1.08	1.07
	16	0.574	0.580	1.08	1.14	1.13
	17	0.606	0.604	1.14	1.21	1.21
	18	0.645	0.646	1.21	1.24	1.23
	19	0.660	0.661	1.24	1.24	1.23
	20	0.659	0.657	1.24	1.21	1.21
	21	0.647	0.639	1.21	1.11	1.11
	22	0.594	0.592	1.11	0.96	0.95
	23	0.510	0.514	0.96	0.77	0.77
Weekend	24	0.427	0.423	0.80	0.67	0.67
	25	0.358	0.363	0.67	0.58	0.58
	26	0.311	0.319	0.58	0.54	0.54
	27	0.287	0.293	0.54	0.52	0.51
	28	0.275	0.280	0.52	0.52	0.52
	29	0.277	0.282	0.52	0.56	0.55
	30	0.296	0.299	0.56	0.68	0.68
	31	0.362	0.356	0.68	1.00	1.01
	32	0.535	0.510	1.00	1.23	1.25
	33	0.657	0.645	1.23	1.37	1.39
	34	0.729	0.726	1.37	1.43	1.44
	35	0.763	0.750	1.43	1.43	1.44
	36	0.763	0.750	1.43	1.43	1.44
	37	0.760	0.744	1.43	1.37	1.39
	38	0.729	0.722	1.37	1.34	1.36
	39	0.712	0.706	1.34	1.30	1.32
	40	0.691	0.683	1.30	1.29	1.31
	41	0.685	0.681	1.29	1.28	1.30
	42	0.685	0.677	1.28	1.27	1.29
	43	0.675	0.661	1.27	1.24	1.26
	44	0.660	0.640	1.24	1.18	1.20
	45	0.629	0.616	1.18	1.10	1.12
	46	0.587	0.575	1.10	0.98	0.98
	47	0.522	0.512	0.98	0.80	0.80
Average						
	Weekday	0.523	0.526	0.98	0.98	0.98
	Weekend	0.557	0.551	1.05	1.05	1.05
	ADWF[1]	0.533	0.533	1.00	1.00	1.00
% Error						
	Weekday		0.5%			
	Weekend		-1.2%			

Notes:

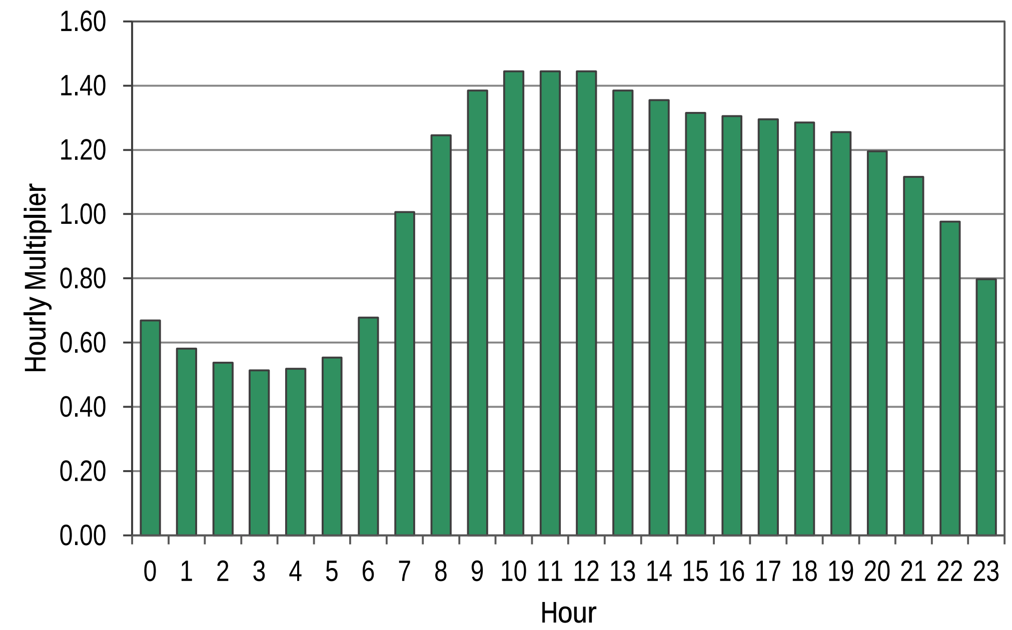
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_86.xlsx

City of Oakland

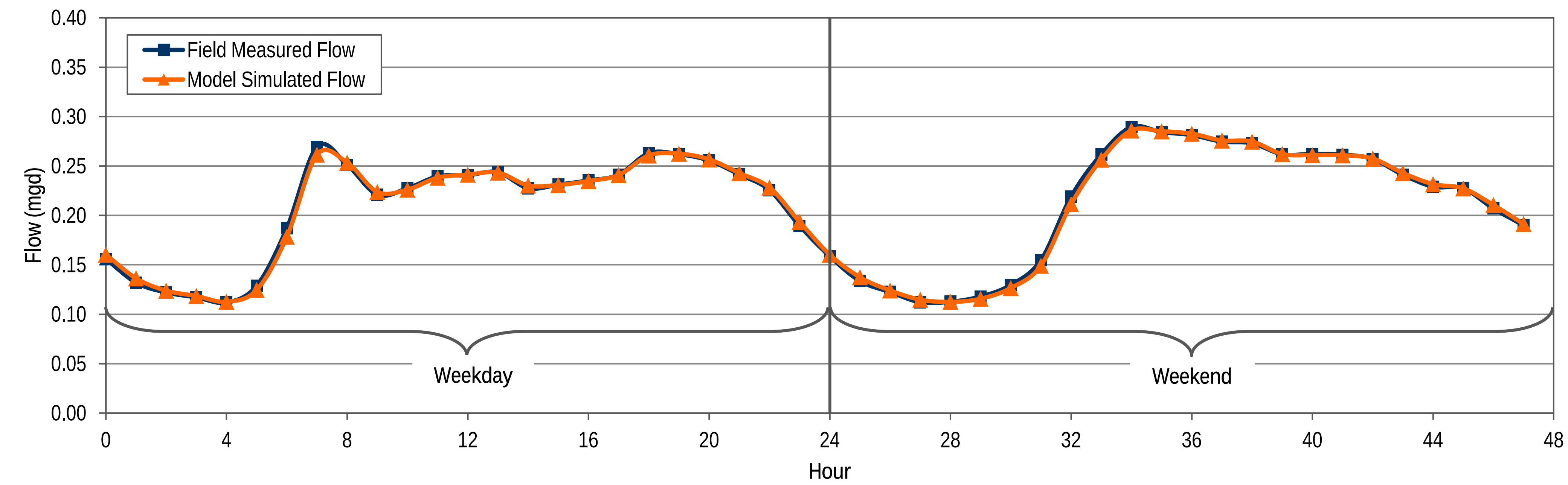
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 86B DRY WEATHER CALIBRATION

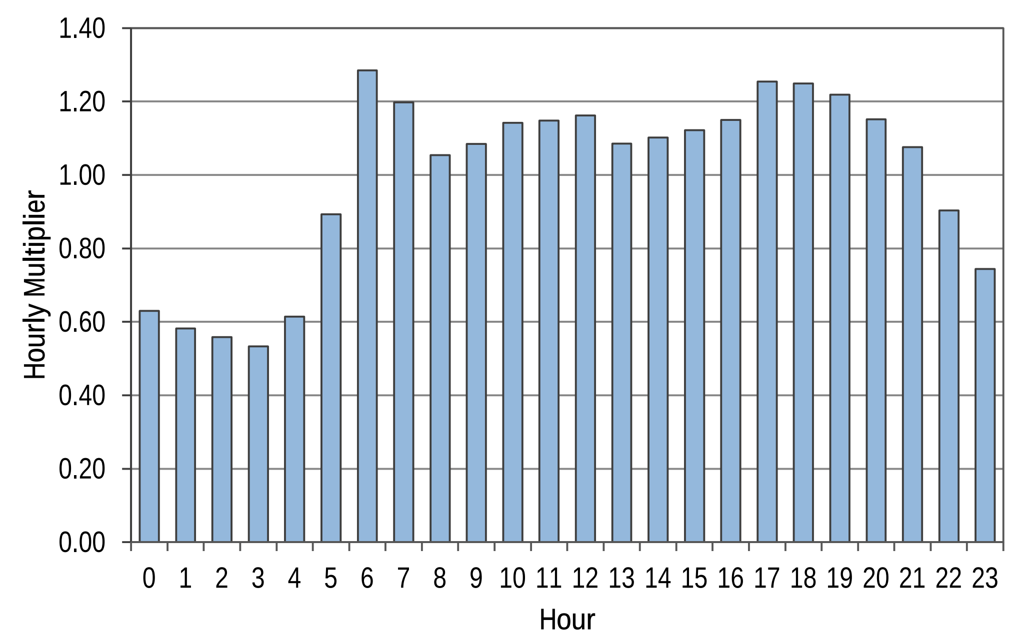
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.156	0.160	0.74	0.63	0.63
	1	0.132	0.136	0.63	0.58	0.58
	2	0.122	0.124	0.58	0.56	0.56
	3	0.117	0.118	0.56	0.53	0.53
	4	0.112	0.113	0.53	0.61	0.61
	5	0.129	0.125	0.61	0.89	0.89
	6	0.187	0.178	0.89	1.28	1.28
	7	0.269	0.261	1.28	1.20	1.20
	8	0.251	0.253	1.20	1.05	1.05
	9	0.221	0.224	1.05	1.08	1.08
	10	0.227	0.226	1.08	1.14	1.14
	11	0.239	0.238	1.14	1.15	1.15
	12	0.241	0.241	1.15	1.16	1.16
	13	0.244	0.243	1.16	1.09	1.09
	14	0.228	0.230	1.09	1.10	1.10
	15	0.231	0.231	1.10	1.12	1.12
	16	0.235	0.235	1.12	1.15	1.15
	17	0.241	0.241	1.15	1.25	1.25
	18	0.263	0.261	1.25	1.25	1.25
	19	0.262	0.262	1.25	1.22	1.22
	20	0.255	0.257	1.22	1.15	1.15
	21	0.241	0.243	1.15	1.08	1.08
	22	0.226	0.228	1.08	0.90	0.90
	23	0.189	0.193	0.90	0.74	0.74
Weekend	24	0.159	0.160	0.76	0.64	0.64
	25	0.134	0.137	0.64	0.58	0.58
	26	0.123	0.124	0.58	0.54	0.54
	27	0.112	0.115	0.54	0.54	0.54
	28	0.113	0.112	0.54	0.56	0.56
	29	0.118	0.116	0.56	0.62	0.62
	30	0.130	0.127	0.62	0.74	0.74
	31	0.155	0.149	0.74	1.04	1.04
	32	0.219	0.211	1.04	1.25	1.25
	33	0.262	0.256	1.25	1.38	1.38
	34	0.289	0.286	1.38	1.36	1.36
	35	0.284	0.285	1.36	1.34	1.34
	36	0.281	0.283	1.34	1.31	1.31
	37	0.275	0.276	1.31	1.30	1.30
	38	0.273	0.275	1.30	1.25	1.25
	39	0.262	0.262	1.25	1.25	1.25
	40	0.262	0.261	1.25	1.25	1.25
	41	0.261	0.261	1.25	1.23	1.23
	42	0.257	0.257	1.23	1.15	1.15
	43	0.241	0.243	1.15	1.09	1.09
	44	0.229	0.232	1.09	1.08	1.08
	45	0.227	0.227	1.08	0.99	0.99
	46	0.207	0.211	0.99	0.91	0.91
	47	0.190	0.191	0.91	0.76	0.76
Average						
	Weekday	0.209	0.209	1.00	1.00	1.00
	Weekend	0.211	0.211	1.01	1.01	1.01
	ADWF(1)	0.210	0.210	1.00	1.00	1.00
% Error						
	Weekday		0.1%			
	Weekend		-0.1%			

Notes:

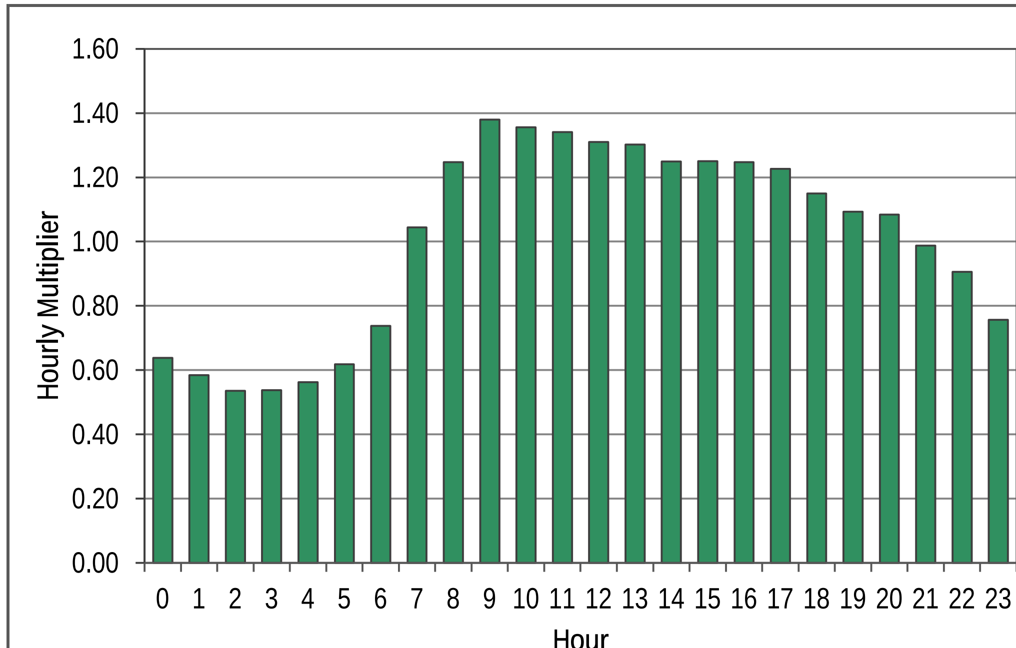
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

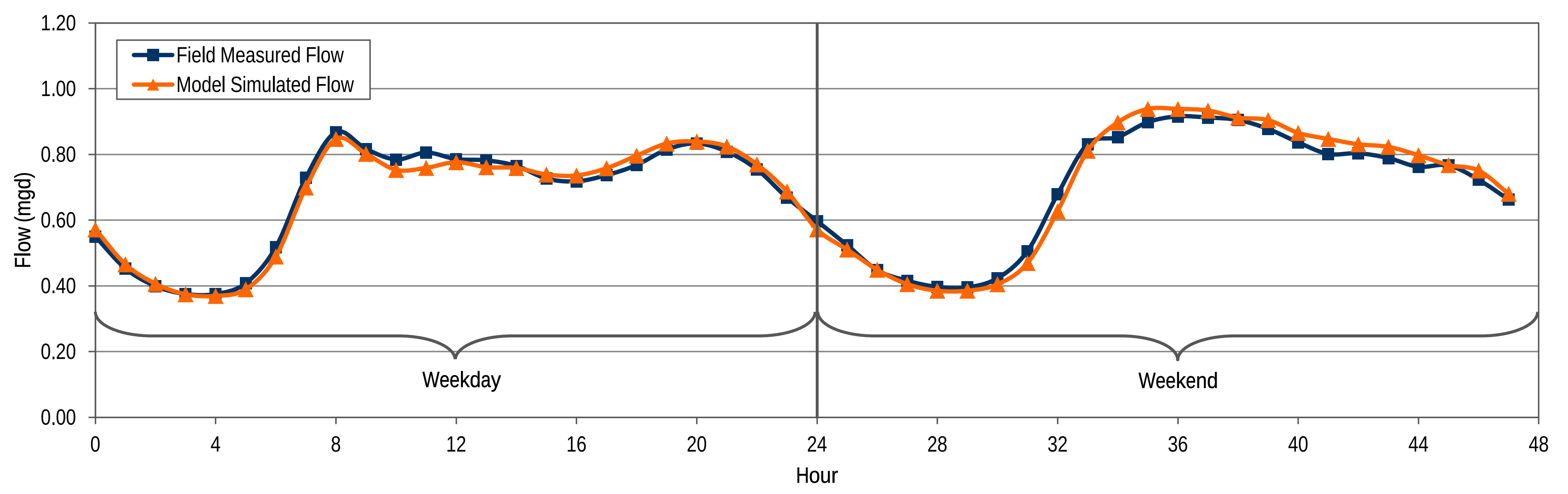
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 86-1 DRY WEATHER CALIBRATION

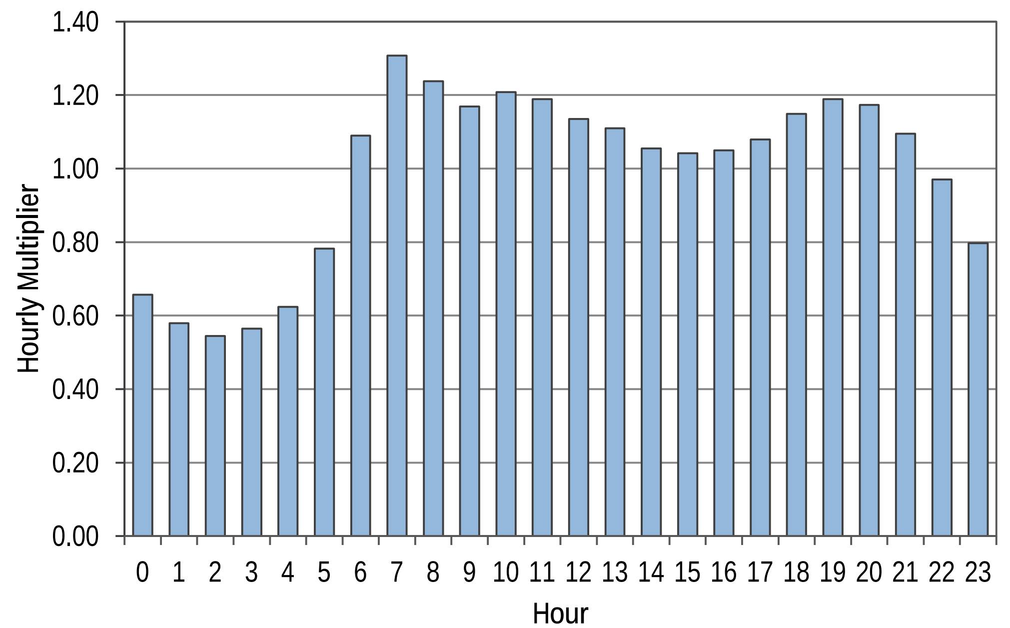
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.549	0.572	0.81	0.66	0.66
	1	0.453	0.466	0.66	0.58	0.58
	2	0.399	0.406	0.58	0.55	0.54
	3	0.375	0.374	0.55	0.55	0.56
	4	0.375	0.370	0.55	0.60	0.62
	5	0.408	0.390	0.60	0.76	0.78
	6	0.518	0.489	0.76	1.07	1.09
	7	0.729	0.700	1.07	1.27	1.31
	8	0.867	0.847	1.27	1.20	1.24
	9	0.816	0.802	1.20	1.15	1.17
	10	0.784	0.753	1.15	1.18	1.21
	11	0.805	0.759	1.18	1.15	1.19
	12	0.785	0.776	1.15	1.15	1.13
	13	0.782	0.761	1.15	1.12	1.11
	14	0.765	0.759	1.12	1.06	1.05
	15	0.726	0.739	1.06	1.05	1.04
	16	0.718	0.736	1.05	1.08	1.05
	17	0.737	0.758	1.08	1.12	1.08
	18	0.767	0.796	1.12	1.19	1.15
	19	0.815	0.833	1.19	1.22	1.19
	20	0.833	0.839	1.22	1.18	1.17
	21	0.808	0.824	1.18	1.11	1.09
	22	0.754	0.770	1.11	0.98	0.97
	23	0.668	0.687	0.98	0.81	0.80
Weekend	24	0.597	0.572	0.87	0.77	0.88
	25	0.524	0.511	0.77	0.66	0.78
	26	0.448	0.449	0.66	0.61	0.70
	27	0.415	0.405	0.61	0.58	0.69
	28	0.397	0.385	0.58	0.58	0.72
	29	0.396	0.386	0.58	0.62	0.78
	30	0.423	0.405	0.62	0.74	0.91
	31	0.506	0.470	0.74	0.99	1.14
	32	0.679	0.627	0.99	1.22	1.34
	33	0.831	0.811	1.22	1.25	1.25
	34	0.852	0.897	1.25	1.32	1.23
	35	0.898	0.938	1.32	1.34	1.22
	36	0.916	0.938	1.34	1.34	1.21
	37	0.912	0.933	1.34	1.33	1.23
	38	0.905	0.912	1.33	1.29	1.27
	39	0.877	0.904	1.29	1.23	1.18
	40	0.837	0.865	1.23	1.17	1.07
	41	0.801	0.847	1.17	1.18	0.97
	42	0.803	0.831	1.18	1.16	1.00
	43	0.789	0.823	1.16	1.12	0.97
	44	0.762	0.797	1.12	1.12	0.96
	45	0.767	0.768	1.12	1.06	1.09
	46	0.723	0.751	1.06	0.97	1.00
	47	0.662	0.680	0.97	0.87	0.90
Average						
	Weekday	0.677	0.675	0.99	0.99	0.99
	Weekend	0.697	0.704	1.02	1.02	1.02
	ADWF[1]	0.682	0.684	1.00	1.00	1.00
% Error						
	Weekday		-0.2%			
	Weekend		1.1%			

Notes:

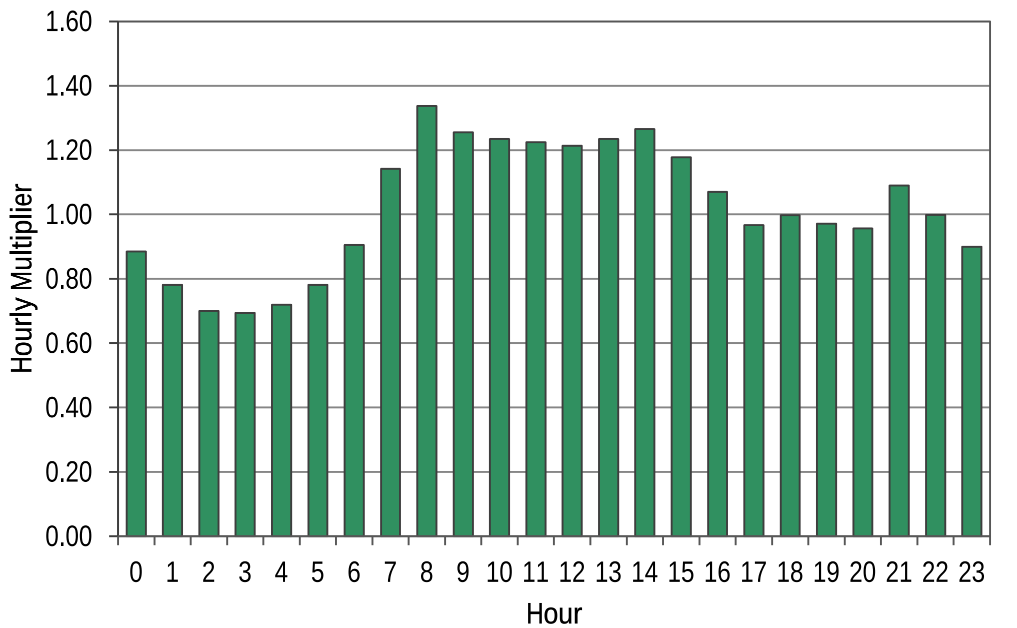
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

City of Oakland

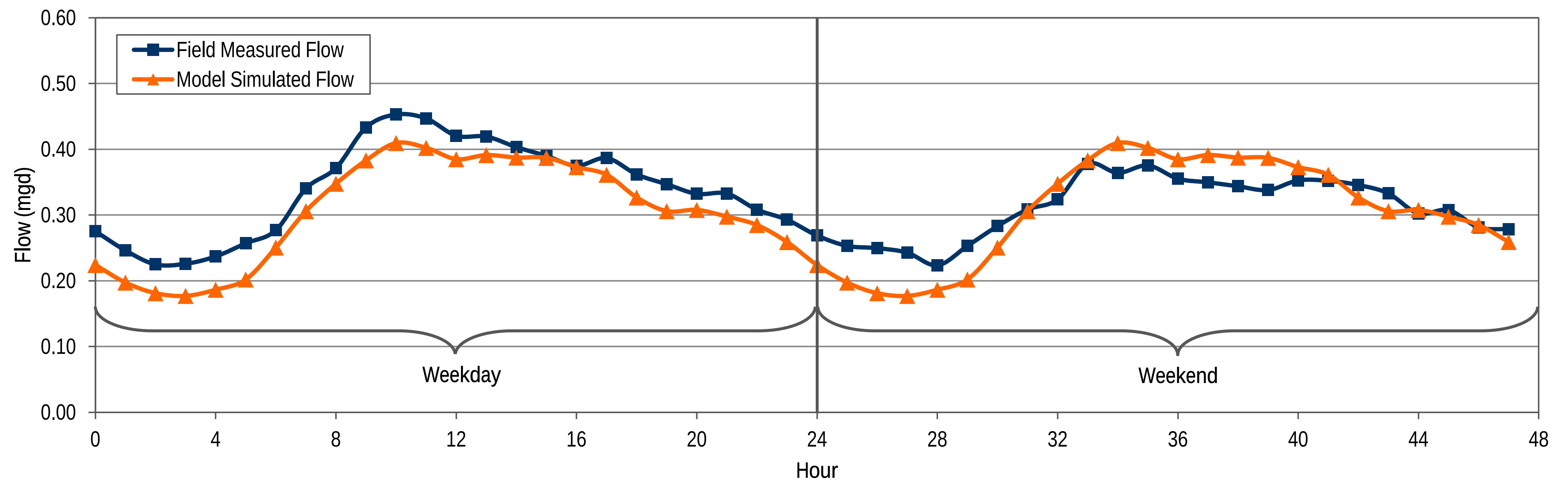
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 87-1 DRY WEATHER CALIBRATION

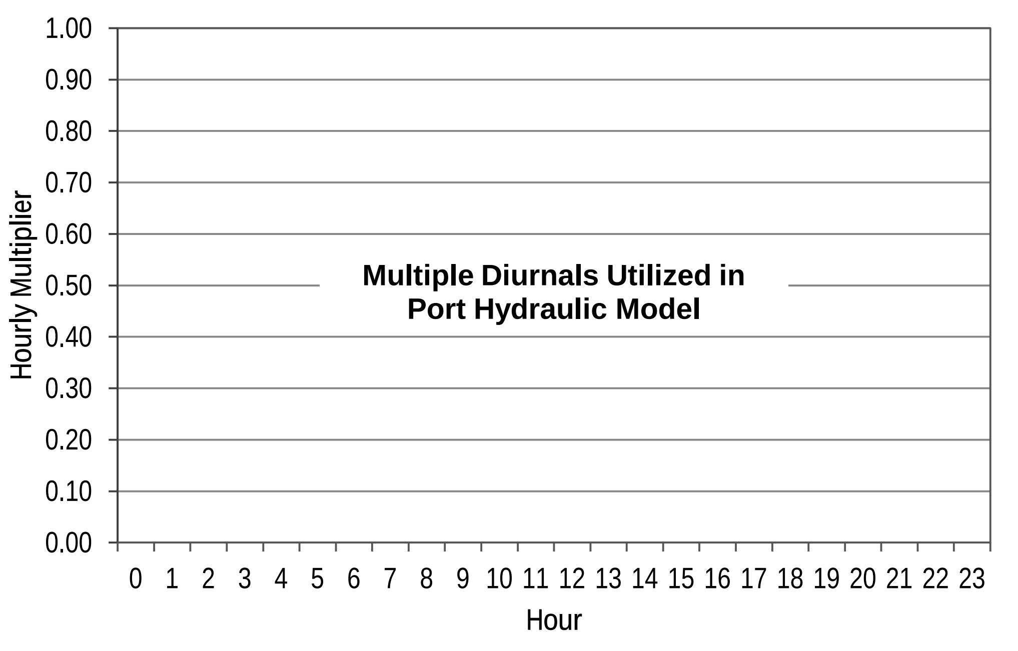
	Hour	Measured Flow (mgd)	Modeled Flow (mgd)	Initial Curve	Modified Curve	Calibrated Curve
Weekday	0	0.275	0.224	0.83	--	--
	1	0.246	0.197	0.74	--	--
	2	0.225	0.181	0.68	--	--
	3	0.226	0.177	0.68	--	--
	4	0.237	0.186	0.71	--	--
	5	0.257	0.202	0.78	--	--
	6	0.277	0.251	0.84	--	--
	7	0.340	0.306	1.03	--	--
	8	0.372	0.348	1.12	--	--
	9	0.433	0.383	1.31	--	--
	10	0.453	0.409	1.37	--	--
	11	0.447	0.402	1.35	--	--
	12	0.421	0.385	1.27	--	--
	13	0.419	0.391	1.26	--	--
	14	0.403	0.387	1.22	--	--
	15	0.390	0.387	1.18	--	--
	16	0.375	0.373	1.13	--	--
	17	0.387	0.361	1.17	--	--
	18	0.362	0.327	1.09	--	--
	19	0.347	0.306	1.05	--	--
	20	0.332	0.308	1.00	--	--
	21	0.333	0.297	1.00	--	--
	22	0.308	0.285	0.93	--	--
	23	0.293	0.259	0.88	--	--
Weekend	24	0.269	0.224	0.81	--	--
	25	0.253	0.197	0.76	--	--
	26	0.250	0.181	0.75	--	--
	27	0.243	0.177	0.73	--	--
	28	0.224	0.186	0.67	--	--
	29	0.253	0.202	0.76	--	--
	30	0.283	0.250	0.85	--	--
	31	0.309	0.306	0.93	--	--
	32	0.324	0.347	0.98	--	--
	33	0.378	0.383	1.14	--	--
	34	0.364	0.409	1.10	--	--
	35	0.375	0.402	1.13	--	--
	36	0.355	0.385	1.07	--	--
	37	0.350	0.391	1.05	--	--
	38	0.344	0.387	1.04	--	--
	39	0.338	0.387	1.02	--	--
	40	0.353	0.373	1.06	--	--
	41	0.352	0.361	1.06	--	--
	42	0.346	0.327	1.04	--	--
	43	0.333	0.306	1.00	--	--
	44	0.302	0.308	0.91	--	--
	45	0.308	0.297	0.93	--	--
	46	0.281	0.285	0.85	--	--
	47	0.278	0.259	0.84	--	--
Average						
	Weekday	0.340	0.305	1.02	--	--
	Weekend	0.311	0.305	0.94	--	--
	ADWF[(1)]	0.332	0.305	1.00	--	--
% Error						
	Weekday		-10.1%			
	Weekend		-1.8%			

Notes:

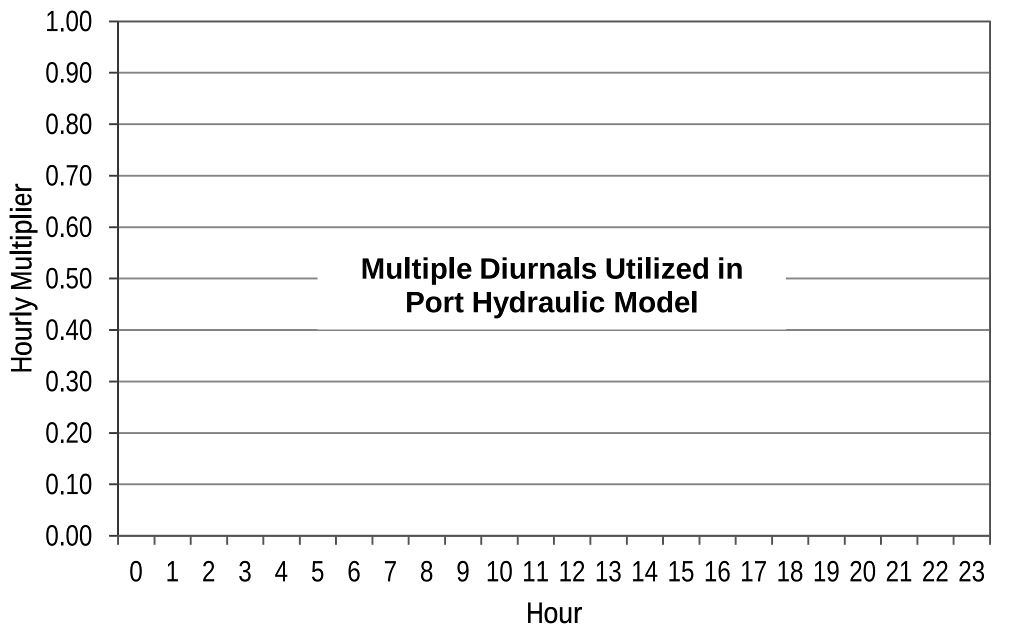
1. ADWF = (5xWeekday Average + 2xWeekend Average)/7



Dry Weather Flow Monitoring Comparison Chart



Dry Weather Flow Weekday Diurnal



Dry Weather Flow Weekend Diurnal

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_DRY_87.xlsx

APPENDIX E – WET WEATHER FLOW CALIBRATION SHEETS

City of Oakland

Sewer System Hydraulic Model Calibration

WET WEATHER FLOW CALIBRATION SUMMARY

	Calibration Rainfall Events											
	Field Measured Flow[2,3]				Modeled Simulated Flow[3]				Percent Difference[4]			
Meter	Average	Peak Hourly Flow (mgd)			Average	Peak Hourly Flow (mgd)			Average	Peak Hourly Flow (%)		
Site	(mgd)	3/24/2012	3/25/2012	3/26/2012	(mgd)	3/24/2012	3/25/2012	3/26/2012	(%)	3/24/2012	3/25/2012	3/26/2012
Basin 17												
17A[1]	0.053	0.165	0.129	0.137	--	--	--	--	--	--	--	--
17B[1]	0.132	0.388	0.278	0.324	--	--	--	--	--	--	--	--
17U-S1	0.171	0.465	0.330	0.335	0.172	0.489	0.341	0.438	0.8%	5.2%	3.2%	30.9%
17U-S2[5]	0.168	--	--	--	0.171	0.540	0.368	0.484	1.6%	--	--	--
17U-S3[1]	0.134	0.429	0.292	0.327	--	--	--	--	--	--	--	--
Basin 20												
20A[1]	0.024	0.145	0.083	0.099	--	--	--	--	--	--	--	--
20B	0.175	0.922	0.702	0.808	0.172	0.939	0.614	0.722	-1.8%	1.8%	-12.6%	-10.7%
20-S1[5]	0.647	2.496	1.868	1.874	0.608	2.649	1.723	2.068	-6.0%	6.1%	-7.7%	10.4%
20-S2[1,5]	0.212	0.856	0.537	0.519	--	--	--	--	--	--	--	--
Basin 21												
21A	0.309	1.647	1.494	1.534	0.280	1.807	0.941	1.259	-9.5%	9.7%	-37.0%	-18.0%
21U-1	0.613	3.095	2.788	2.777	0.606	3.092	1.967	2.494	-1.3%	-0.1%	-29.4%	-10.2%
21L-S1	0.396	1.646	1.296	1.431	0.425	1.796	1.241	1.435	7.3%	9.1%	-4.2%	0.3%
21L-S2	0.328	1.511	1.009	0.939	0.325	1.445	1.146	1.102	-0.8%	-4.4%	13.6%	17.4%
21L-S3[1]	0.328	1.511	1.009	0.939	--	--	--	--	--	--	--	--
Basin 23												
23-1	0.246	0.904	0.585	0.653	--	--	--	--	--	--	--	--
Basin 50												
50L-S1	0.178	1.329	0.668	0.636	0.199	1.127	0.666	0.824	12.1%	-15.2%	-0.2%	29.5%
50	5.857	21.677	12.244	16.246	6.102	25.907	15.832	18.499	4.2%	19.5%	29.3%	13.9%
50A	2.182	7.314	4.653	4.852	2.098	8.456	5.064	6.171	-3.8%	15.6%	8.8%	27.2%
50B	1.729	6.713	3.857	4.644	1.649	7.661	4.079	5.206	-4.6%	14.1%	5.8%	12.1%
50U-1	6.630	24.972	17.087	19.620	6.358	27.766	16.853	19.509	-4.1%	11.2%	-1.4%	-0.6%
50L-1	6.415	23.153	15.491	18.741	6.140	26.097	15.912	18.544	-4.3%	12.7%	2.7%	-1.0%
50C.1	0.831	1.123	1.323	1.217	1.084	3.856	2.372	2.753	30.4%	243.3%	79.3%	126.2%
50C.2	0.193	0.597	0.452	0.420	0.194	0.777	0.364	0.485	0.3%	30.2%	-19.4%	15.6%
50D	2.739	8.004	9.143	7.987	2.856	11.381	7.552	8.089	4.3%	42.2%	-17.4%	1.3%
50E	0.210	1.102	0.501	0.646	0.232	1.191	0.704	0.860	10.7%	8.0%	40.4%	33.1%
50F	0.472	1.459	1.357	1.125	0.482	1.786	1.094	1.316	2.2%	22.4%	-19.3%	17.0%
50G	2.534	8.278	5.276	5.642	2.306	8.997	5.935	6.428	-9.0%	8.7%	12.5%	13.9%
50H	1.044	2.926	2.290	2.372	0.966	3.389	2.344	2.564	-7.5%	15.8%	2.4%	8.1%
Basin 52												
52A	5.902	19.641	9.870	14.689	6.436	21.171	11.770	16.218	9.0%	7.8%	19.2%	10.4%
52B	2.545	6.087	4.506	6.213	2.593	10.169	5.773	7.609	1.9%	67.1%	28.1%	22.5%
52C	1.704	6.843	2.983	4.638	1.683	7.506	3.730	5.193	-1.2%	9.7%	25.1%	11.9%
52-1[5]	8.000	29.093	14.824	20.735	8.799	30.731	15.917	22.035	10.0%	5.6%	7.4%	6.3%
Basin 54												
54-S1	0.987	6.364	2.782	3.058	0.970	5.705	2.748	3.534	-1.7%	-10.3%	-1.2%	15.5%
54-S2	0.970	4.850	2.336	3.480	0.943	5.483	2.150	3.469	-2.8%	13.1%	-8.0%	-0.3%
54B.1	0.285	1.120	0.591	0.821	0.395	1.511	0.883	1.151	38.9%	34.9%	49.5%	40.1%
54B.2	1.477	7.057	3.318	4.427	1.069	6.065	2.444	3.694	-27.7%	-14.0%	-26.4%	-16.5%
54B.3	0.706	4.703	1.892	2.740	0.725	5.483	2.023	3.183	2.7%	16.6%	6.9%	16.2%
54B.4	0.367	0.731	0.713	0.720	0.348	1.057	0.796	0.881	-5.1%	44.6%	11.6%	22.3%
54-1	7.686	10.790	10.268	10.610	7.544	12.253	11.948	12.028	-1.9%	13.6%	16.4%	13.4%
54-2	1.979	19.335	6.467	14.089	1.049	25.014	8.129	15.657	-47.0%	29.4%	25.7%	11.1%
54-S3[5]	0.197	1.051	0.336	0.593	0.195	1.169	0.456	0.722	-1.1%	11.2%	35.6%	21.7%
54-S4	0.017	0.022	0.017	0.020	0.029	0.184	0.076	0.111	72.6%	742.2%	340.3%	442.9%
54-S4A	0.110	0.691	0.219	0.360	0.104	0.749	0.288	0.460	-5.9%	8.4%	31.3%	27.8%
54D	1.208	6.751	2.995	4.953	1.112	6.888	2.951	4.381	-7.9%	2.0%	-1.5%	-11.6%
54D.1	0.168	1.317	0.715	1.010	0.239	2.320	0.757	1.406	42.2%	76.2%	5.9%	39.2%
54-S5[1]	0.317	1.667	0.713	1.002	--	--	--	--	--	--	--	--
54-S6	0.255	0.934	0.606	0.664	0.244	1.056	0.583	0.749	-4.1%	13.1%	-3.8%	12.8%
54-S7	0.154	1.094	0.433	0.465	0.156	0.843	0.381	0.518	1.3%	-22.9%	-11.9%	11.5%
54-S8[1]	0.120	1.035	0.343	0.382	--	--	--	--	--	--	--	--
54-S9[1]	0.169	0.615	0.404	0.466	--	--	--	--	--	--	--	--
54A	1.150	4.248	2.935	4.237	1.205	4.370	3.083	3.690	4.8%	2.9%	5.0%	-12.9%
54C	1.565	4.816	4.224	6.149	1.570	7.549	3.909	5.148	0.3%	56.8%	-7.5%	-16.3%
54C.1	1.414	6.643	3.565	5.389	1.315	6.682	3.407	4.511	-7.0%	0.6%	-4.4%	-16.3%
Basin 56												
56A	0.495	1.585	1.163	0.878	0.571	1.469	1.241	1.406	15.4%	-7.3%	6.7%	60.1%
56A.1	2.210	--	--	--	2.514	8.605	6.235	7.405	13.8%	--	--	--
56B	1.292	3.658	2.195	3.846	1.375	4.606	3.265	3.852	6.4%	25.9%	48.7%	0.2%
56C	0.389	1.482	0.801	0.925	0.379	1.367	0.898	1.083	-2.8%	-7.7%	12.2%	17.1%
56D	0.528	2.410	1.326	1.780	0.546	2.079	1.294	1.723	3.5%	-13.7%	-2.5%	-3.2%
56E	0.815	3.164	1.743	2.284	0.802	2.842	1.960	2.340	-1.6%	-10.2%	12.4%	2.5%
56-1[5]	4.019	--	--	--	3.996	15.683	10.402	12.718	-0.6%	--	--	--
Basin 58												
58A	1.579	10.697	4.001	5.982	1.448	9.719	3.870	5.044	-8.3%	-9.1%	-3.3%	-15.7%
58B	0.926	3.467	1.957	2.751	0.800	3.909	1.640	2.432	-13.6%	12.8%	-16.2%	-11.6%
58-1	3.145	15.273	6.398	9.610	2.830	15.047	5.901	8.277	-10.0%	-1.5%	-7.8%	-13.9%
Basin 59												
59A	0.833	2.293	1.506	1.941	0.766	2.304	1.651	1.941	-8.0%	0.5%	9.6%	0.0%
59-1[5]	1.071	4.330	1.921	2.712	1.218	4.288	2.495	3.248	13.8%	-1.0%	29.9%	19.8%

City of Oakland

Sewer System Hydraulic Model Calibration

WET WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Calibration Rainfall Events: Field Measured Flow[(2),(3)] Average (mgd)	Peak Hourly Flow (mgd) 3/24/2012	3/25/2012	3/26/2012	Modeled Simulated Flow[(3)] Average (mgd)	Peak Hourly Flow (mgd) 3/24/2012	3/25/2012	3/26/2012	Percent Difference[(4)] Average (%)	Peak Hourly Flow (%) 3/24/2012	3/25/2012	3/26/2012
Basin 60												
60A	0.681	3.515	1.517	2.702	0.574	3.387	1.264	1.867	-15.6%	-3.6%	-16.7%	-30.9%
60B	0.804	2.411	1.002	2.208	0.805	3.579	2.048	2.215	0.1%	48.4%	104.4%	0.3%
60-1[(5)]	1.634	10.532	2.758	5.546	2.002	10.657	4.440	5.952	22.5%	1.2%	61.0%	7.3%
Basin 61												
61A	0.270	0.724	0.393	0.596	0.258	0.752	0.409	0.568	-4.5%	4.0%	4.2%	-4.8%
Basin 62												
62A	0.599	2.831	1.067	1.835	0.586	2.848	1.298	1.774	-2.1%	0.6%	21.7%	-3.3%
62-1[(5)]	0.626	2.846	1.148	1.980	0.686	3.322	1.483	2.055	9.5%	16.7%	29.2%	3.8%
Basin 64												
64-1	0.277	1.517	0.387	0.651	0.261	1.556	0.376	0.736	-5.7%	2.5%	-2.8%	13.1%
64-2	0.167	0.391	0.258	0.331	0.150	0.394	0.267	0.347	-9.9%	0.9%	3.5%	5.0%
64-3	0.159	0.450	0.256	0.360	0.162	0.545	0.318	0.309	1.8%	21.3%	24.3%	-14.3%
64-4	0.488	1.341	0.689	0.656	0.500	1.340	0.681	0.803	2.3%	0.0%	-1.2%	22.4%
64-5	0.371	0.937	0.814	0.895	0.422	1.480	0.661	0.910	13.8%	57.9%	-18.8%	1.6%
64-6	0.411	1.825	0.633	0.856	0.402	1.974	0.751	1.150	-2.1%	8.2%	18.8%	34.4%
64-7	0.073	0.178	0.105	0.136	0.072	0.471	0.241	0.188	-1.9%	164.1%	128.8%	38.8%
64-8	0.115	0.238	0.162	0.197	0.111	0.239	0.156	0.206	-3.6%	0.4%	-3.8%	4.6%
Basin 80												
80A	0.437	1.862	0.819	1.406	0.427	1.948	1.059	1.225	-2.4%	4.6%	29.3%	-12.9%
80B	3.341	8.332	6.268	9.997	3.338	12.623	7.616	9.134	-0.1%	51.5%	21.5%	-8.6%
80C	0.964	3.831	2.110	2.585	0.907	3.998	2.647	2.504	-5.9%	4.4%	25.5%	-3.1%
80D	0.730	2.152	1.481	1.886	0.724	2.367	1.410	1.760	-0.8%	10.0%	-4.8%	-6.7%
80E	0.894	3.754	1.708	2.788	0.928	3.450	1.971	2.661	3.8%	-8.1%	15.4%	-4.6%
80-1[(5)]	3.985	11.879	6.183	8.874	3.875	13.494	8.276	9.830	-2.8%	13.6%	33.9%	10.8%
80-2[(5)]	0.457	2.254	0.864	1.399	0.513	2.622	1.129	1.508	12.3%	16.3%	30.8%	7.8%
Basin 81												
81A	0.144	1.925	0.179	1.584	0.154	2.796	0.204	0.755	6.9%	45.2%	13.9%	-52.3%
81A.1	0.789	2.439	1.528	2.406	0.799	2.375	1.844	2.223	1.3%	-2.7%	20.7%	-7.6%
81B	2.468	9.660	4.253	8.031	2.231	9.710	4.283	6.373	-9.6%	0.5%	0.7%	-20.6%
81C	1.003	2.564	1.465	2.770	1.034	2.678	1.926	2.491	3.1%	4.4%	31.5%	-10.1%
81-1[(5)]	2.624	6.192	4.582	5.887	2.222	6.764	4.202	4.772	-15.3%	9.2%	-8.3%	-18.9%
81-2[(5)]	1.578	7.394	2.829	7.085	1.825	9.498	3.292	6.320	15.6%	28.5%	16.4%	-10.8%
81-3[(5)]	0.406	1.681	0.609	1.223	0.368	1.567	0.545	1.010	-9.4%	-6.8%	-10.4%	-17.4%
Basin 82												
82A	0.137	0.516	0.223	0.453	0.131	0.656	0.209	0.342	-4.2%	27.3%	-6.1%	-24.6%
82B	0.946	2.252	1.416	2.035	0.842	2.908	1.329	1.876	-11.0%	29.2%	-6.1%	-7.8%
82U-1	1.278	4.547	2.519	4.085	1.273	5.079	2.119	3.197	-0.4%	11.7%	-15.9%	-21.7%
82L-1[(5)]	1.112	3.791	2.129	3.090	1.075	4.251	1.732	2.561	-3.3%	12.1%	-18.6%	-17.1%
Basin 83												
83B	0.488	2.486	1.110	1.749	0.518	2.394	1.081	1.510	6.2%	-3.7%	-2.6%	-13.7%
83B.1	0.673	2.134	0.860	1.535	0.620	2.344	1.263	1.667	-7.9%	9.8%	46.8%	8.6%
83C	1.097	2.916	1.958	2.653	1.169	3.265	2.357	2.707	6.5%	12.0%	20.4%	2.0%
83D	0.703	3.484	1.107	2.212	0.745	3.230	1.146	1.828	6.1%	-7.3%	3.4%	-17.4%
83E	0.898	2.575	1.500	2.181	0.913	2.552	1.872	2.179	1.7%	-0.9%	24.8%	-0.1%
83L-1	4.213	12.799	6.452	10.562	4.167	12.529	6.815	9.531	-1.1%	-2.1%	5.6%	-9.8%
83L-2	0.860	4.390	1.510	2.501	0.913	4.531	1.762	2.695	6.2%	3.2%	16.7%	7.8%
83U-1	1.300	4.343	2.094	3.573	1.313	4.380	2.354	3.216	1.1%	0.8%	12.4%	-10.0%
83U-2	1.413	4.340	2.209	3.759	1.407	4.391	2.382	3.329	-0.4%	1.2%	7.8%	-11.5%
83U-3	0.473	2.027	0.857	1.572	0.492	2.116	0.961	1.395	4.1%	4.4%	12.1%	-11.3%
83U-4[(5)]	1.793	9.172	3.631	7.119	1.984	9.432	3.642	5.880	10.7%	2.8%	0.3%	-17.4%
83U-F[(5)]	4.177	16.404	6.559	12.518	3.349	14.586	5.822	8.639	-19.8%	-11.1%	-11.2%	-31.0%
83U-1X	1.316	4.373	2.105	3.798	1.314	4.322	2.352	3.224	-0.1%	-1.2%	11.7%	-15.1%
83U-2X	1.612	3.920	2.817	3.835	1.402	3.747	2.381	3.193	-13.0%	-4.4%	-15.5%	-16.7%
83U-3X[(5)]	0.612	2.924	--	--	0.675	2.128	1.202	1.671	10.3%	-27.2%	--	--
Basin 84												
84A	0.755	3.721	1.001	2.269	0.959	3.490	1.463	2.189	27.0%	-6.2%	46.1%	-3.6%
84B	1.795	8.548	3.255	4.673	2.200	7.702	4.083	5.423	22.5%	-9.9%	25.4%	16.0%
84C	0.524	1.404	0.827	1.244	0.470	1.655	0.883	1.217	-10.3%	17.9%	6.8%	-2.2%
84C.1	0.253	0.836	0.569	0.984	0.245	0.905	0.474	0.671	-3.0%	8.2%	-16.7%	-31.8%
84U-1	1.340	4.803	2.411	3.210	1.597	4.737	2.898	3.738	19.2%	-1.4%	20.2%	16.4%
84U-2	1.027	5.276	1.664	3.341	1.069	5.081	1.996	2.846	4.0%	-3.7%	20.0%	-14.8%
84U-3	0.902	3.384	1.217	2.302	1.187	3.386	1.907	2.698	31.6%	0.1%	56.7%	17.2%
84U-1X[(5)]	1.500	5.344	2.457	4.175	1.693	4.646	3.112	3.916	12.9%	-13.1%	26.7%	-6.2%
84U-3X	0.694	2.122	0.836	1.361	0.795	1.818	1.159	1.522	14.7%	-14.3%	38.6%	11.8%
84L-1	2.797	9.835	4.257	7.451	3.314	11.730	5.779	7.997	18.5%	19.3%	35.8%	7.3%
84L-2	0.108	0.380	0.180	0.139	0.108	0.198	0.200	0.143	0.1%	-47.9%	11.0%	2.8%
84U-F	4.383	14.312	7.160	11.097	3.153	13.201	5.445	8.082	-28.1%	-7.8%	-24.0%	-27.2%
Basin 85												
85D	1.227	3.793	1.960	2.726	1.206	3.563	2.330	2.653	-1.7%	-6.1%	18.9%	-2.7%
85D.1[(5)]	--	--	--	--	0.433	1.329	0.840	0.960	--	--	--	--
85D.2	0.126	0.251	0.212	0.231	0.329	0.918	0.642	0.744	161.7%	266.0%	203.0%	221.8%
85E	0.622	4.239	0.740	0.613	0.792	3.795	1.471	1.705	27.3%	-10.5%	98.8%	178.1%
85E.1	0.591	2.448	0.947	1.062	0.576	2.476	1.146	1.166	-2.6%	1.1%	21.1%	9.8%

City of Oakland

Sewer System Hydraulic Model Calibration

WET WEATHER FLOW CALIBRATION SUMMARY

Meter Site	Field Measured Flow[2],[3] Average (mgd)	Field Measured Peak Hourly Flow (mgd) 3/24/2012	3/25/2012	3/26/2012	Modeled Simulated Flow[3] Average (mgd)	Modeled Peak Hourly Flow (mgd) 3/24/2012	3/25/2012	3/26/2012	Percent Difference[4] Average (%)	Peak Hourly Flow (%) 3/24/2012	3/25/2012	3/26/2012
85U-1	2.338	5.338	3.878	4.843	2.048	6.593	3.551	4.077	-12.4%	23.5%	-8.4%	-15.8%
85A	3.913	8.656	5.944	7.503	3.523	8.417	5.055	6.197	-10.0%	-2.8%	-15.0%	-17.4%
85B	1.167	6.482	1.639	2.813	1.187	5.584	1.696	2.274	1.7%	-13.9%	3.5%	-19.2%
85C	0.832	4.673	1.200	2.038	0.860	4.514	1.260	2.146	3.3%	-3.4%	5.0%	5.3%
85U-2	3.018	7.172	4.325	5.636	2.846	7.196	4.075	5.382	-5.7%	0.3%	-5.8%	-4.5%
85U-F	1.444	4.366	2.426	3.562	1.671	6.555	2.840	4.001	15.7%	50.2%	17.1%	12.3%
85L-1	5.189	16.361	7.189	10.550	5.095	15.279	7.331	9.431	-1.8%	-6.6%	2.0%	-10.6%
85U-2BX	0.081	5.163	0.022	0.712	0.092	3.009	0.130	0.498	12.8%	-41.7%	484.8%	-30.0%
Basin 86												
86A	1.037	3.205	1.527	2.026	0.997	3.074	1.568	1.908	-3.9%	-4.1%	2.7%	-5.9%
86B	0.397	1.418	0.631	0.785	0.413	1.431	0.658	0.827	3.8%	0.9%	4.3%	5.5%
86-1	1.411	5.426	2.454	3.076	1.499	5.252	2.422	2.988	6.2%	-3.2%	-1.3%	-2.9%
Basin 87												
87-1[5]	0.502	1.318	0.678	0.855	0.393	1.498	0.482	0.882	-21.7%	13.6%	-29.0%	3.2%

Calibration Rainfall Events

Notes:

(1) Some flow meters were located on small, 8-inch and smaller diameter sewers, which were not included in the hydraulic model.

(2) Source: 2011 Flow Metering Data from V&A and EBMUD (ADS).

(3) Average flows are measured over the duration of the storm events. Peak flows represent the hourly peak flows during the events.

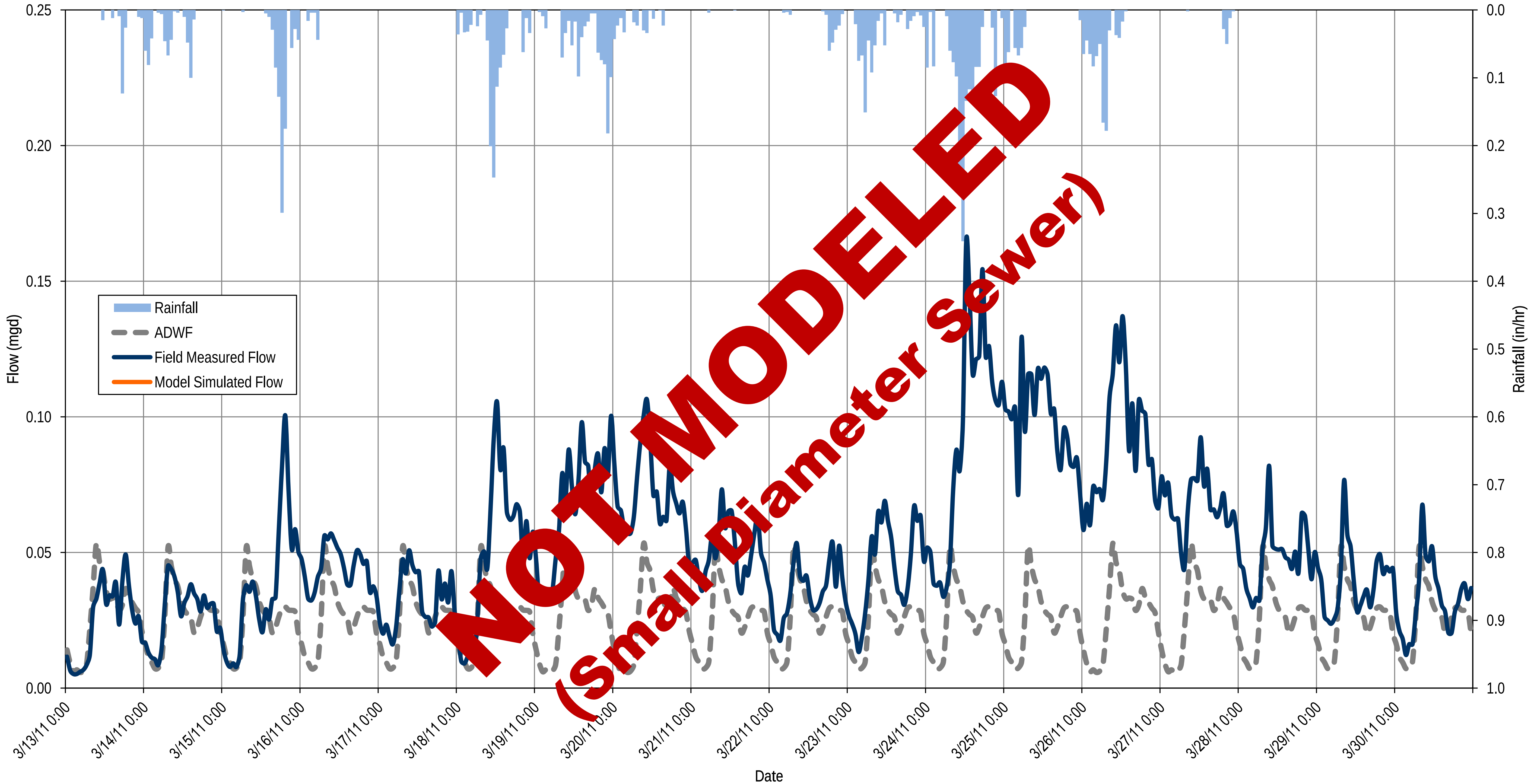
(4) Percent Difference = (Modeled Flow - Measured Flow)/Measured Flow x 100.

(5) Comparsions between modeled and measured flows do not include periods of missing field measured flow data.

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

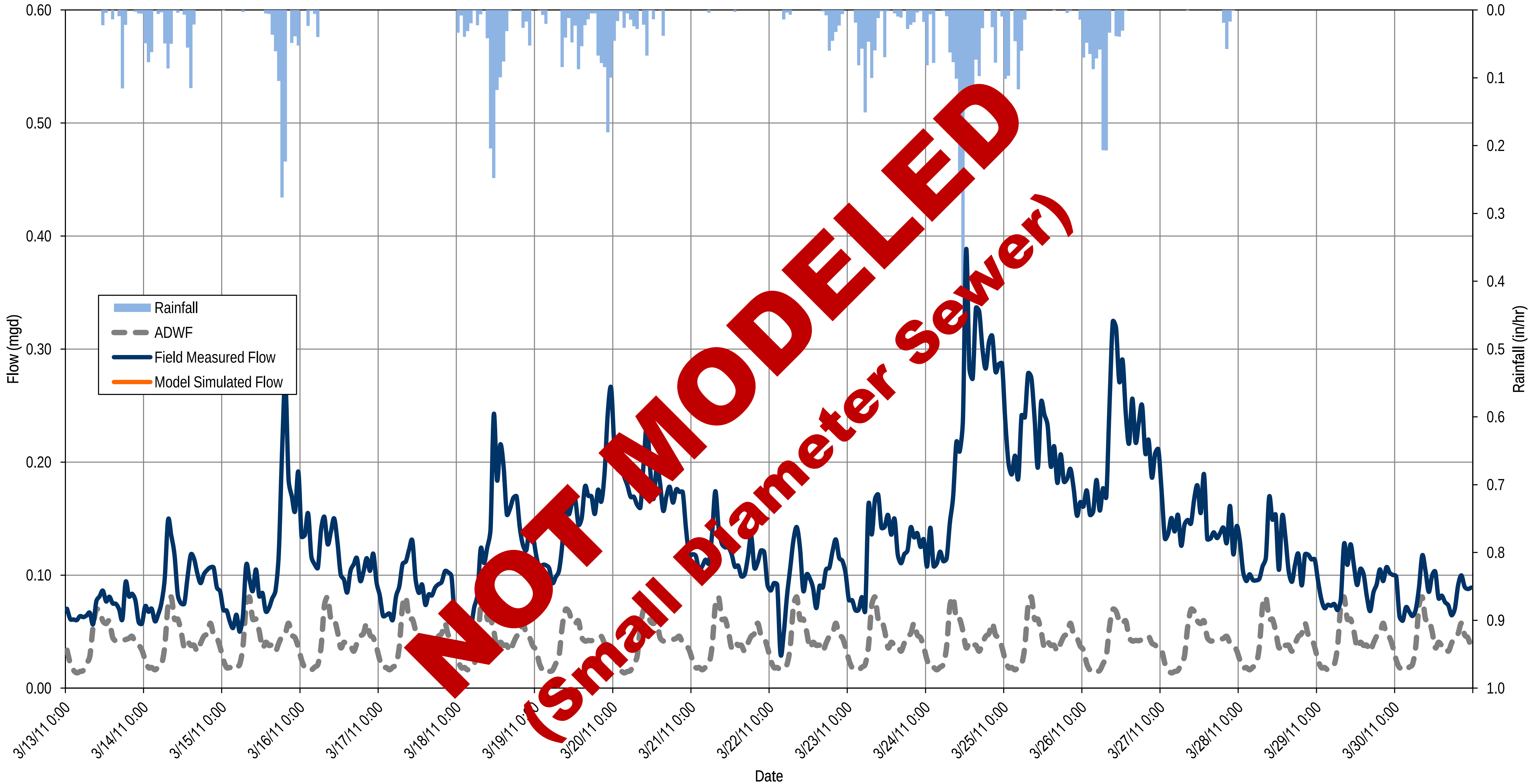
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_17.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

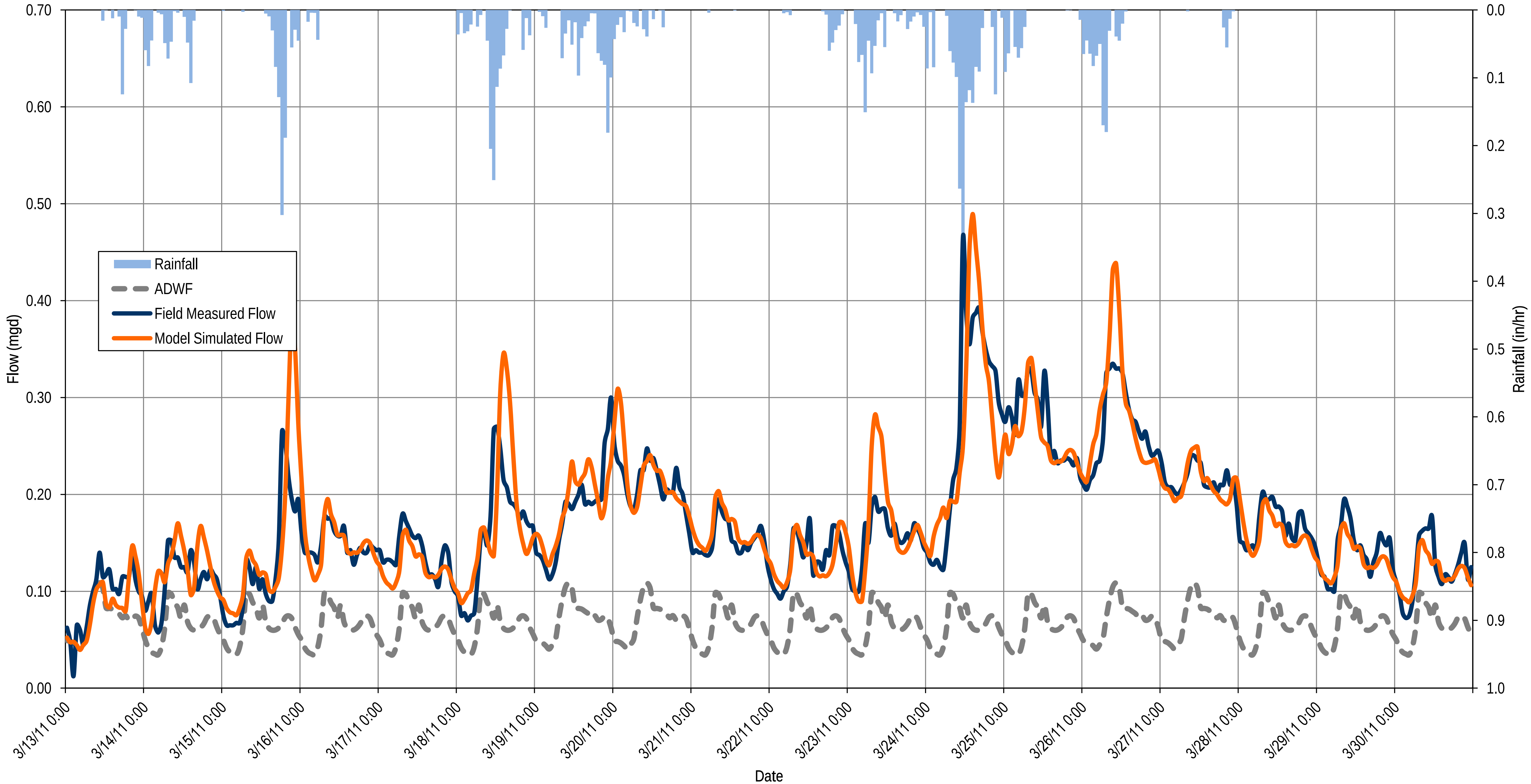
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_17.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17U-S1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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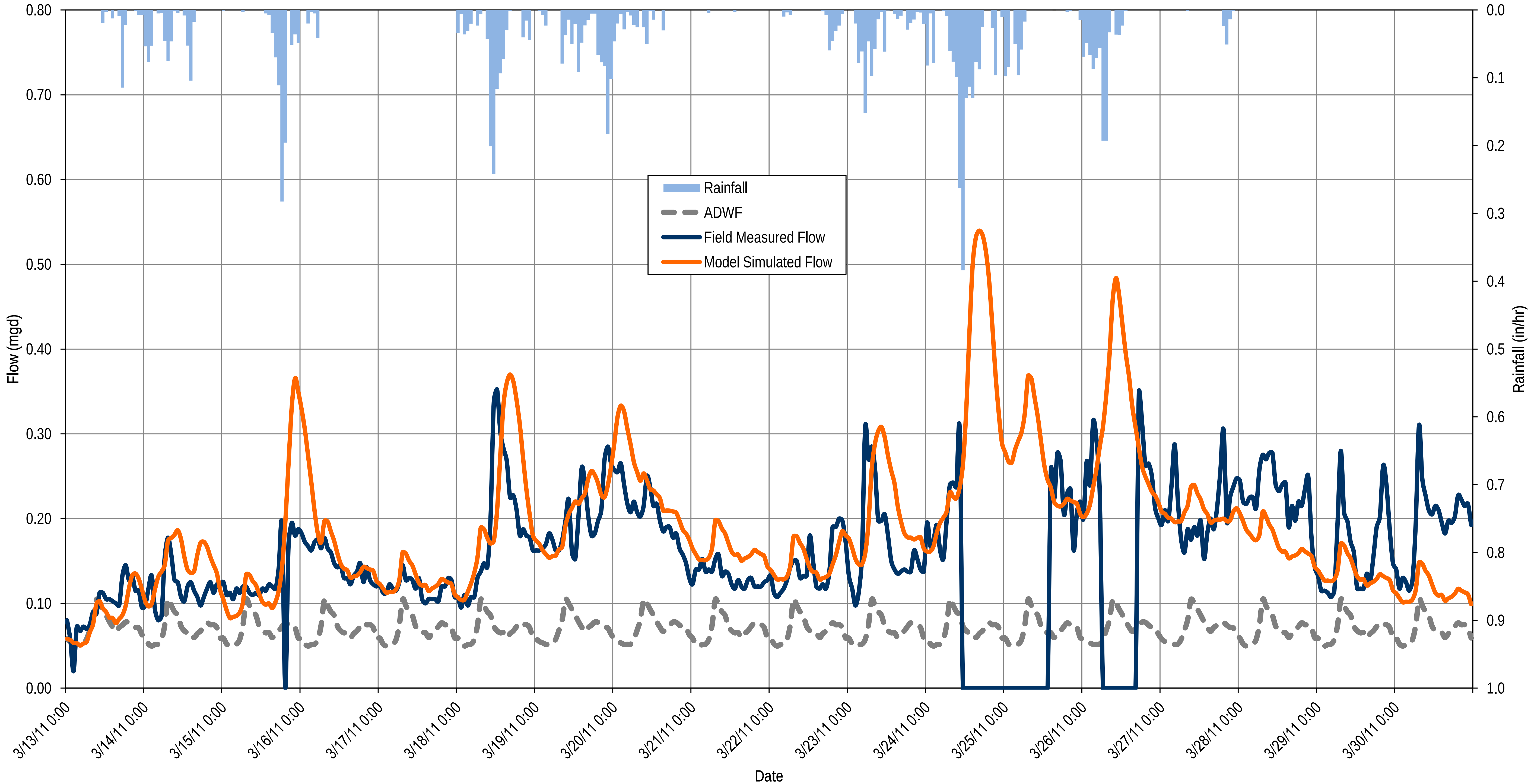
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_17.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 17U-S2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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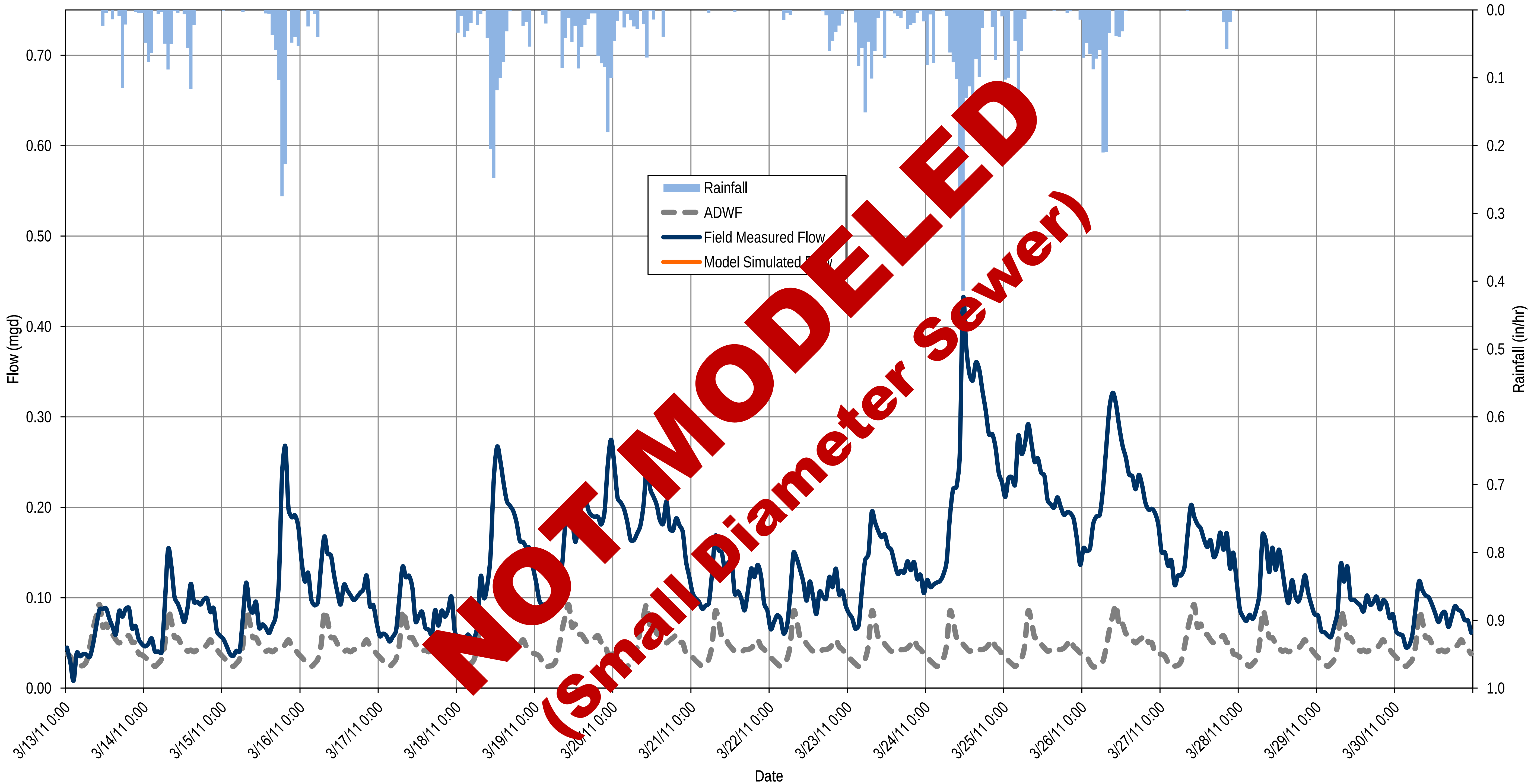
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_17.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 17U-S2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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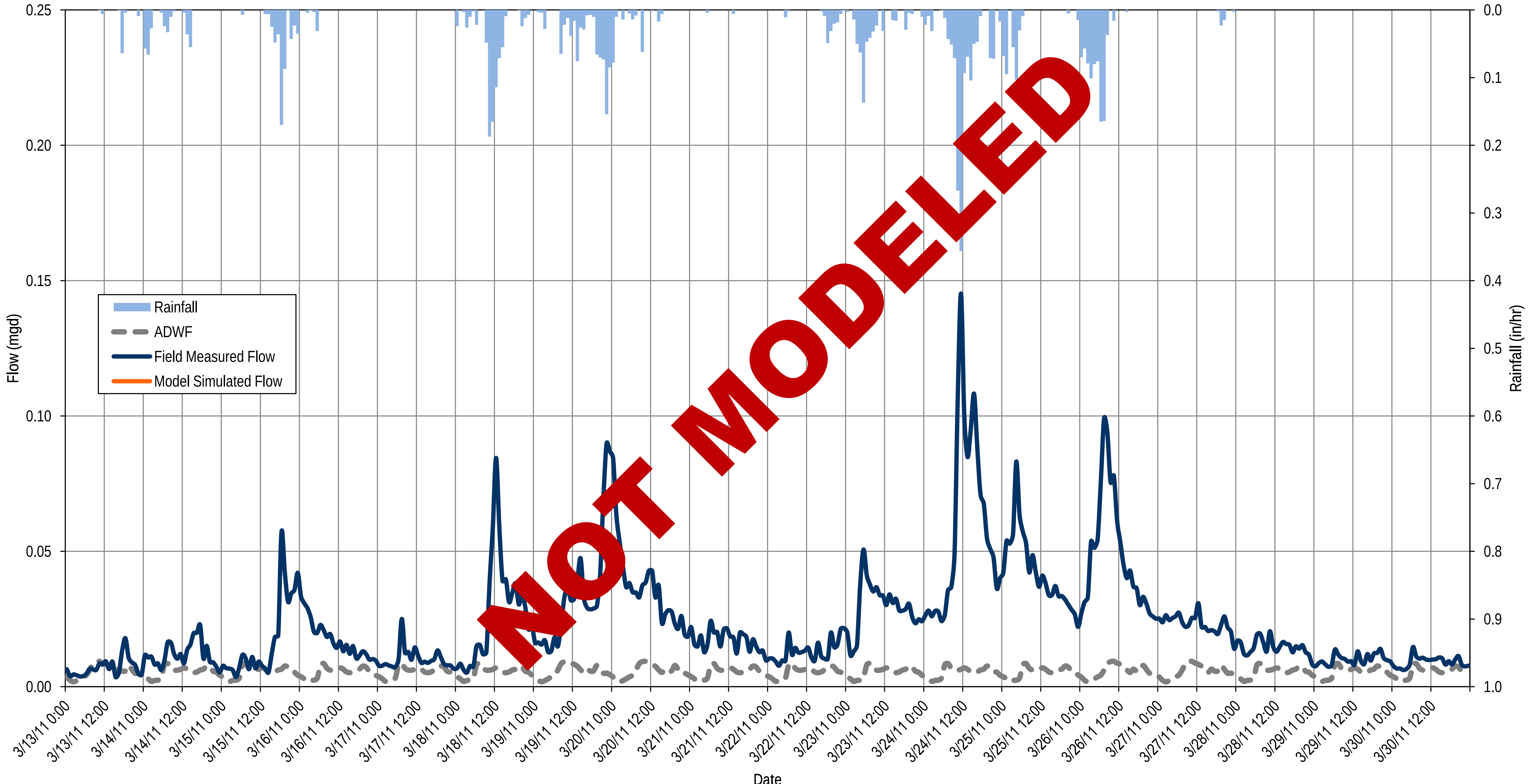
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_17.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 20A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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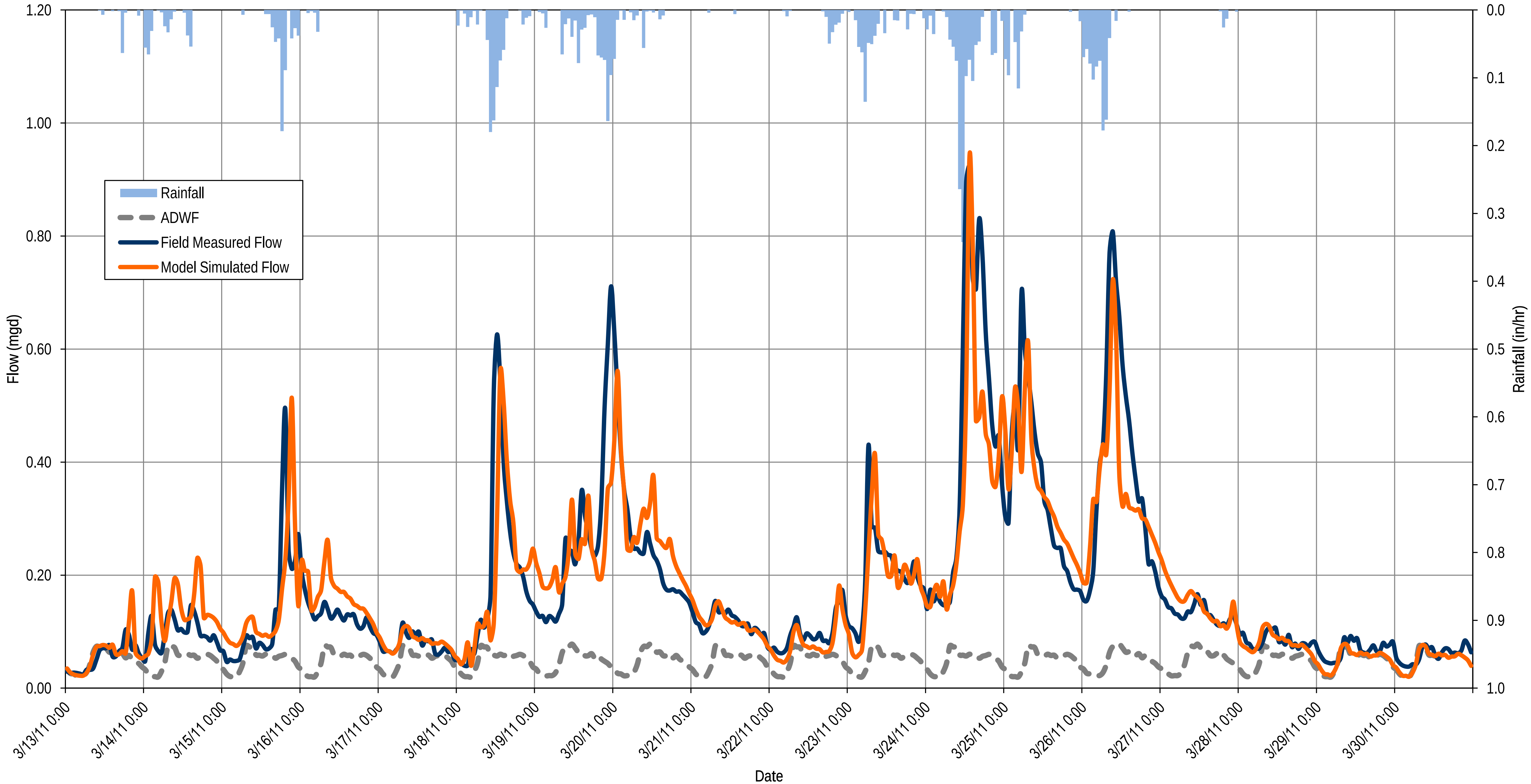
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_20.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

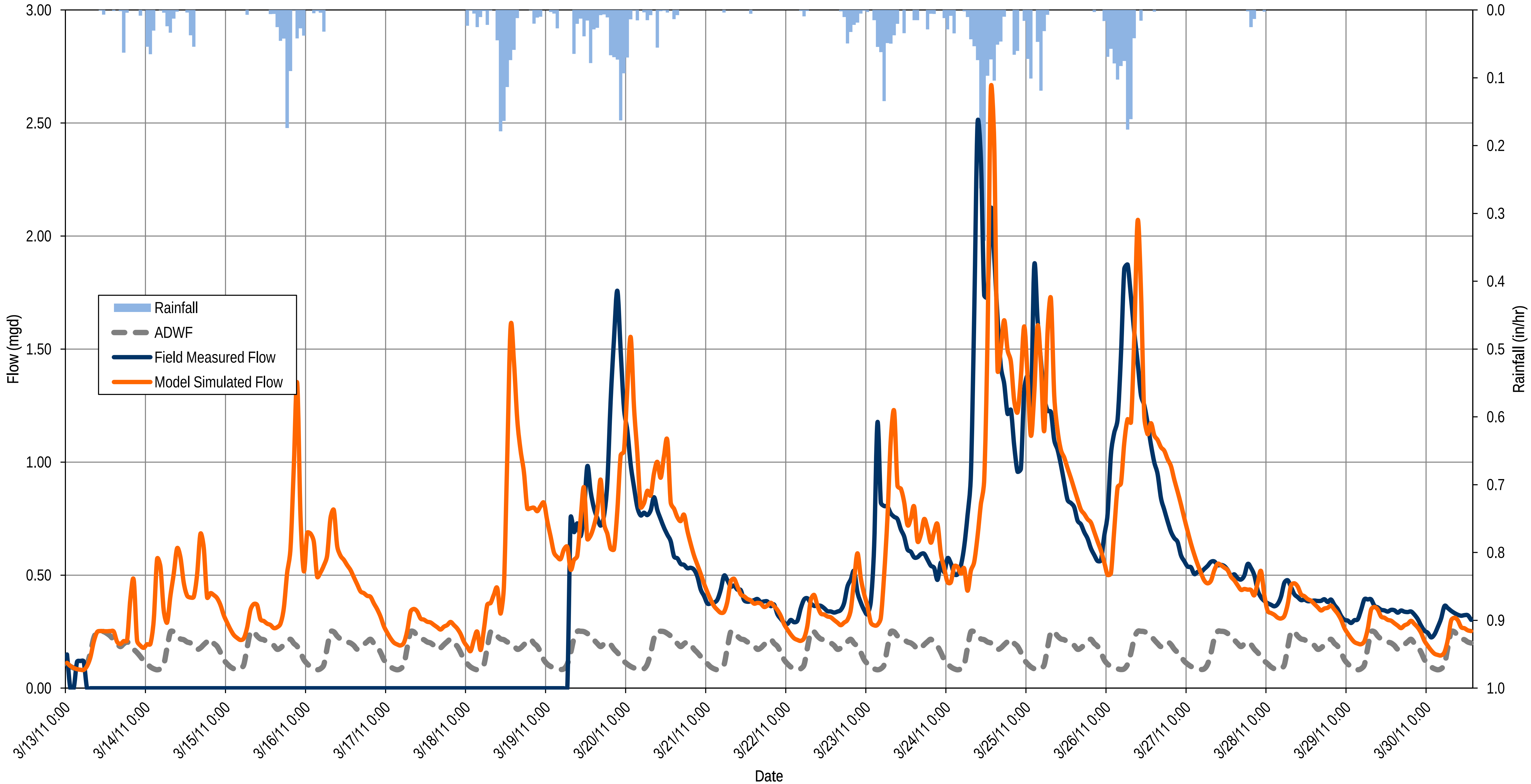
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_20.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20-S1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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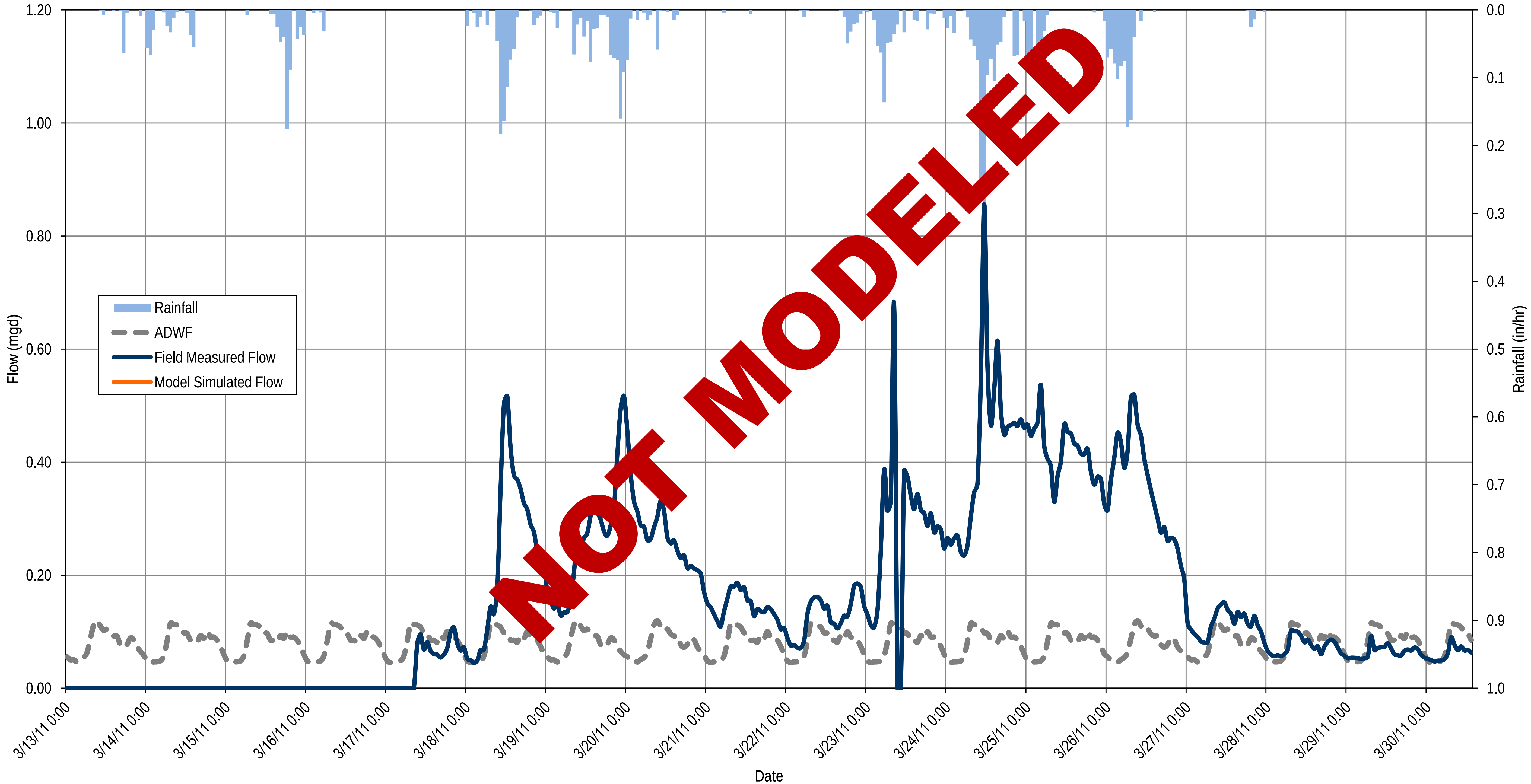
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_20.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 20-S2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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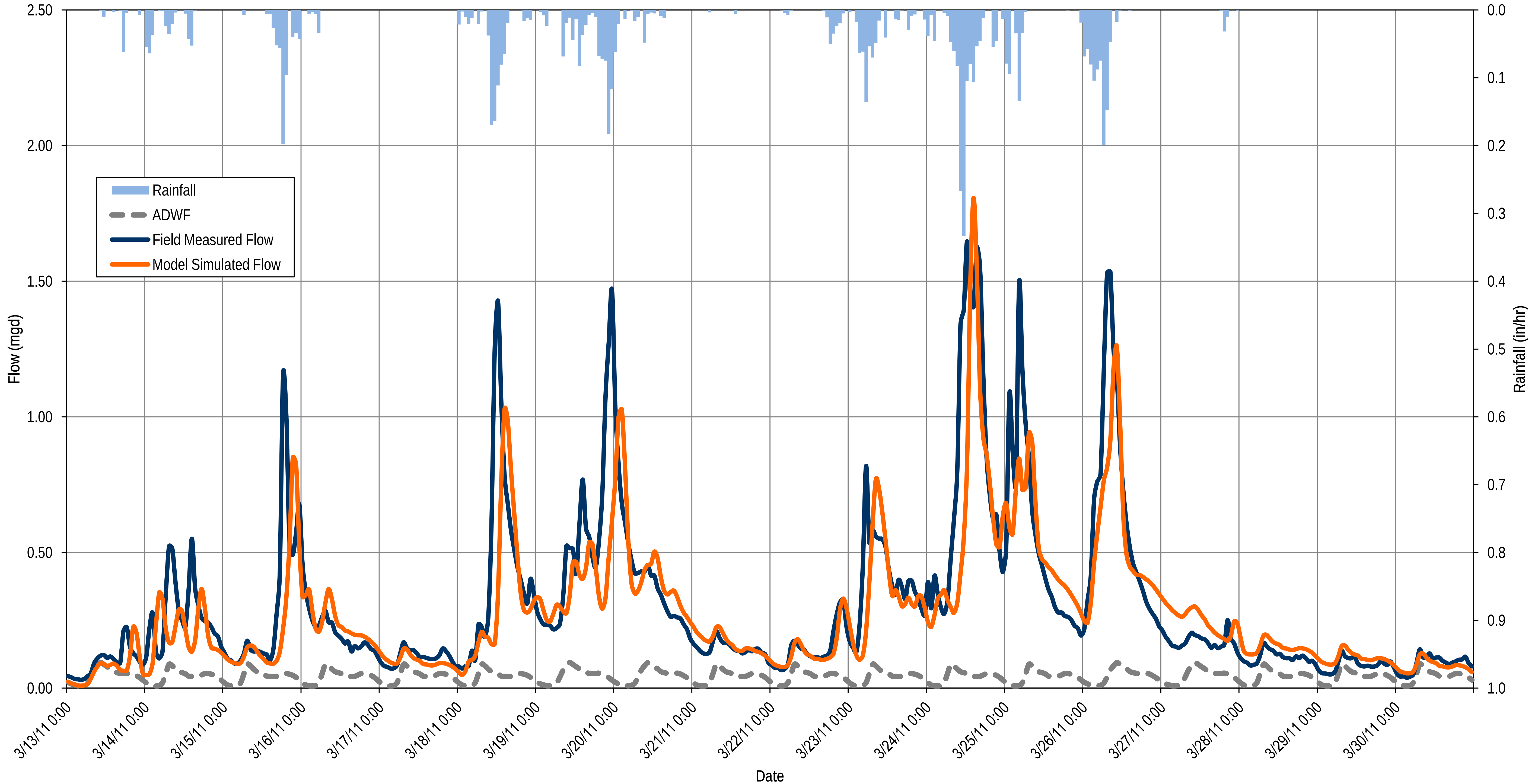
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_20.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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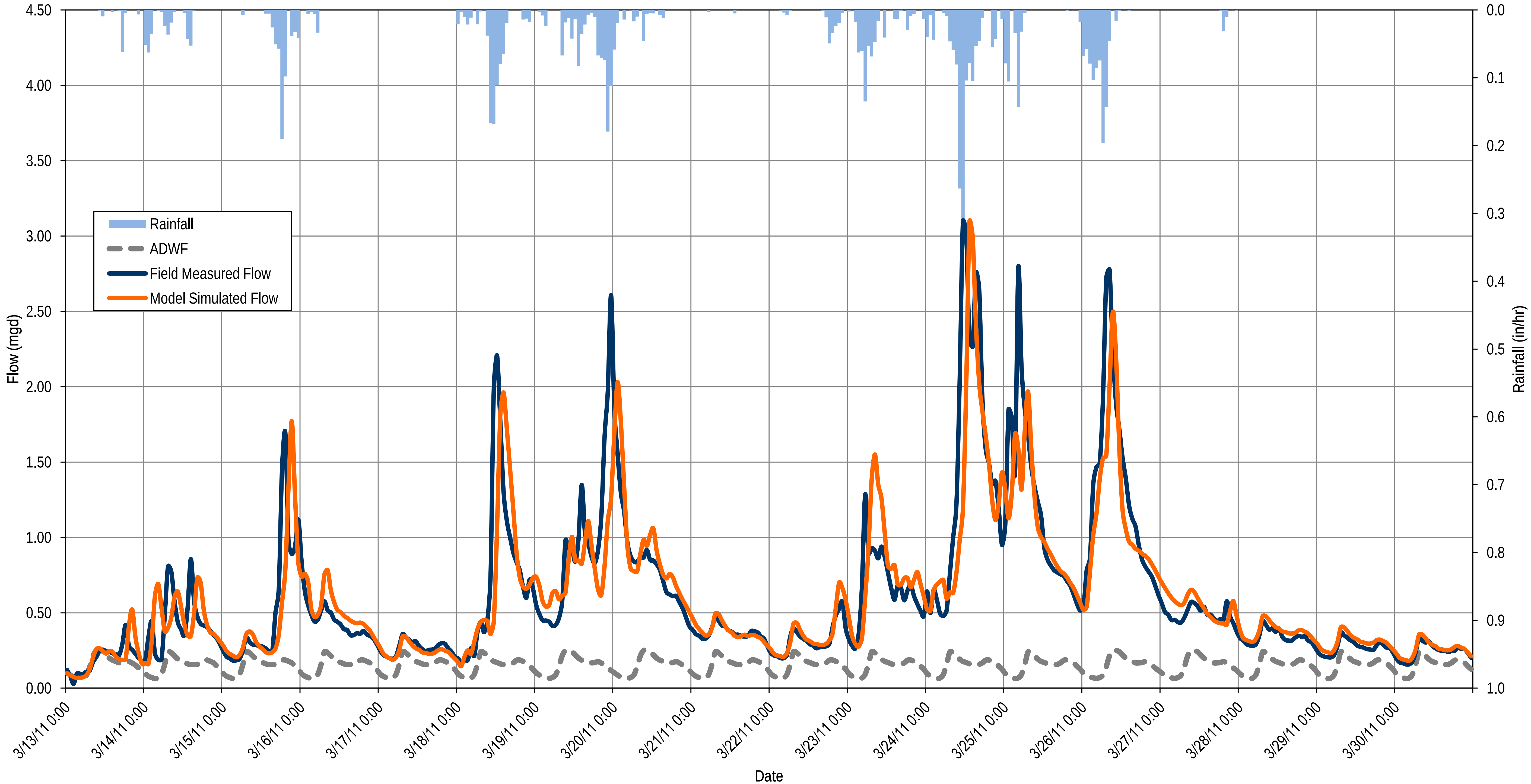
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_21.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 21L-1 WET WEATHER CALIBRATION



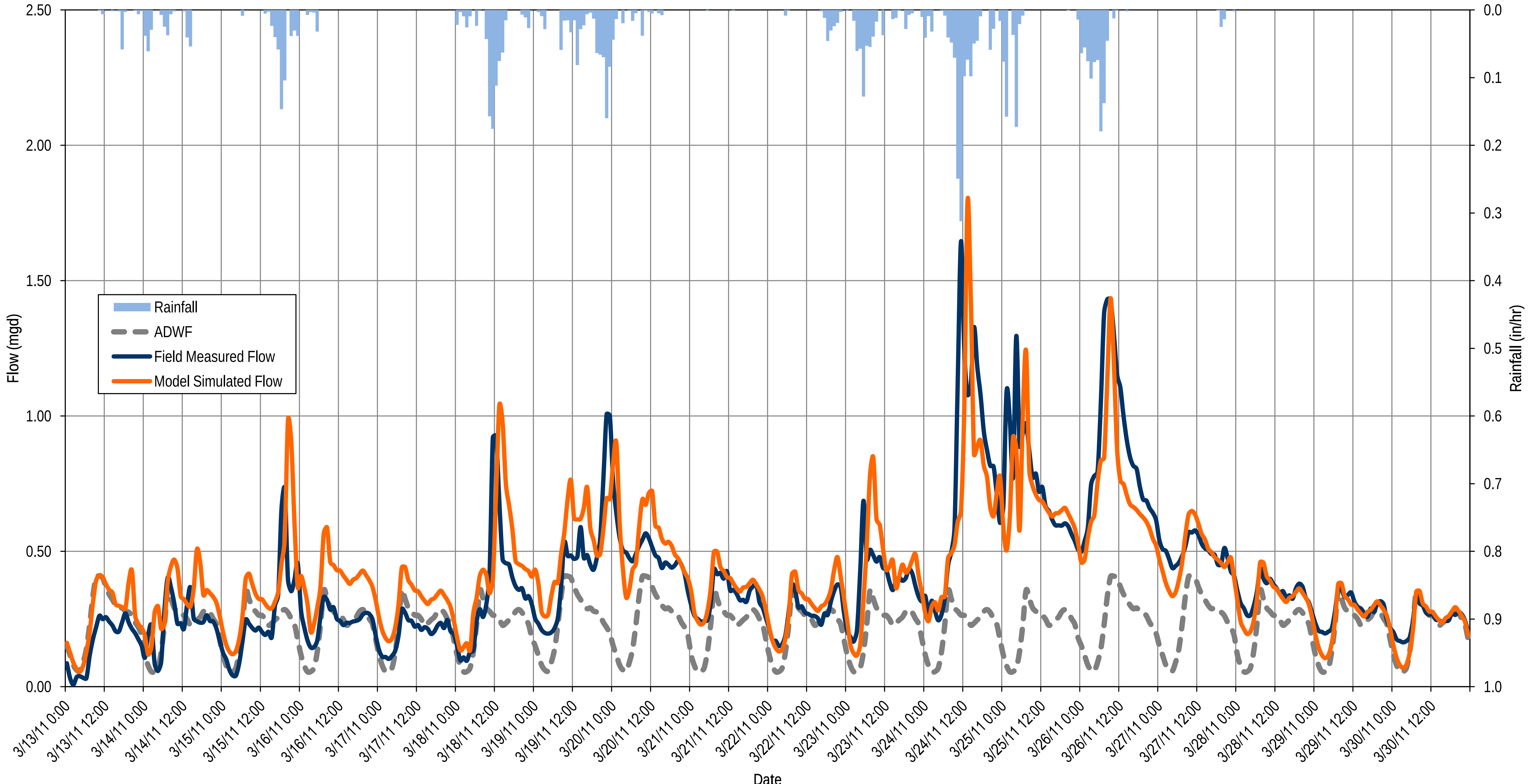
Wet Weather Flow Monitoring Comparison Chart
(3/22/2011 - 3/27/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_21.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/22/2011 - 3/27/2011 Rainfall Event)

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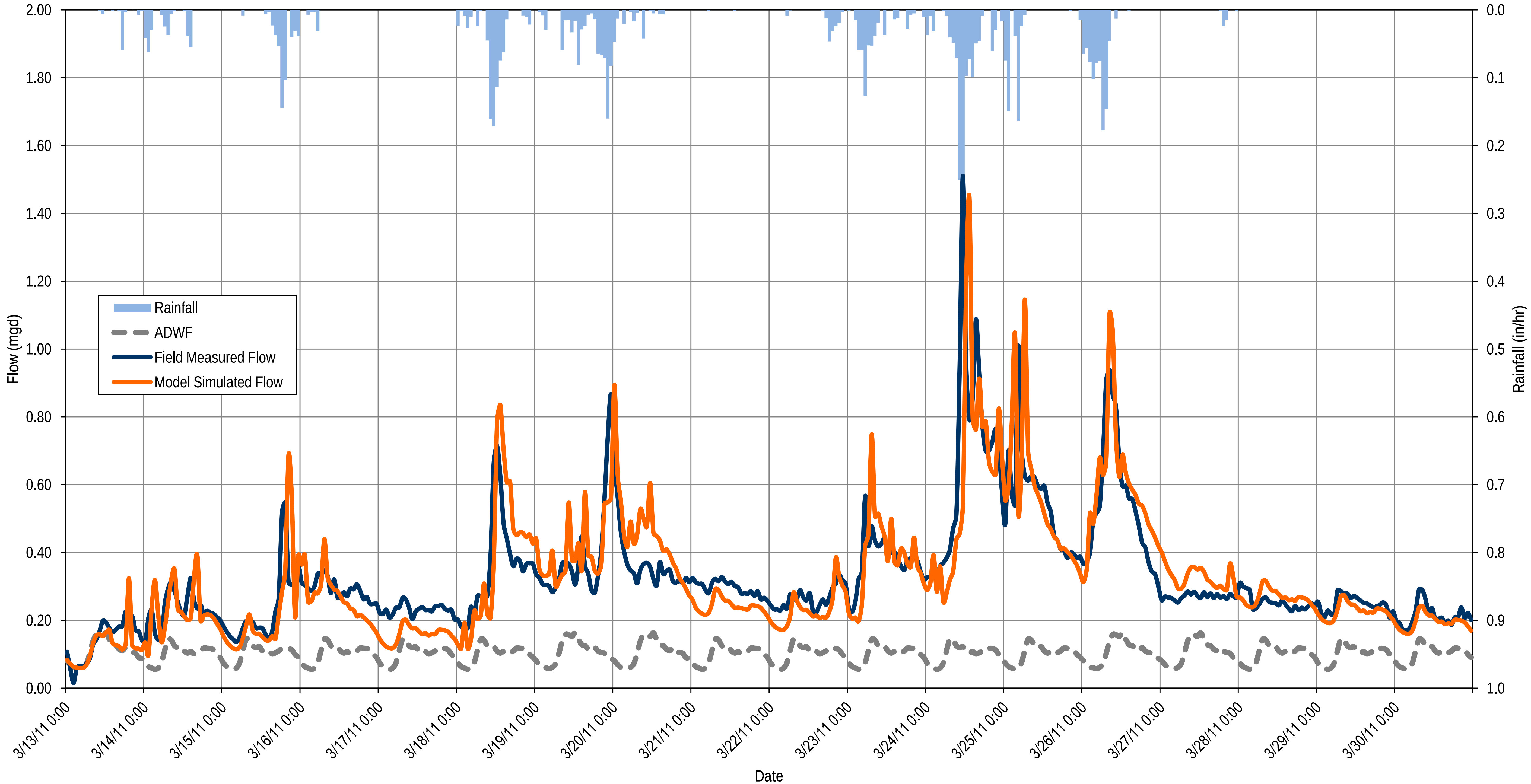
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_21.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/22/2011 - 3/27/2011 Rainfall Event)

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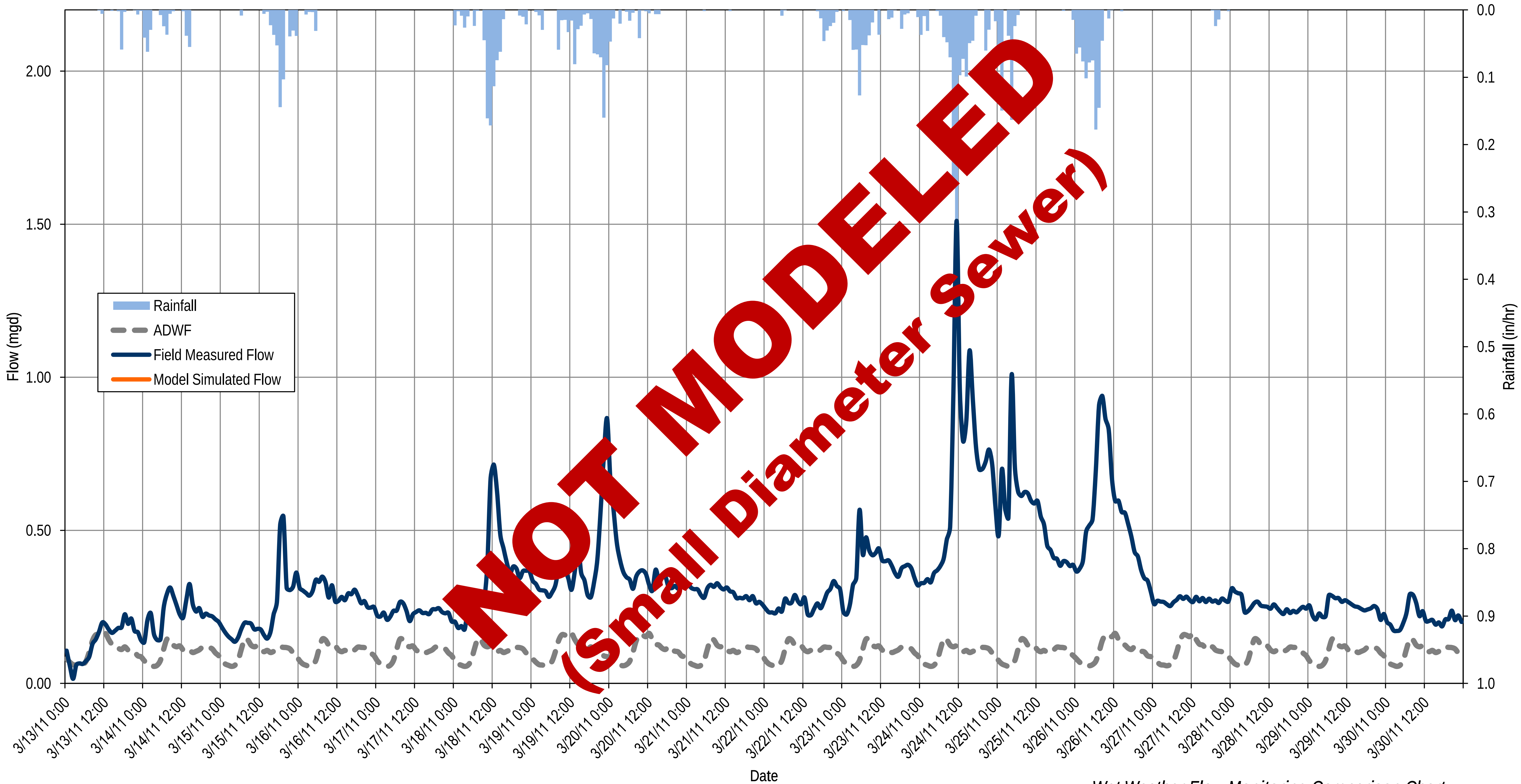
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_21.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 21L-S2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/22/2011 - 3/27/2011 Rainfall Event)

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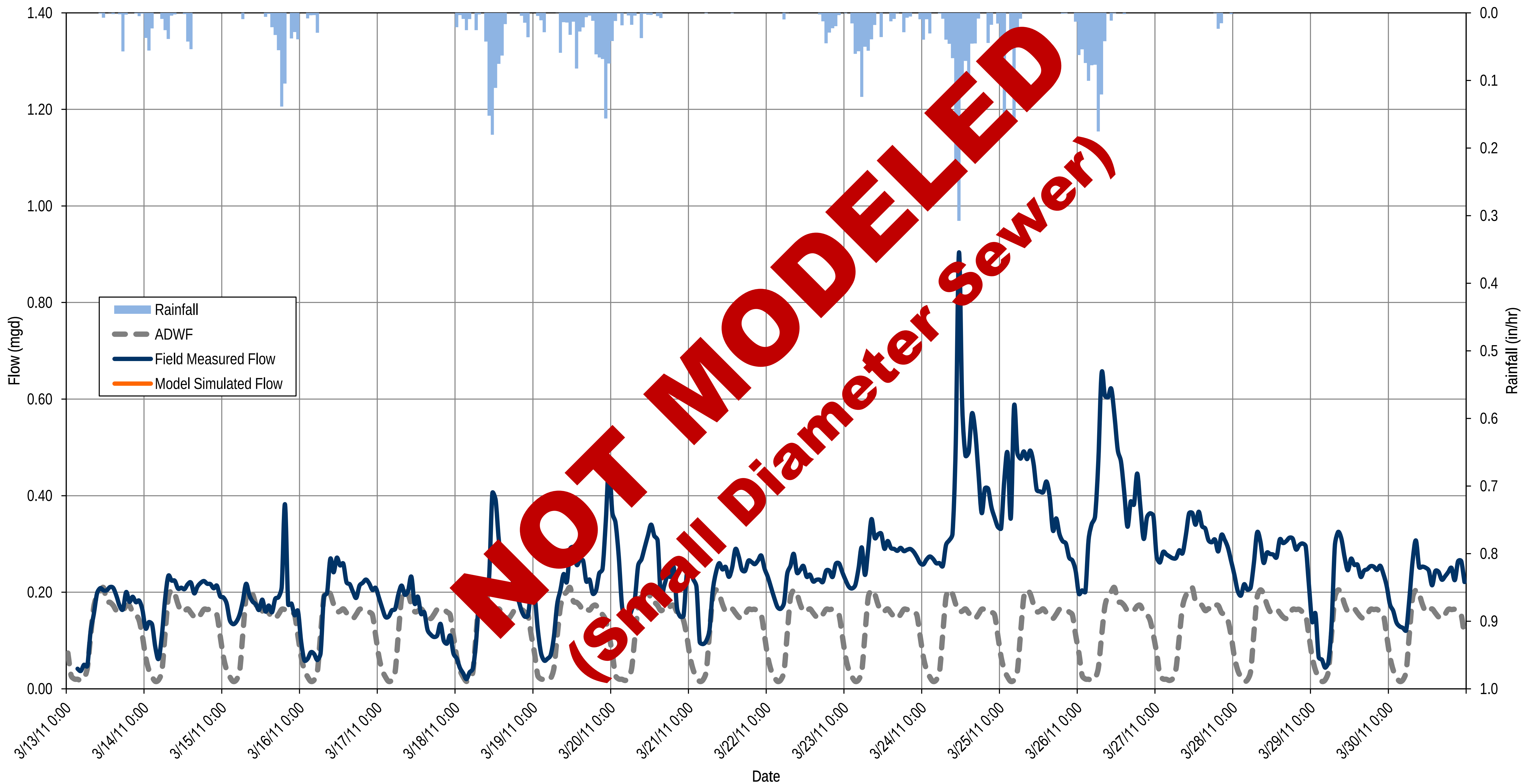
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_21.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 23-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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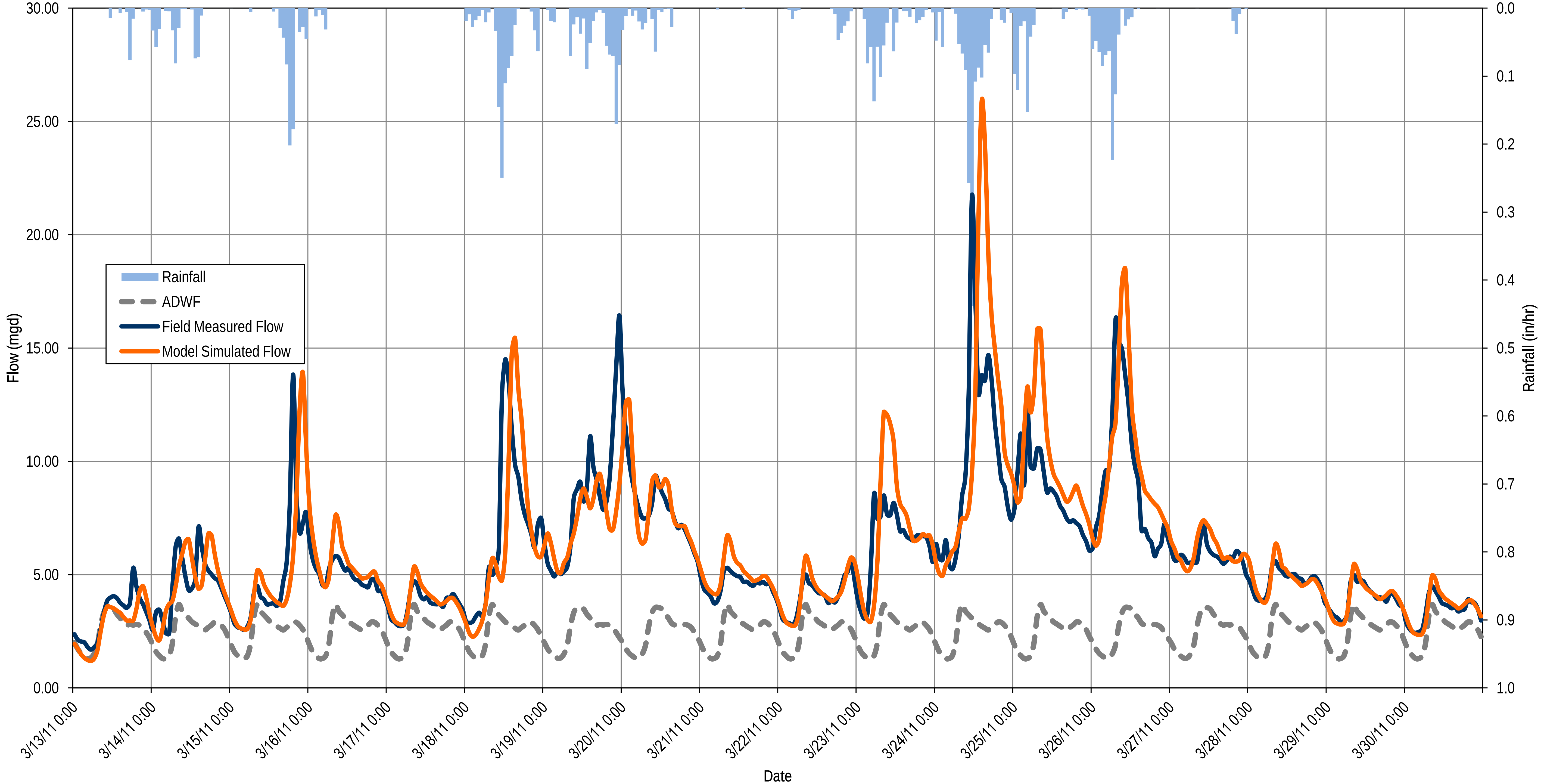
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_23.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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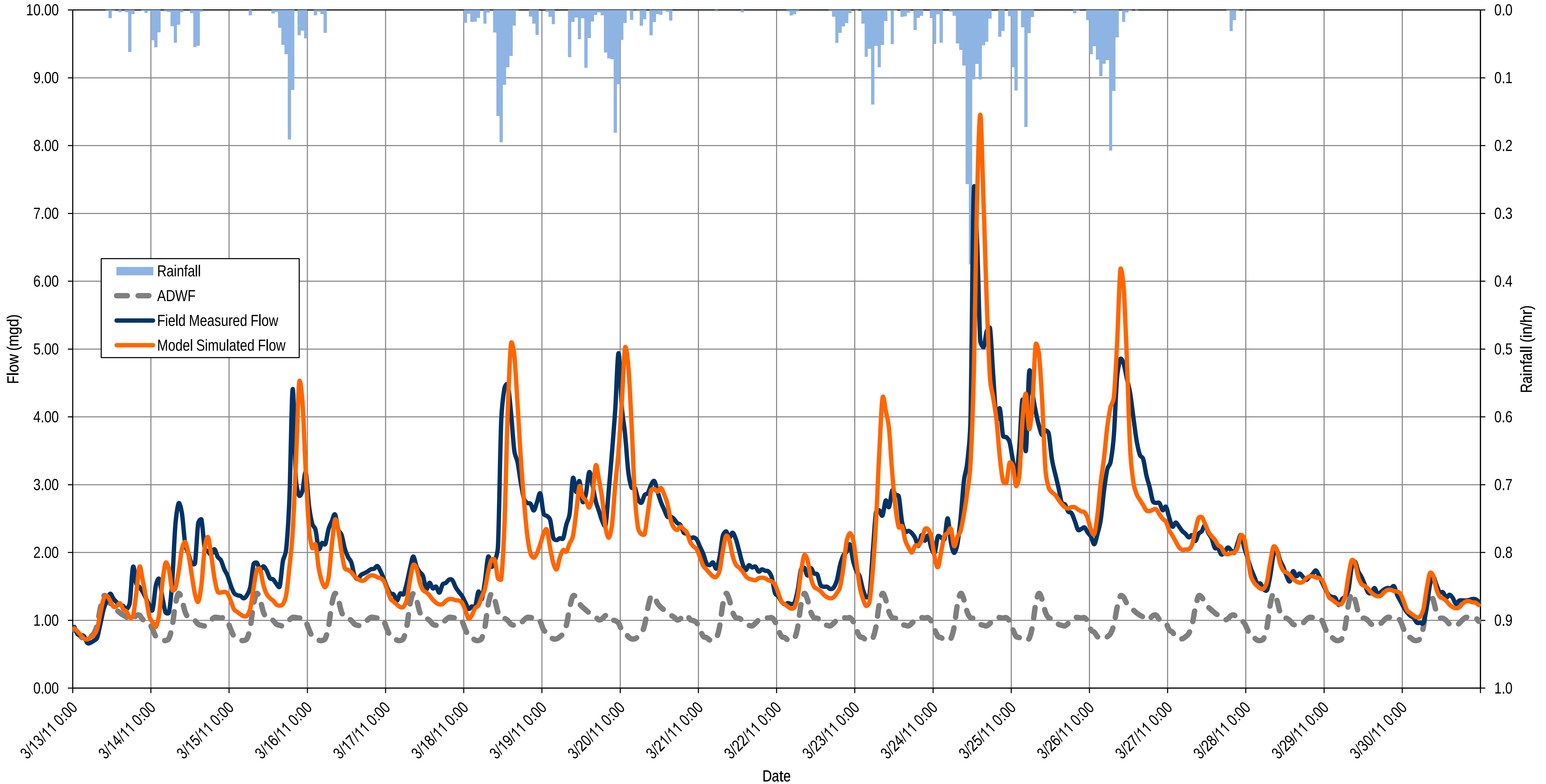
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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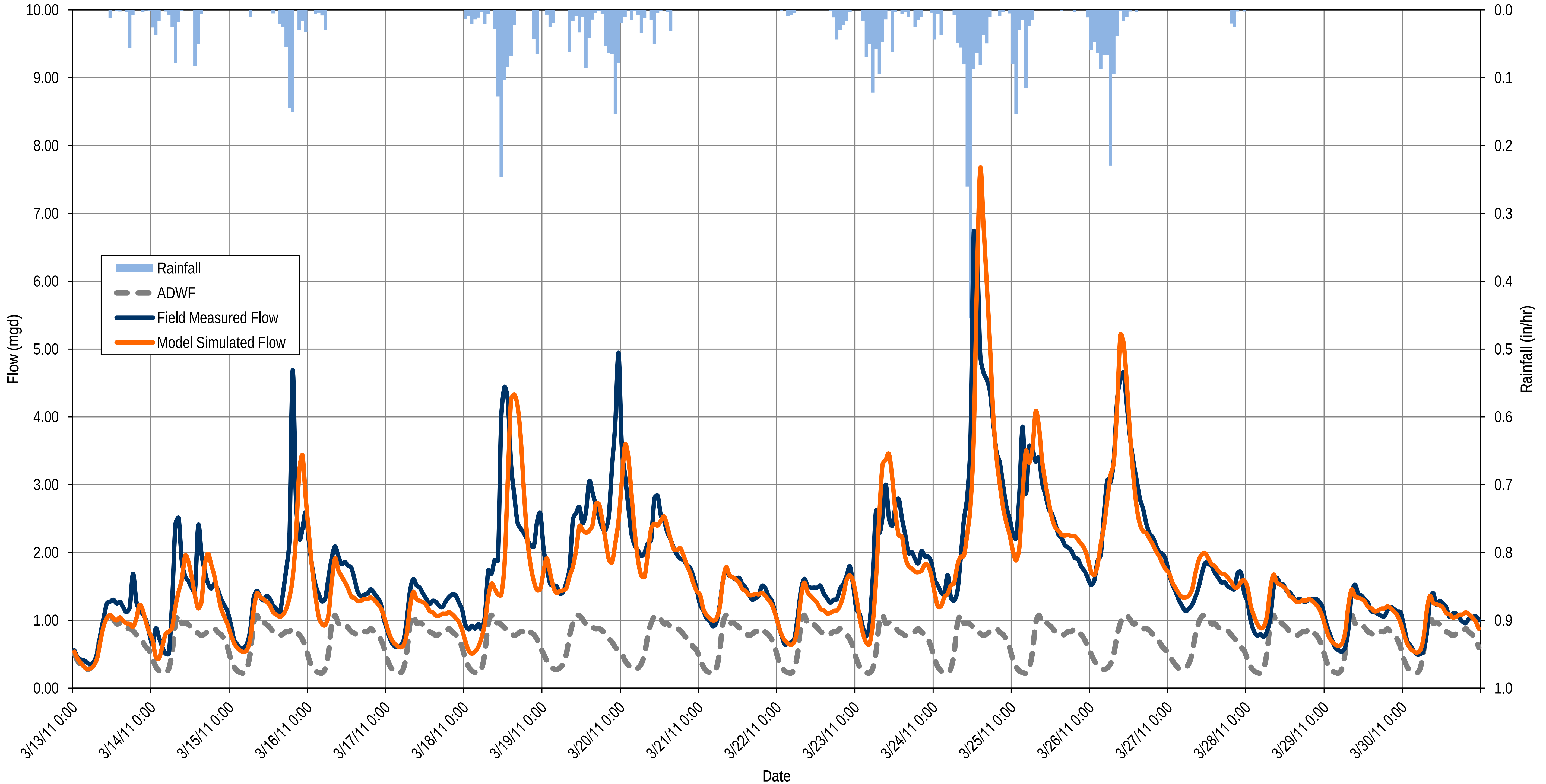
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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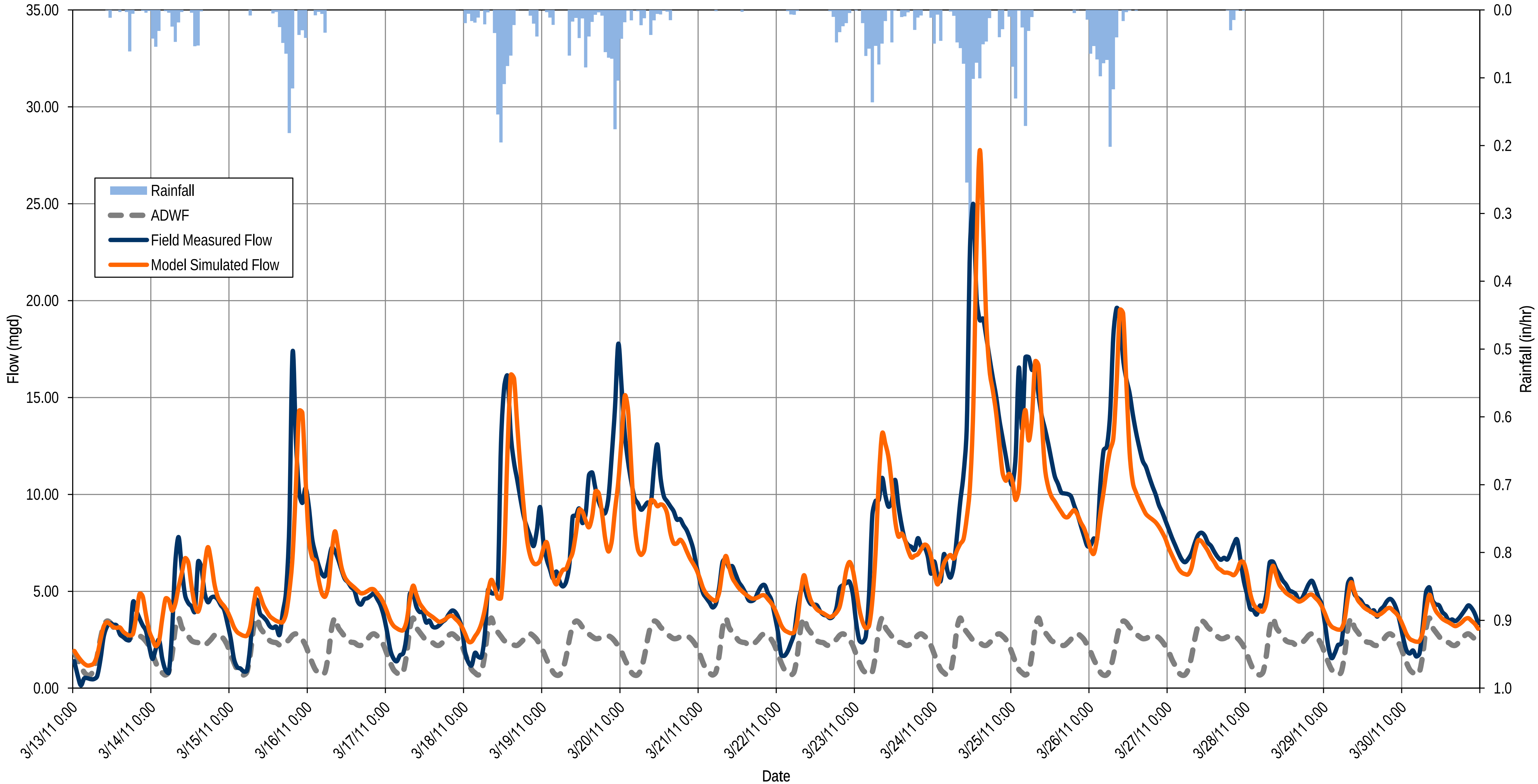
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50U-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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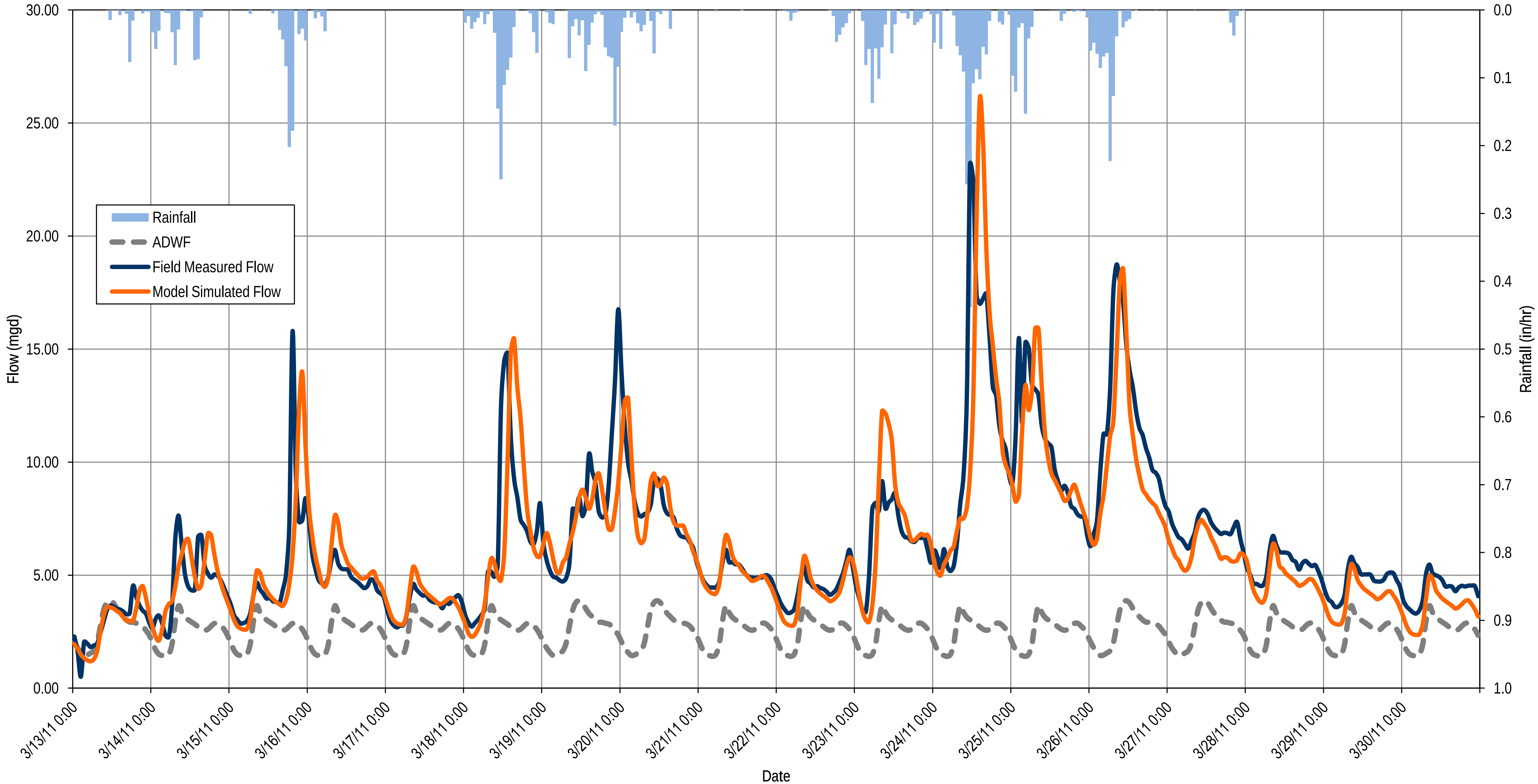
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50L-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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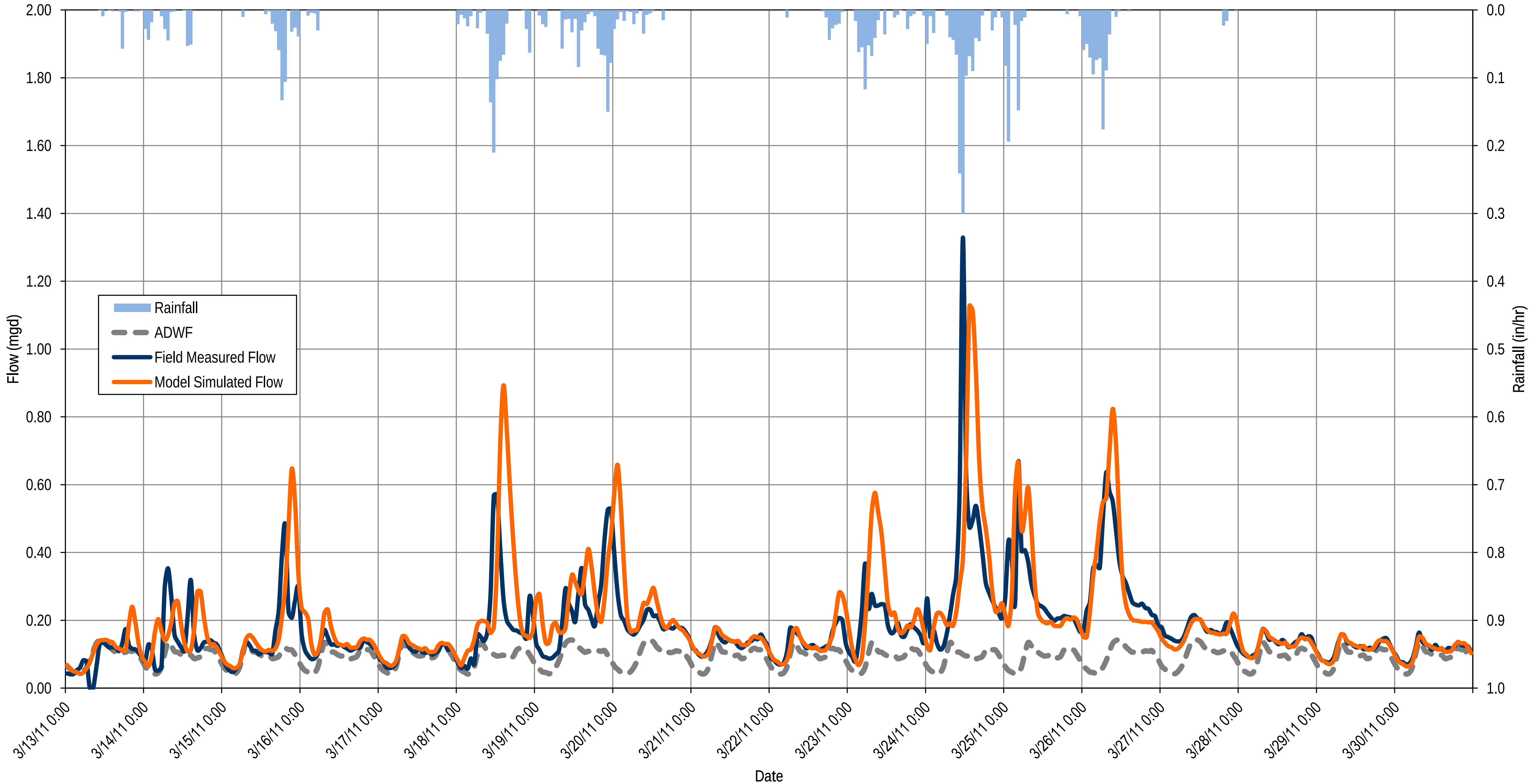
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50L-S1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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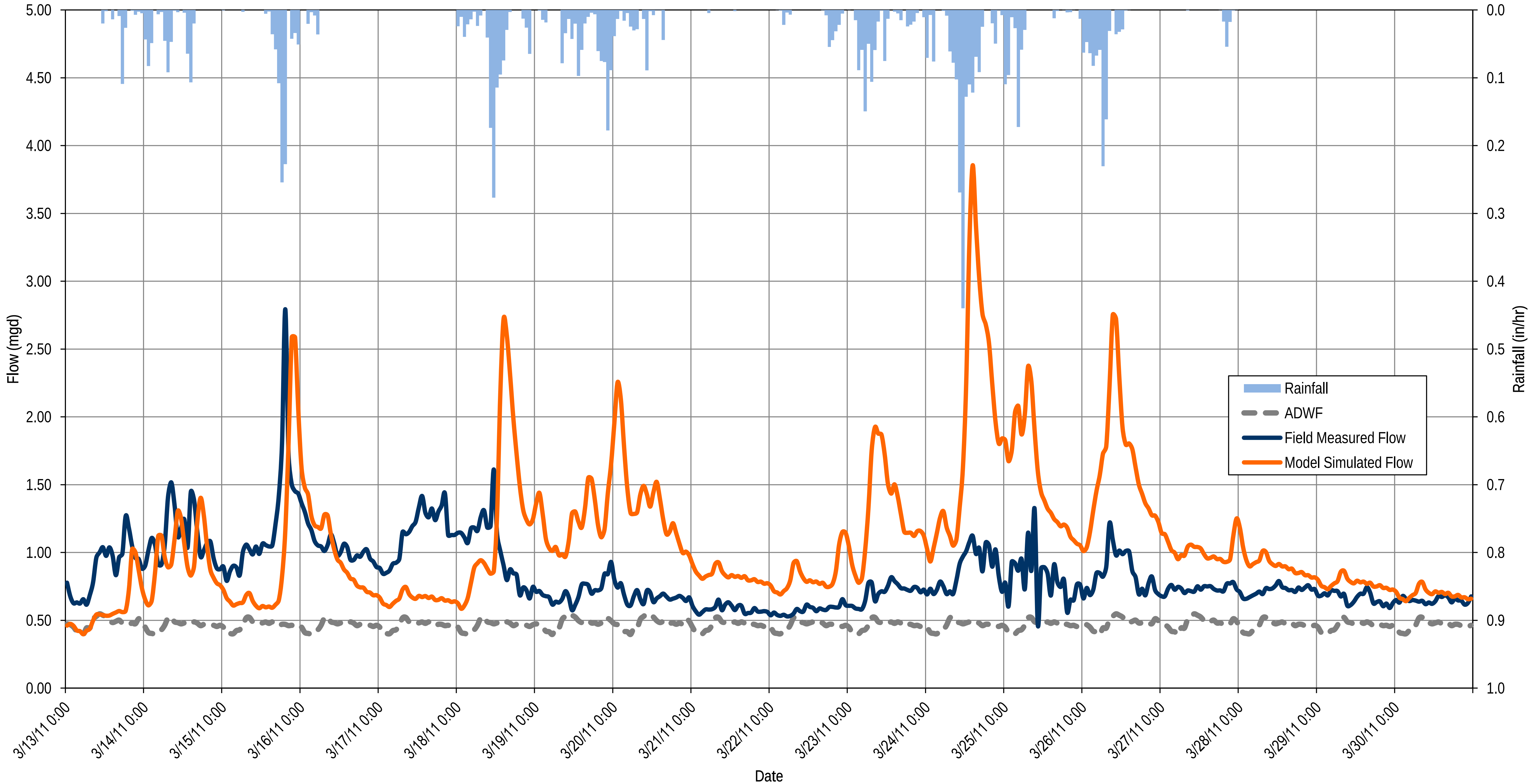
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50C.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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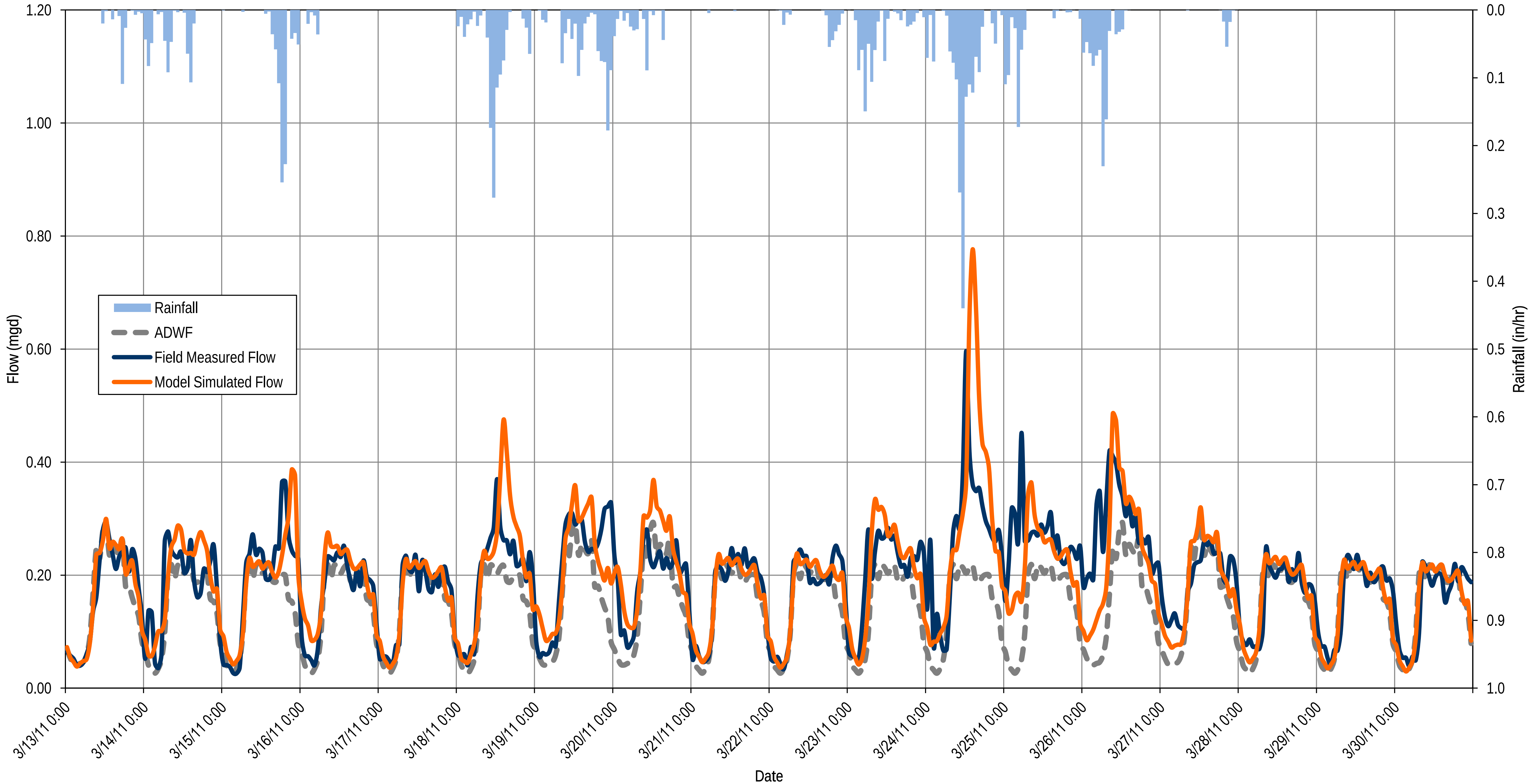
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50C.2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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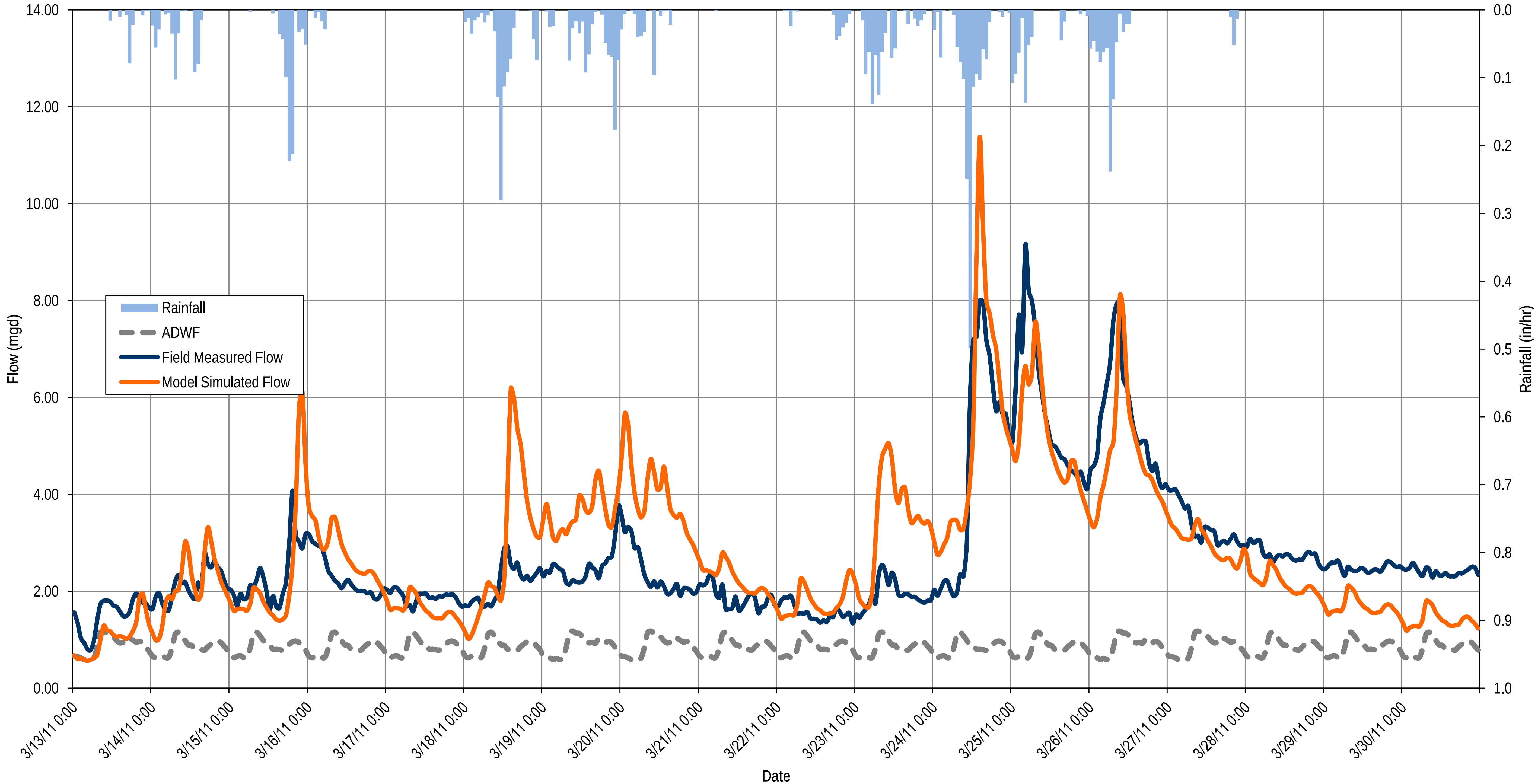
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50D WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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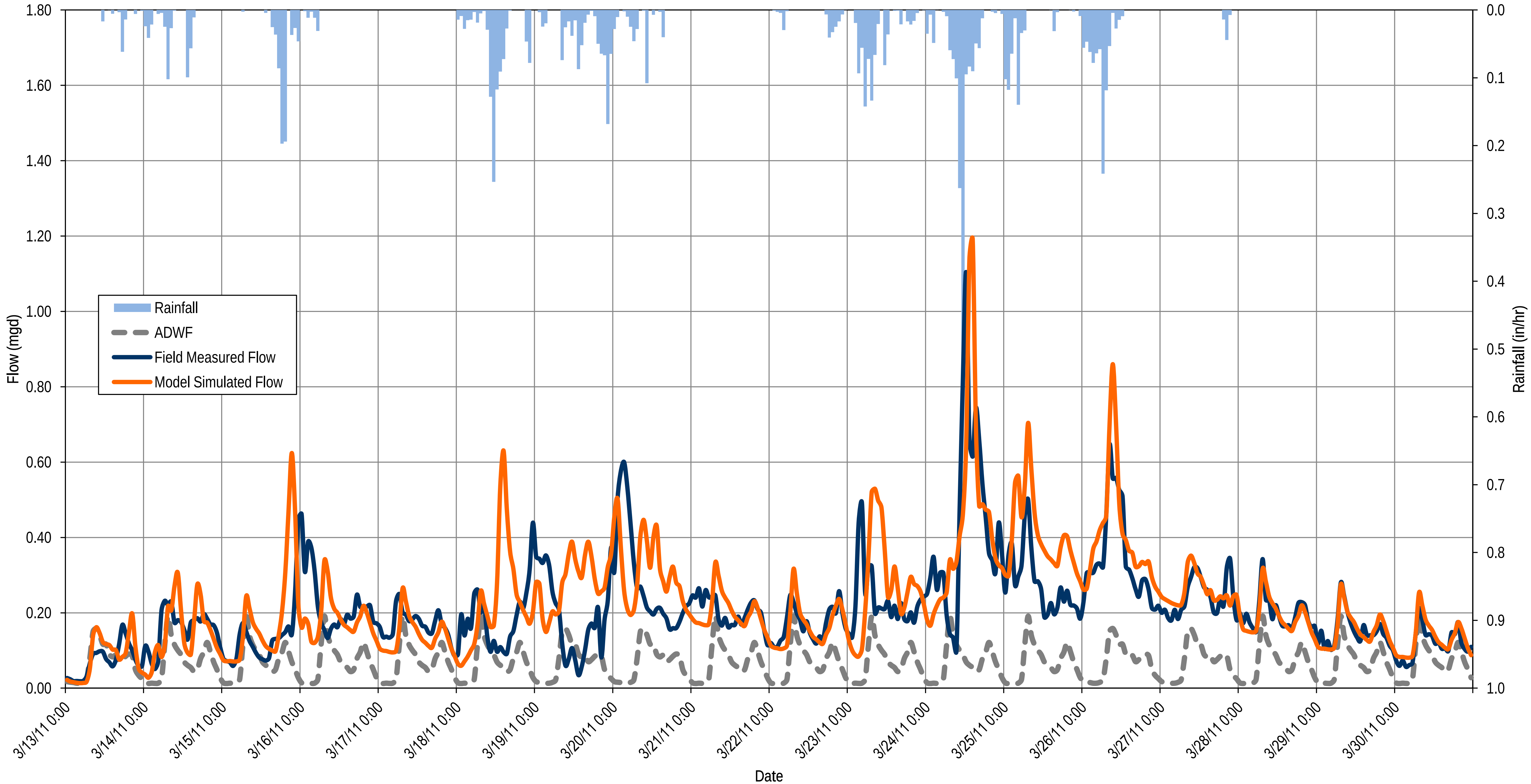
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 50E WET WEATHER CALIBRATION



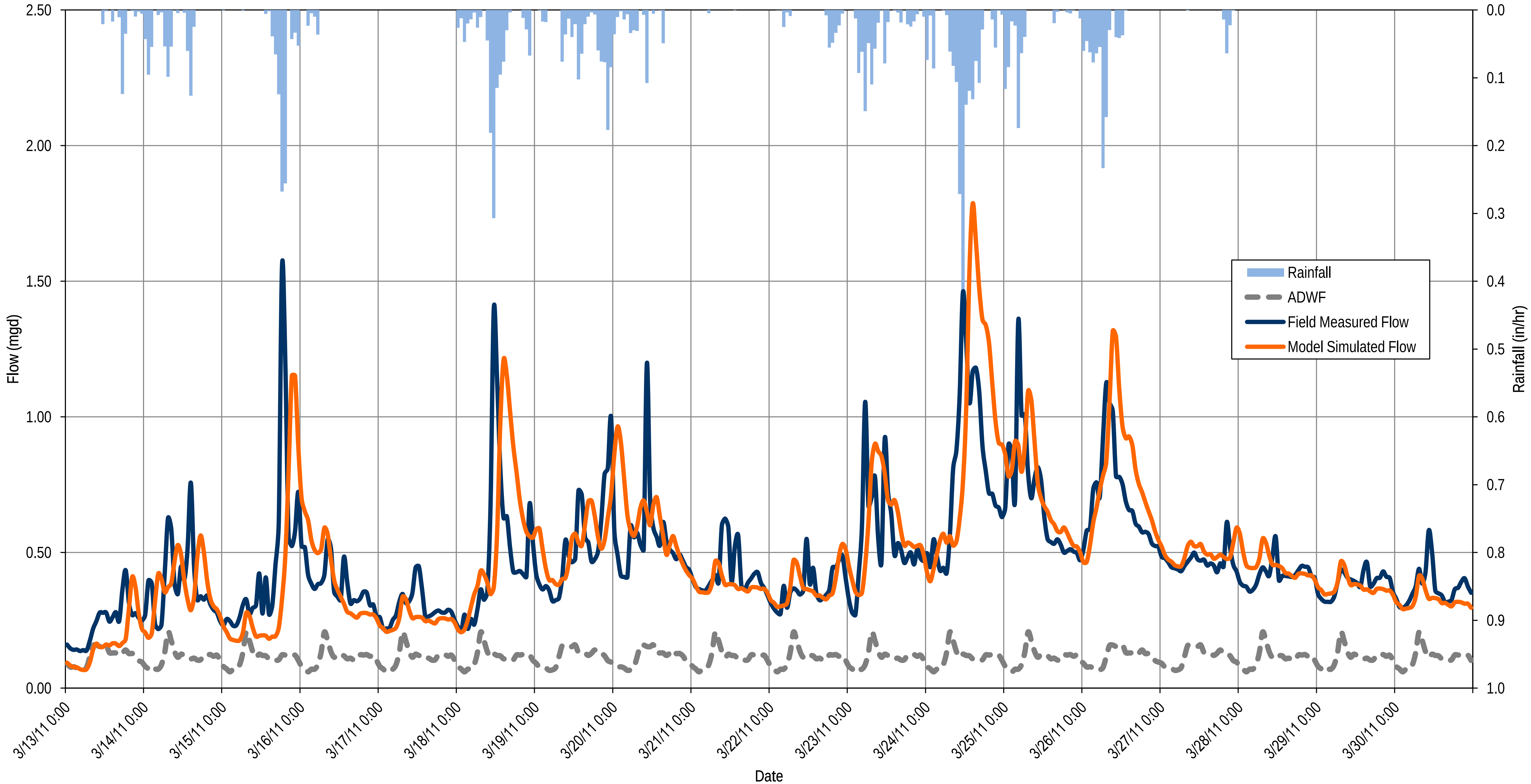
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50F WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

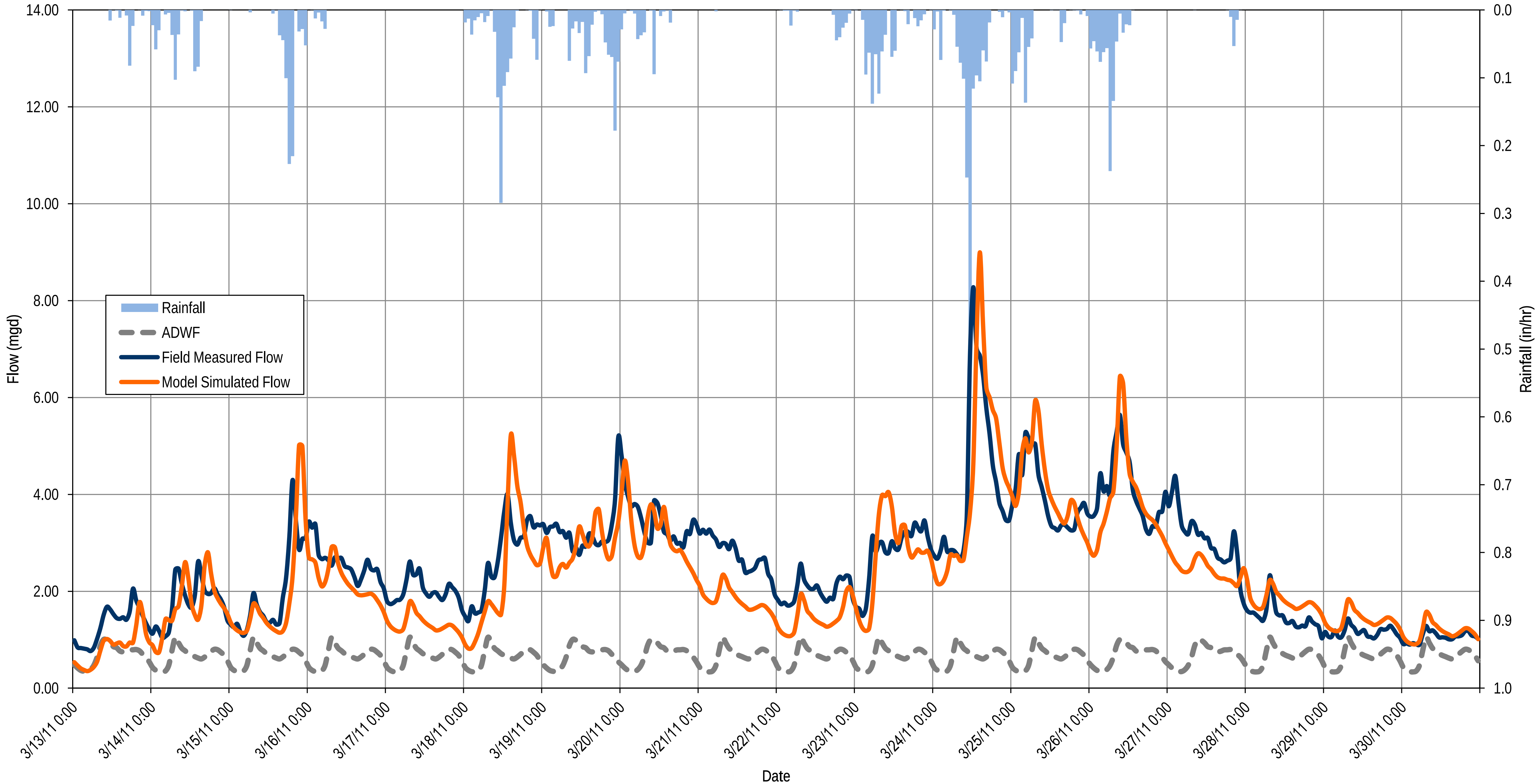
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50G WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

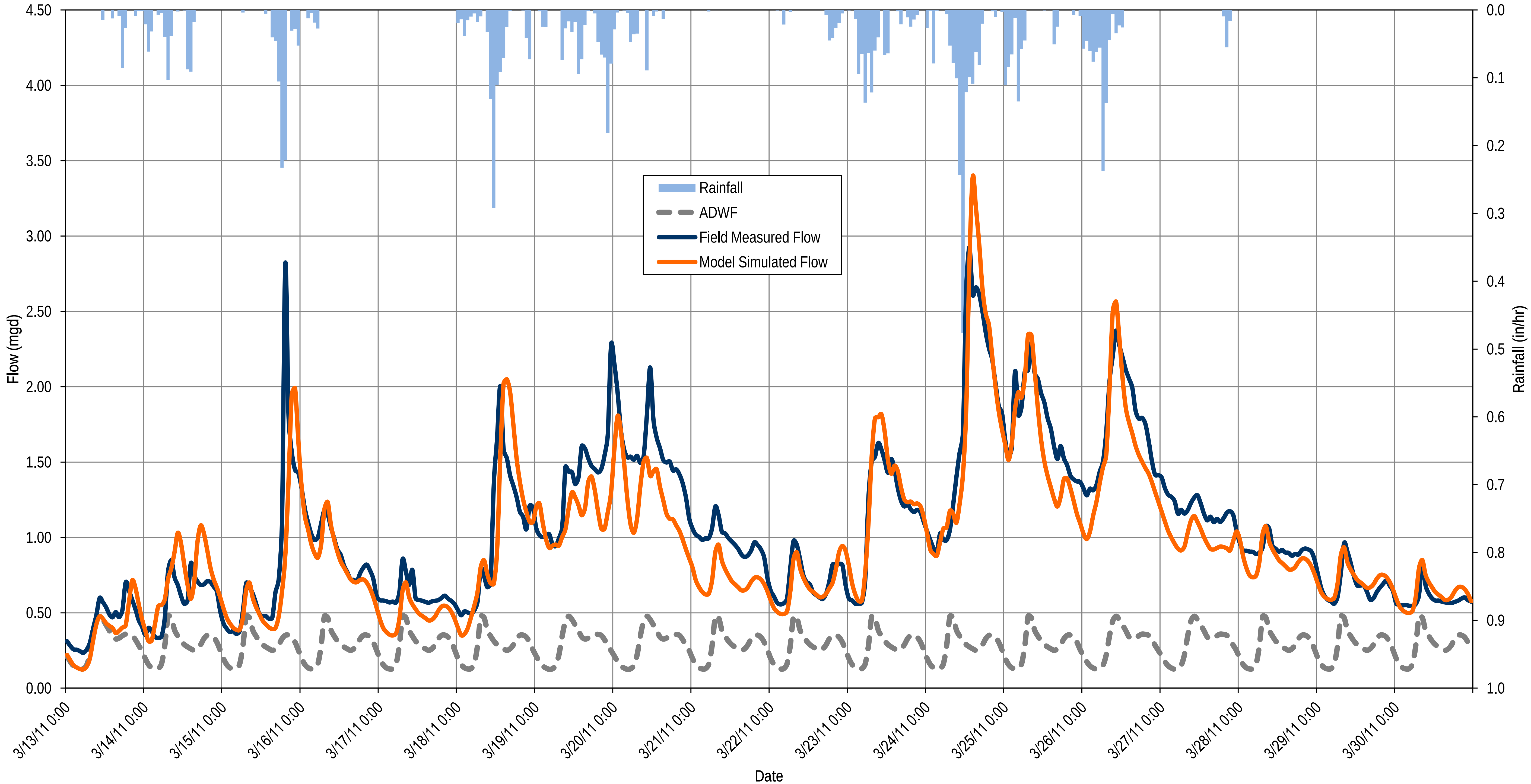
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 50H WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

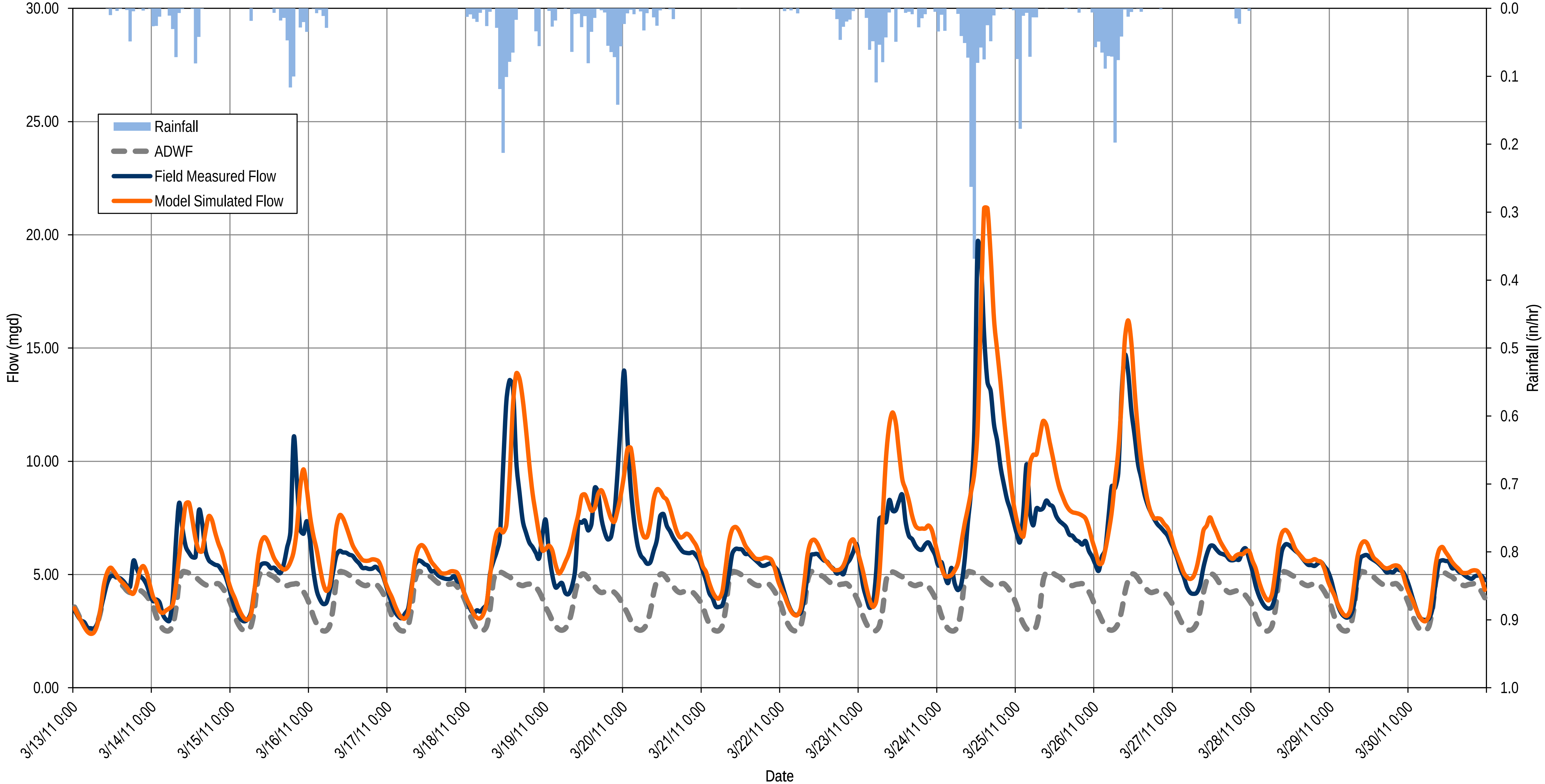
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_50.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52A WET WEATHER CALIBRATION

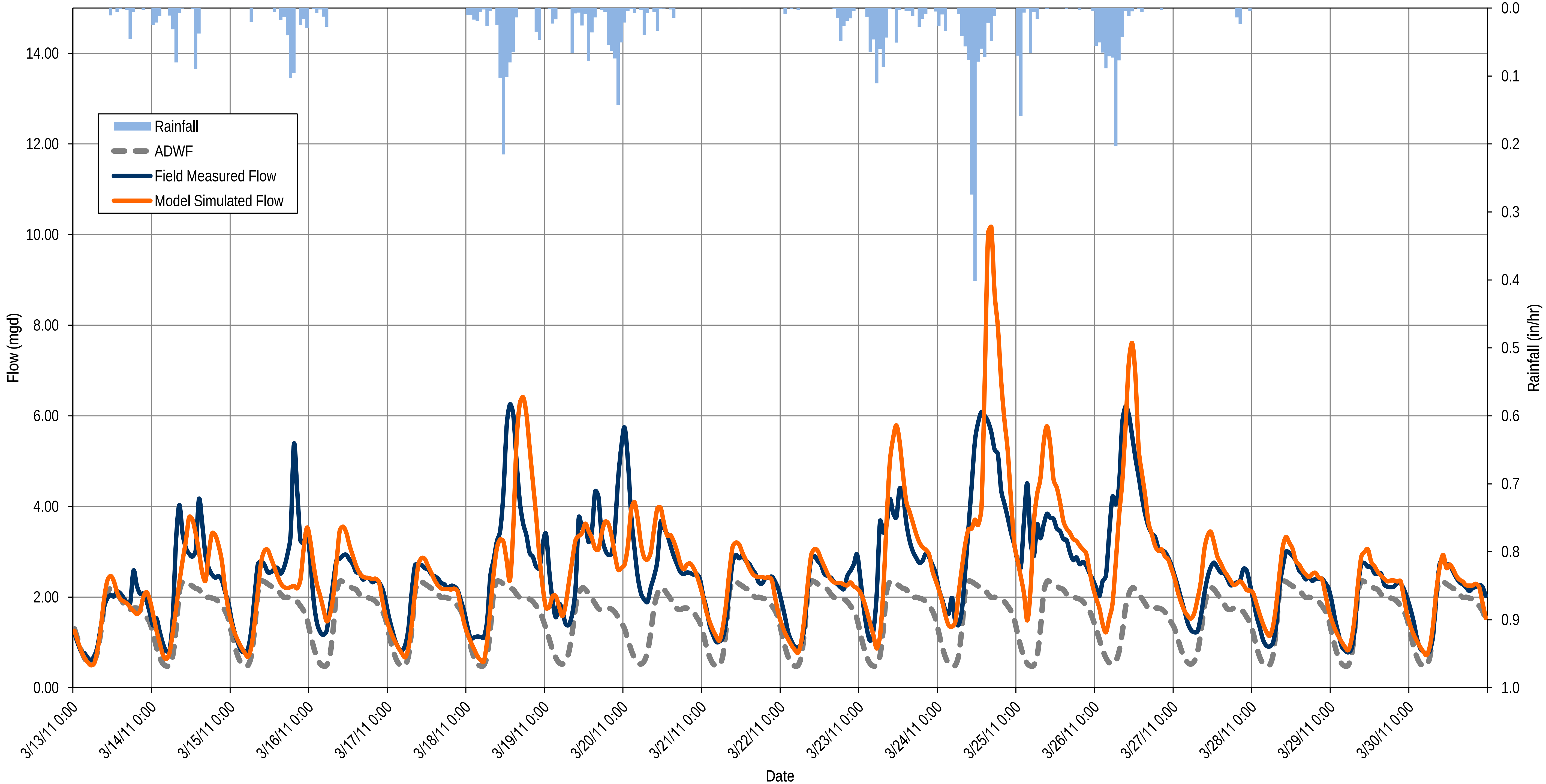


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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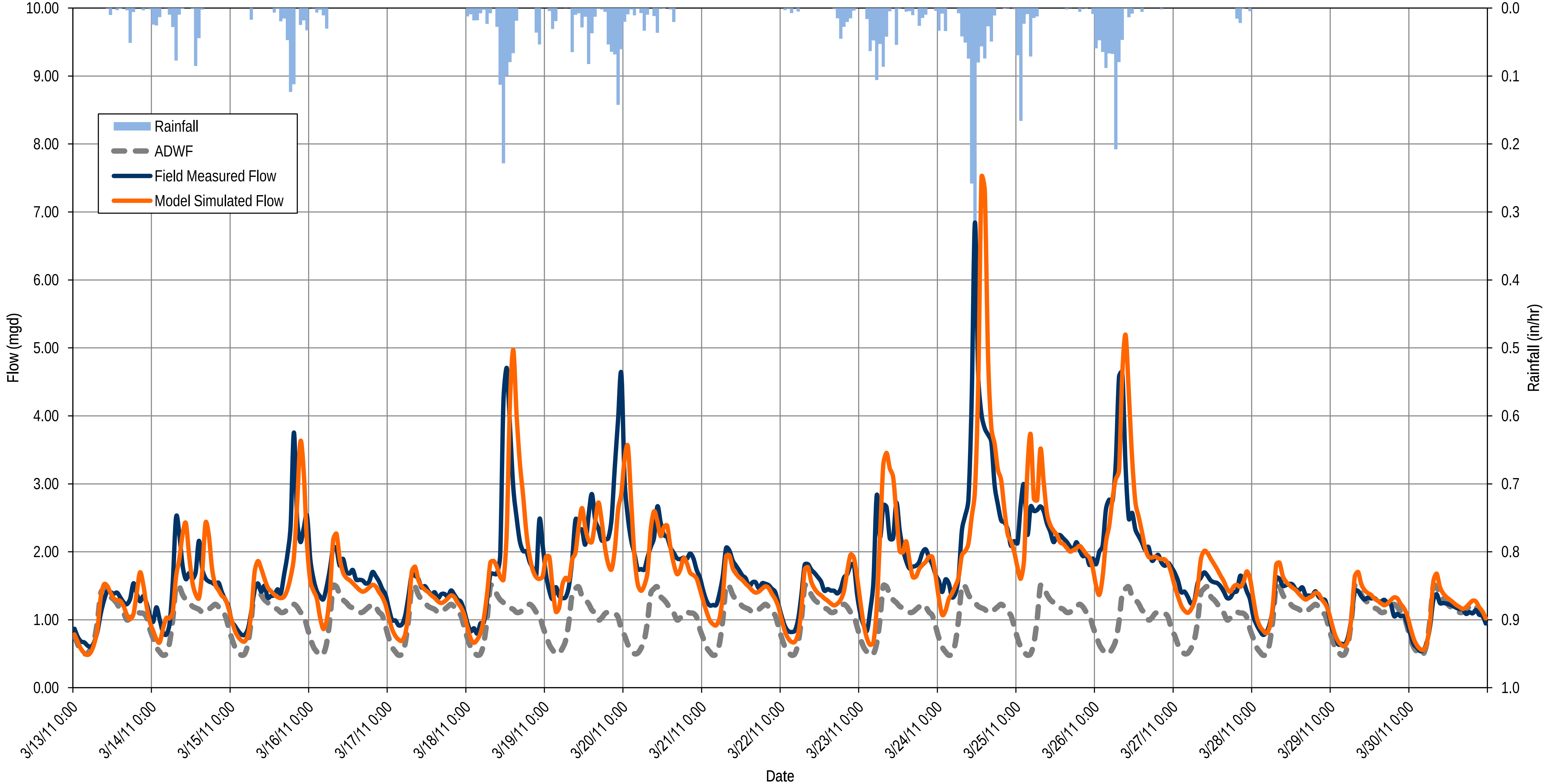
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_52.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52C WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

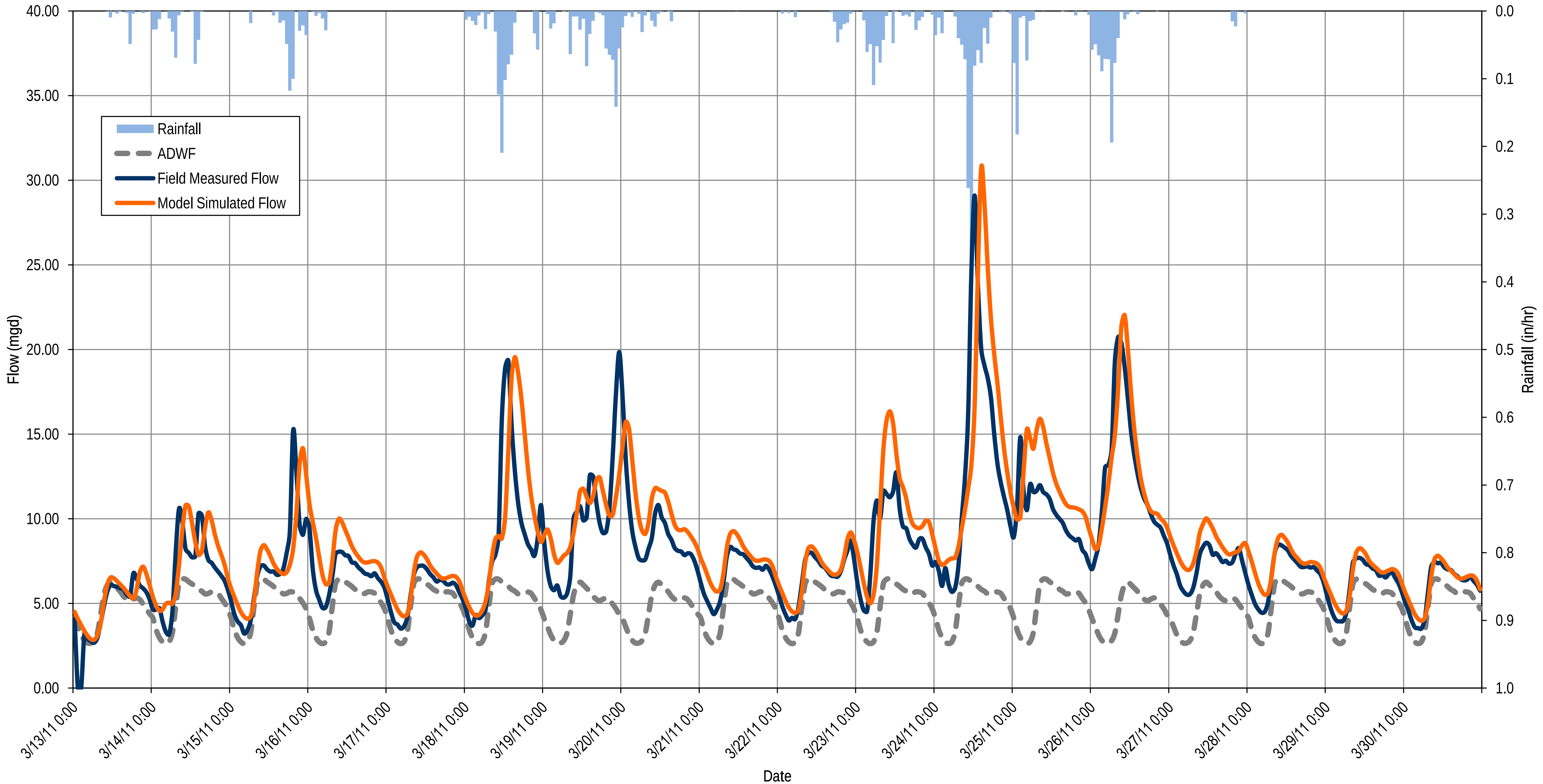
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_52.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 52-1 WET WEATHER CALIBRATION

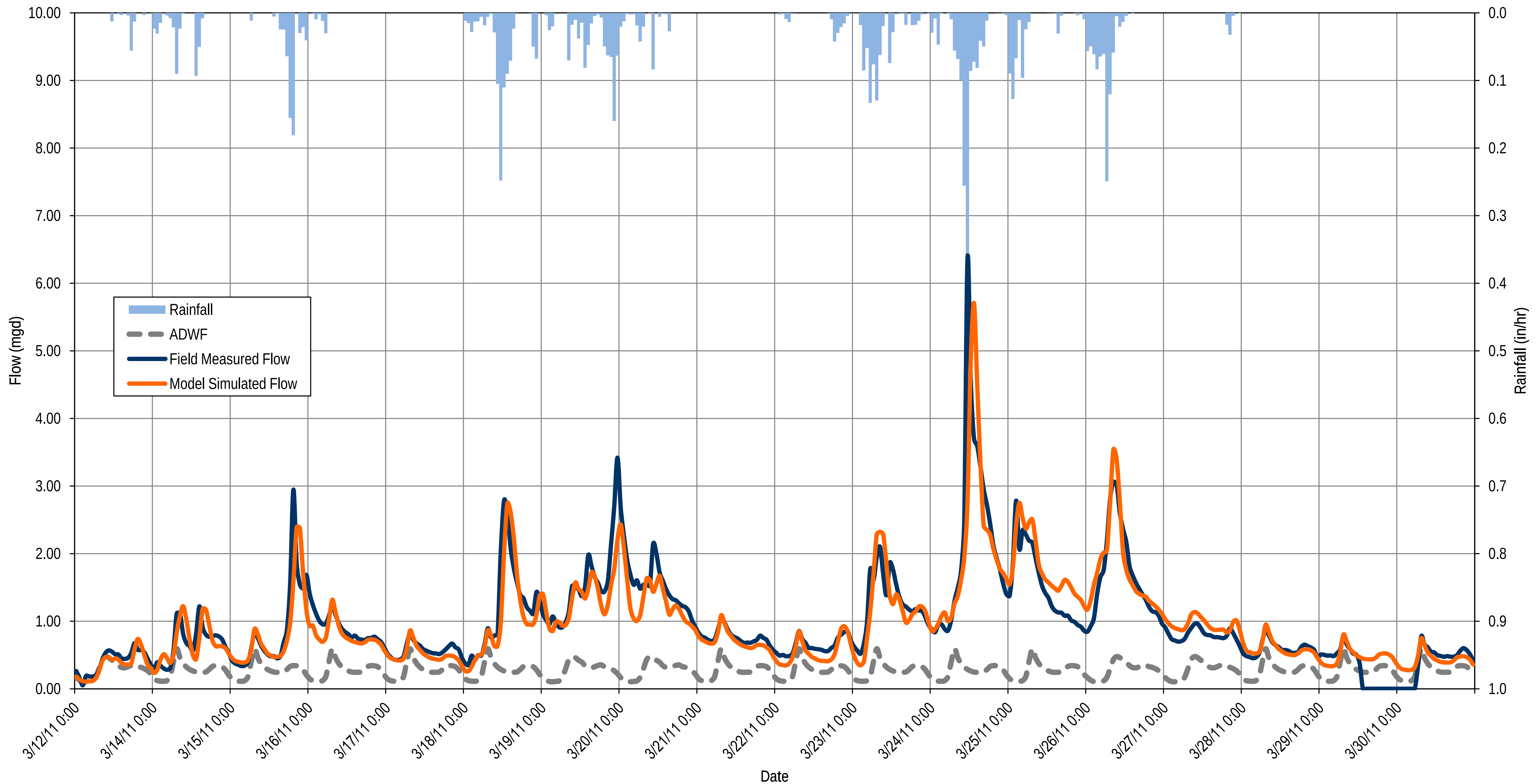


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_52.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-S1 WET WEATHER CALIBRATION

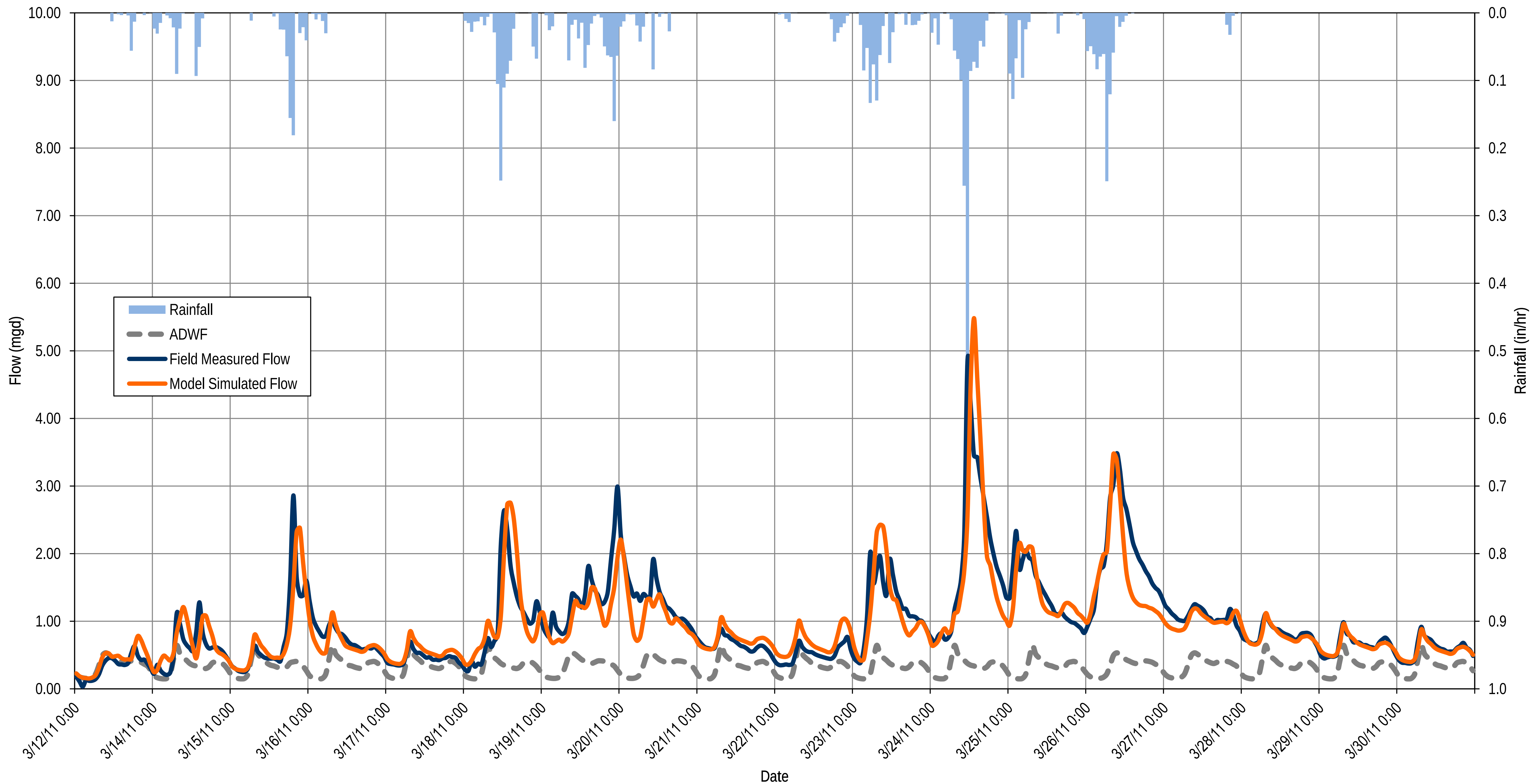


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-S2 WET WEATHER CALIBRATION



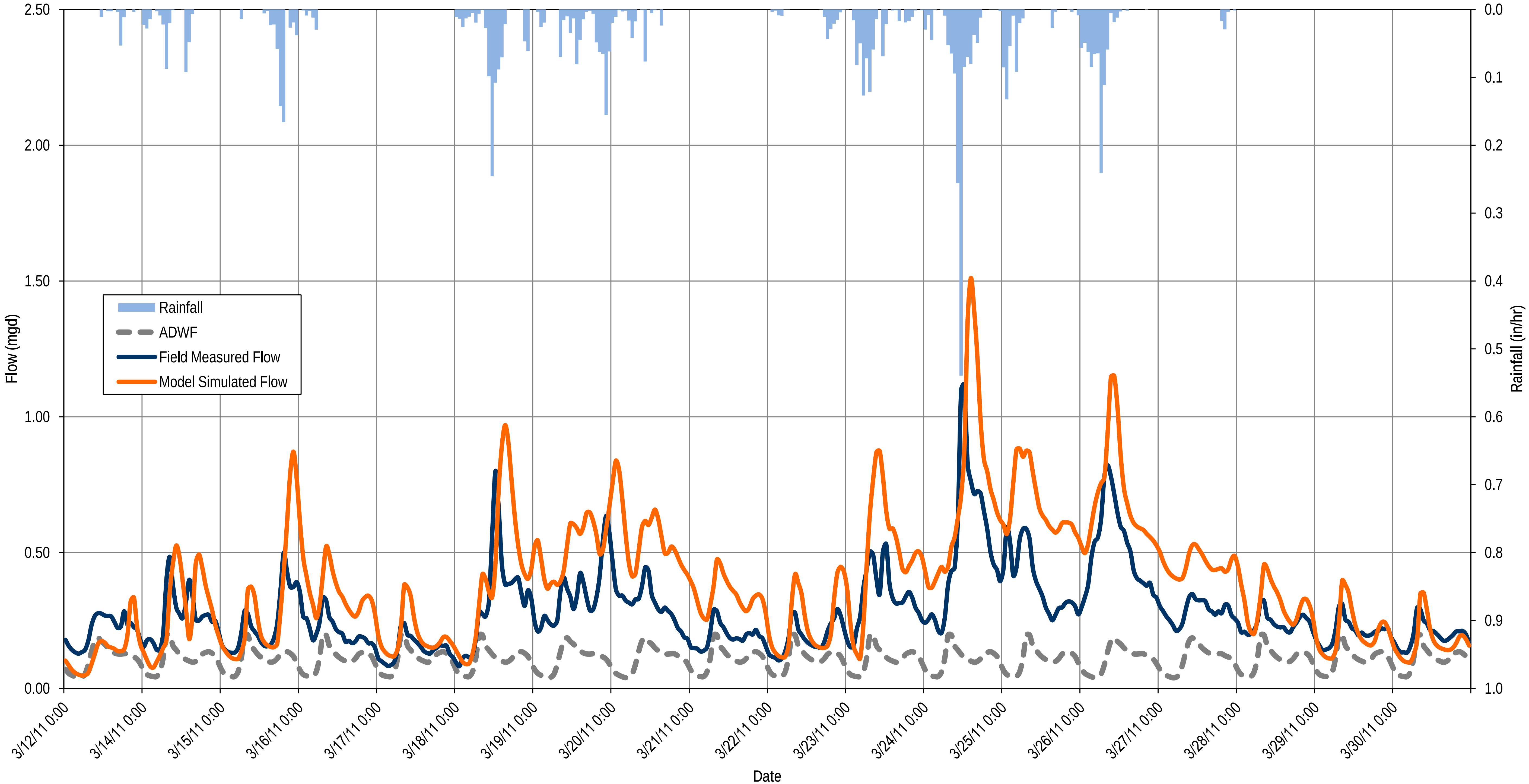
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

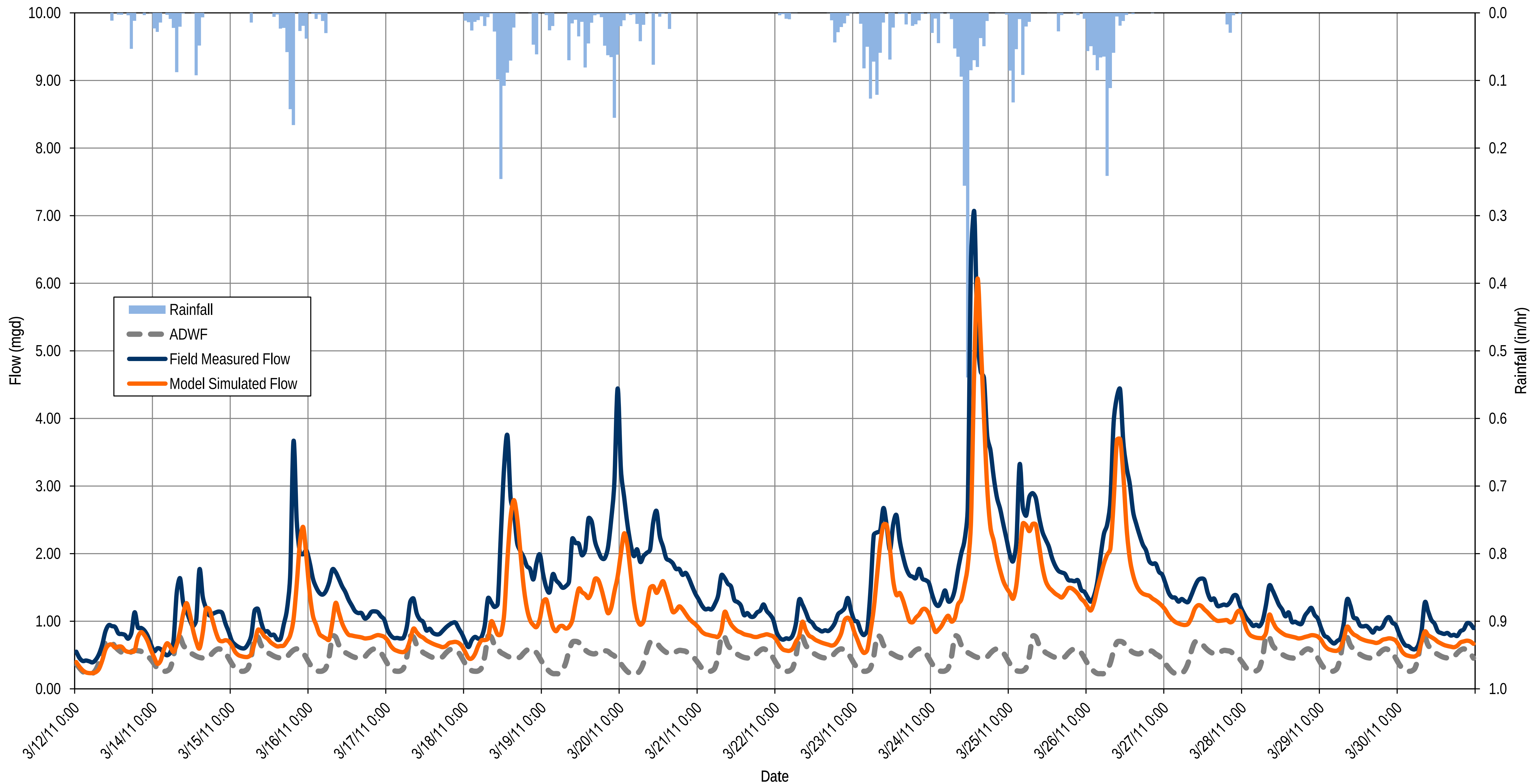
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

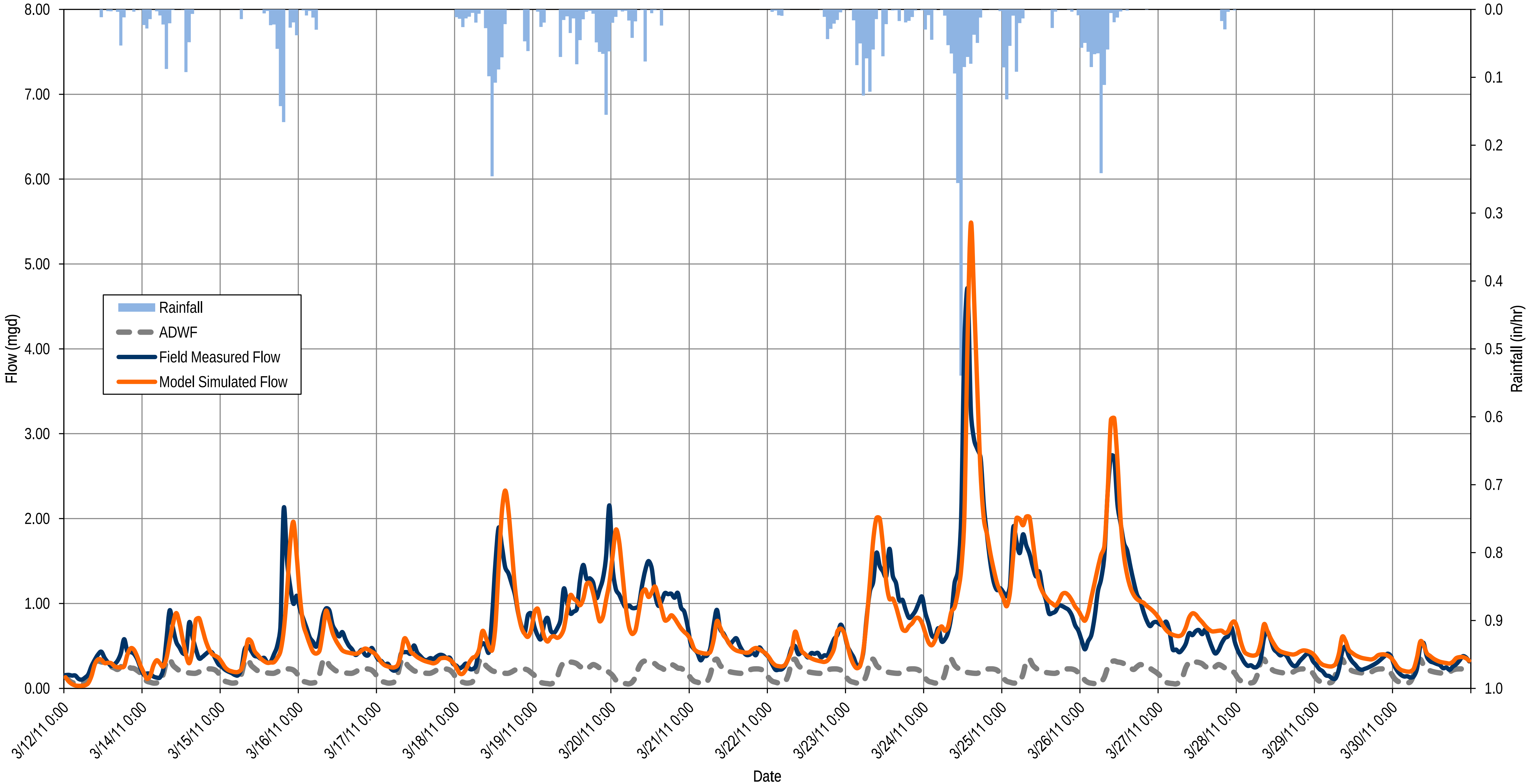
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.3 WET WEATHER CALIBRATION

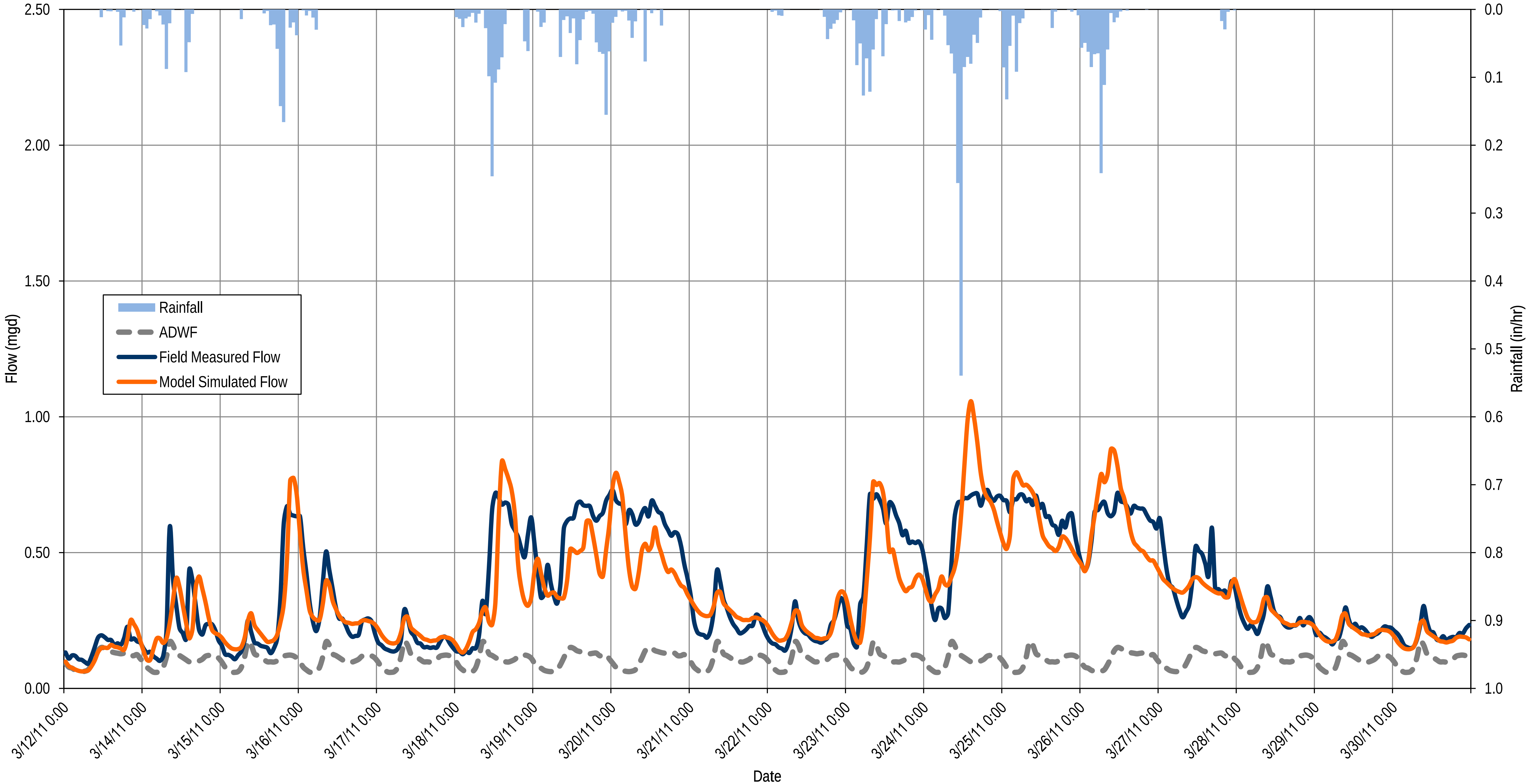


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54B.4 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

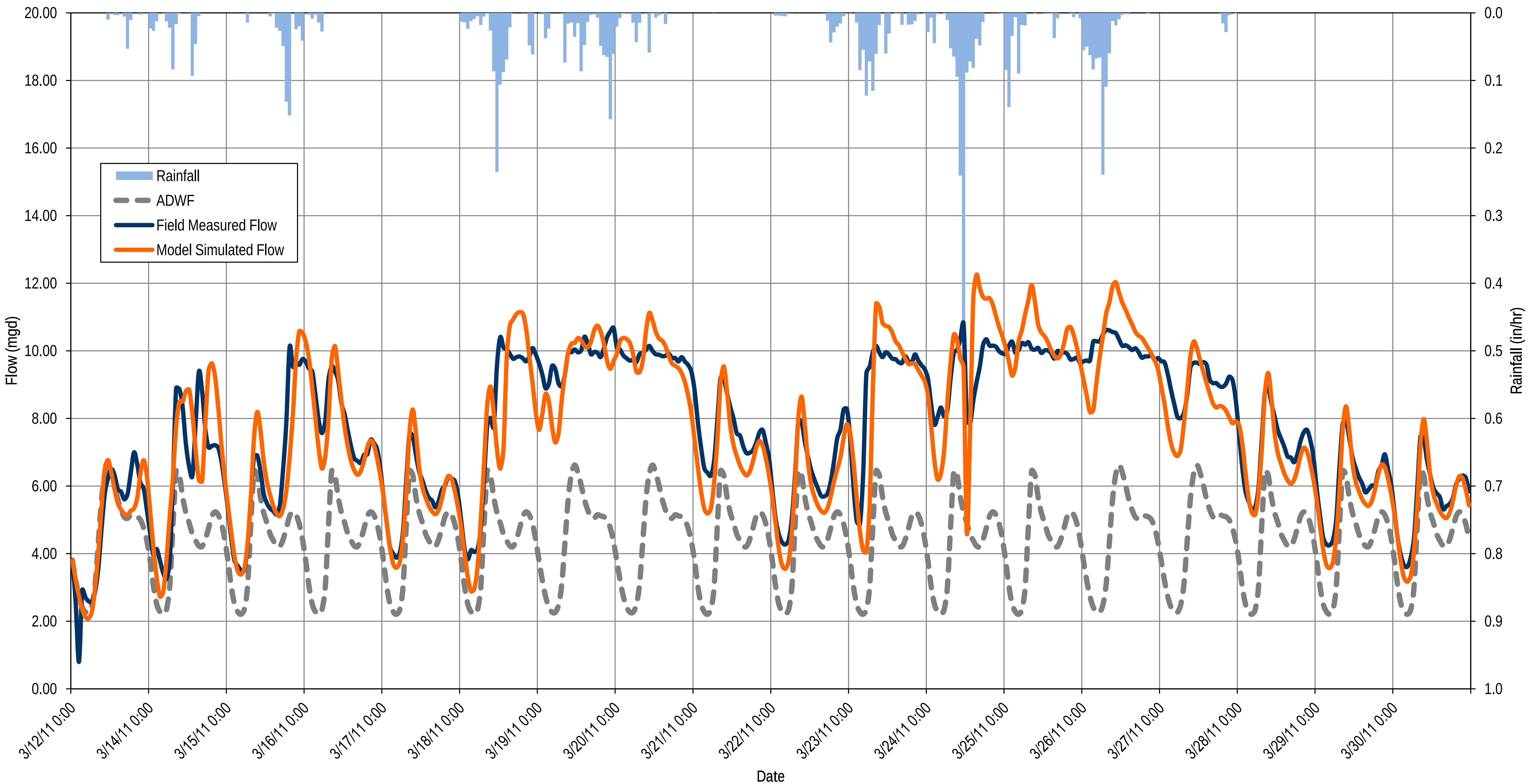
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-1 WET WEATHER CALIBRATION

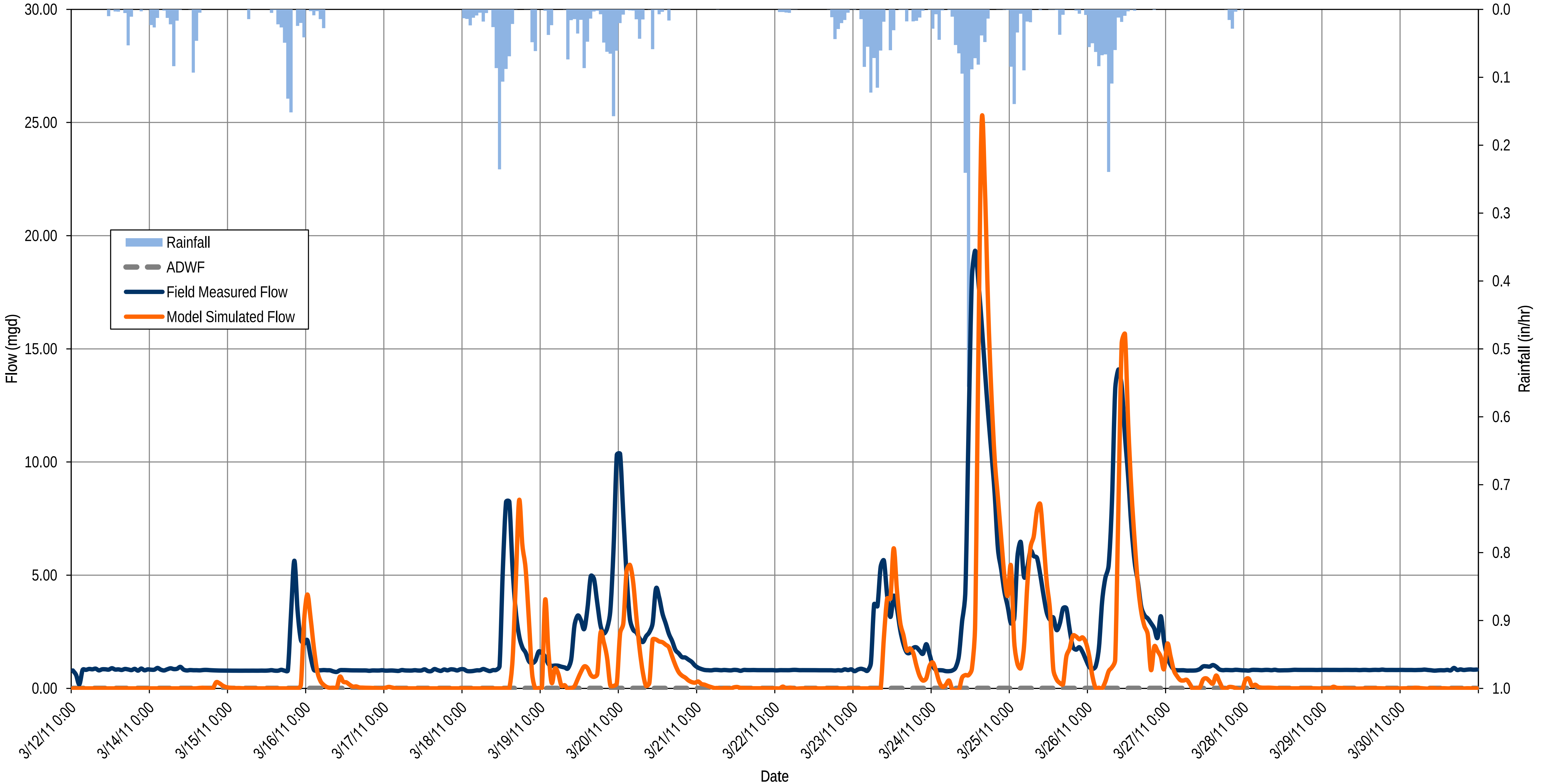


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-2 WET WEATHER CALIBRATION



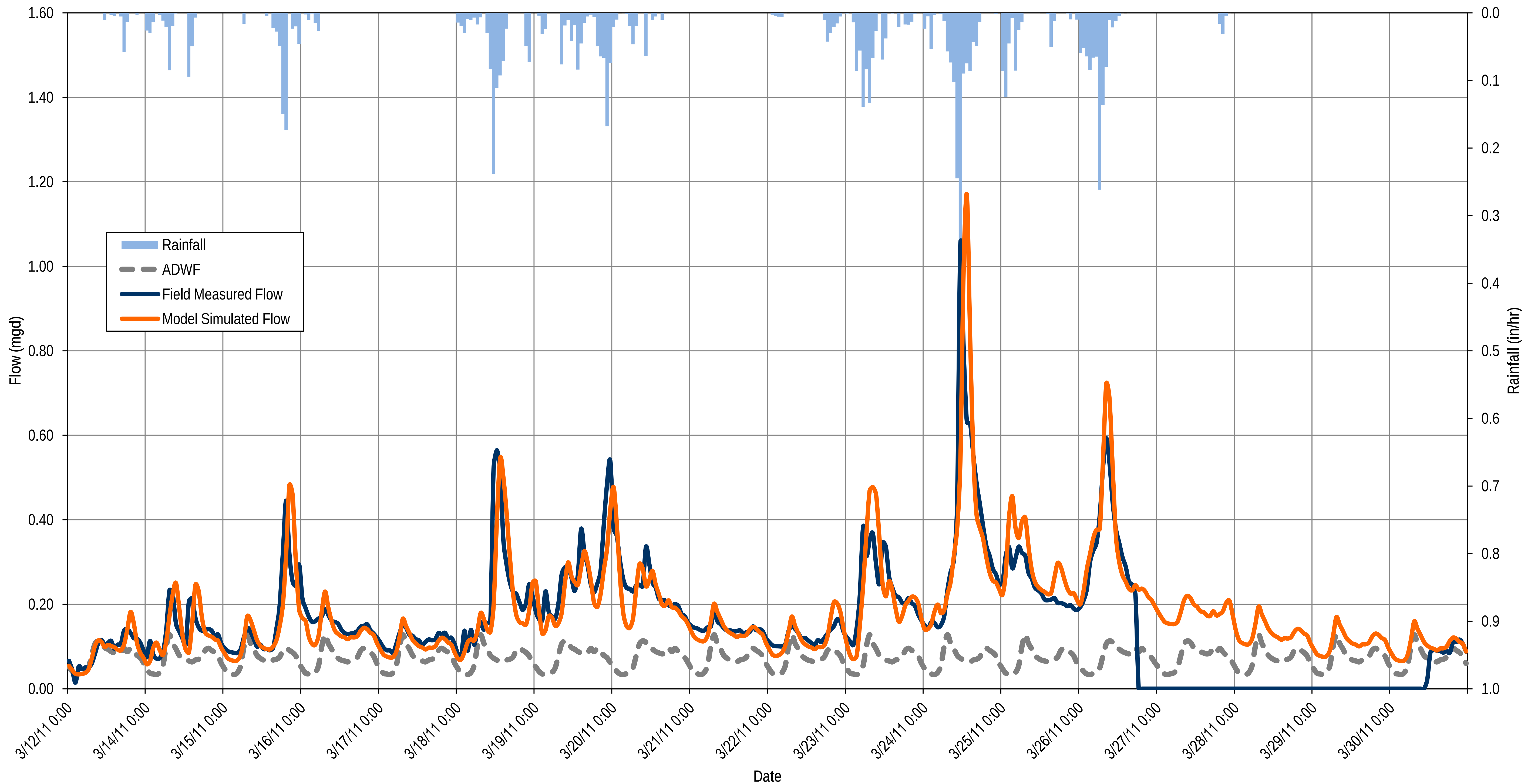
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S3 WET WEATHER CALIBRATION



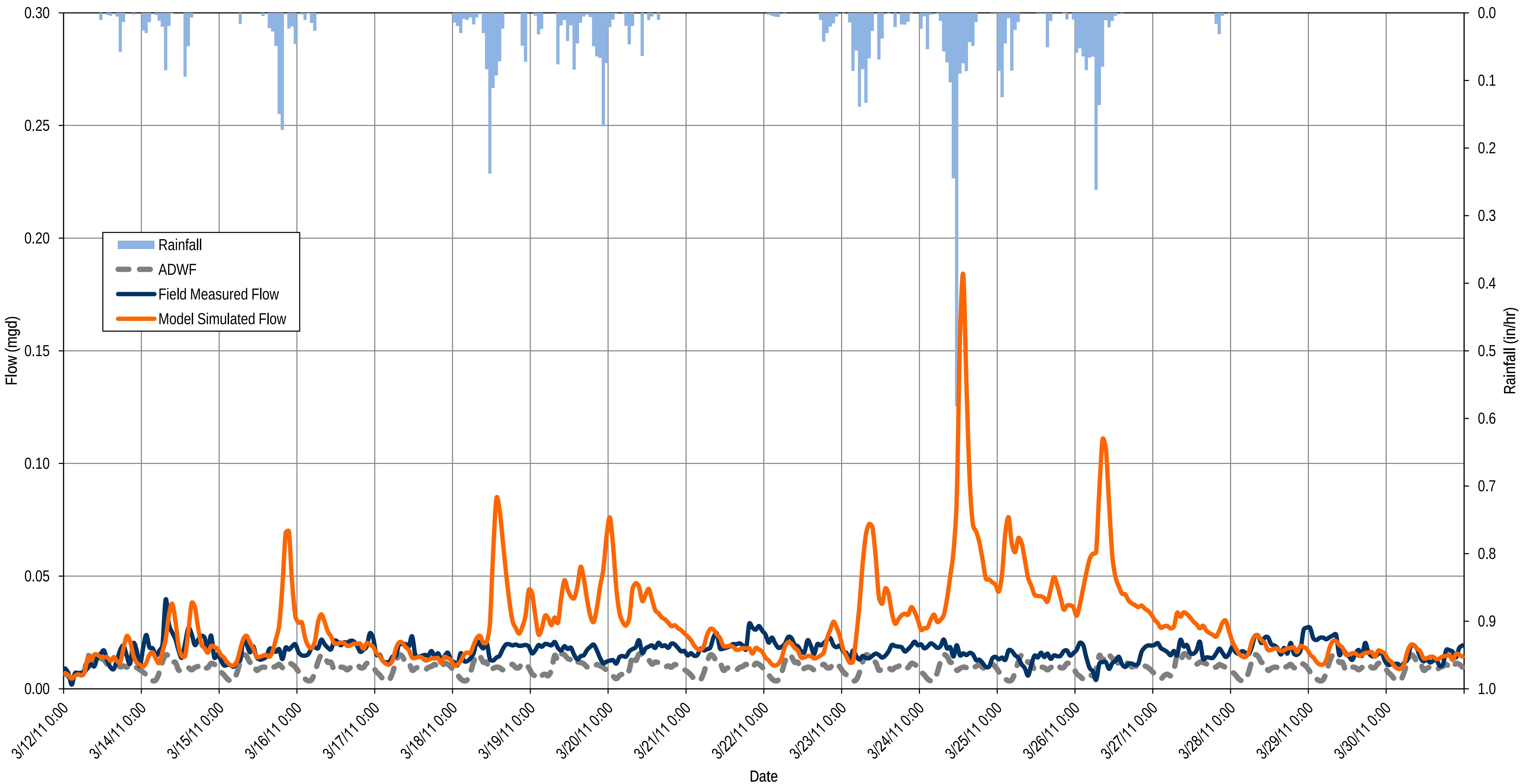
Wet Weather Flow Monitoring Comparison Chart

(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-S4 WET WEATHER CALIBRATION



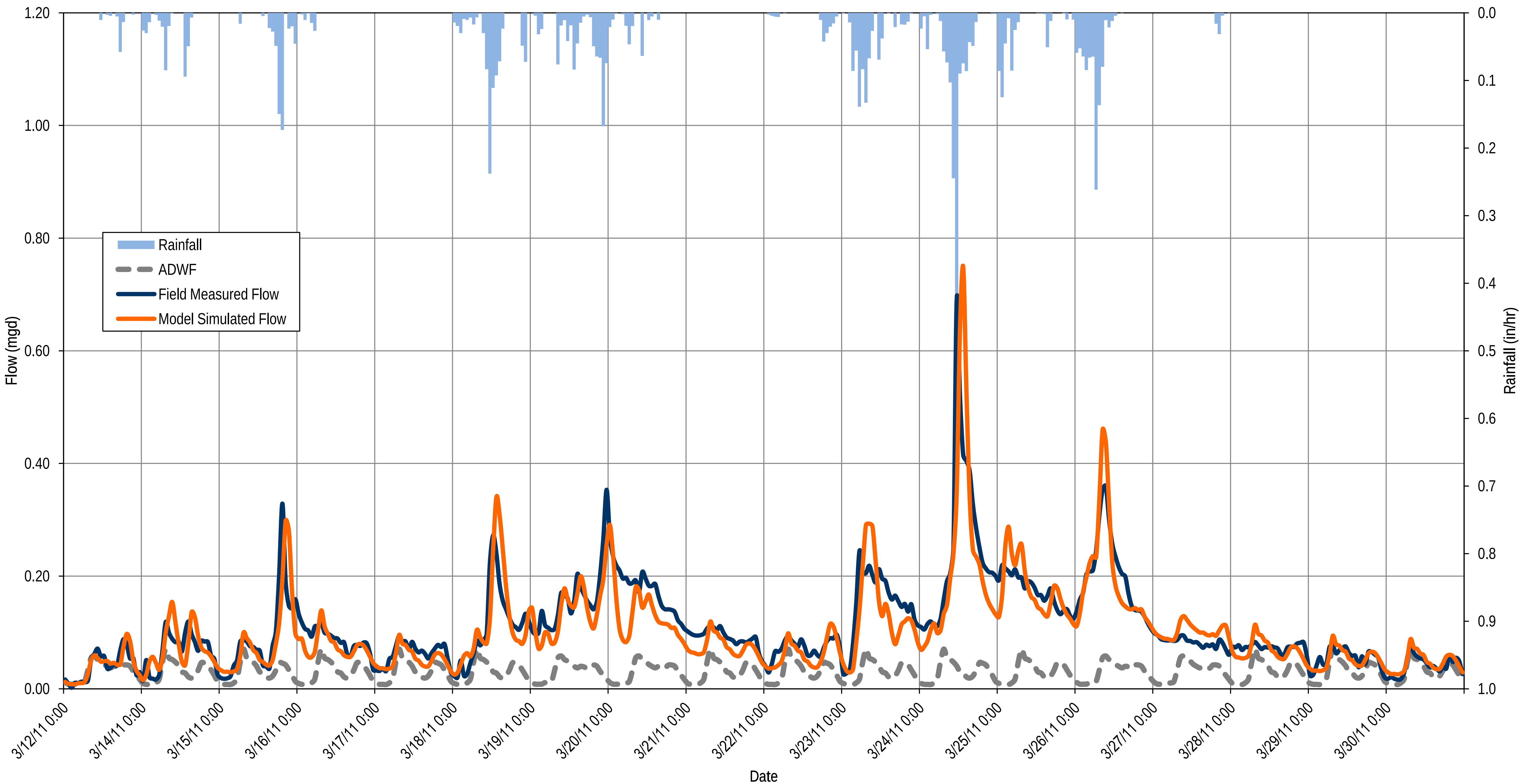
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S4A WET WEATHER CALIBRATION

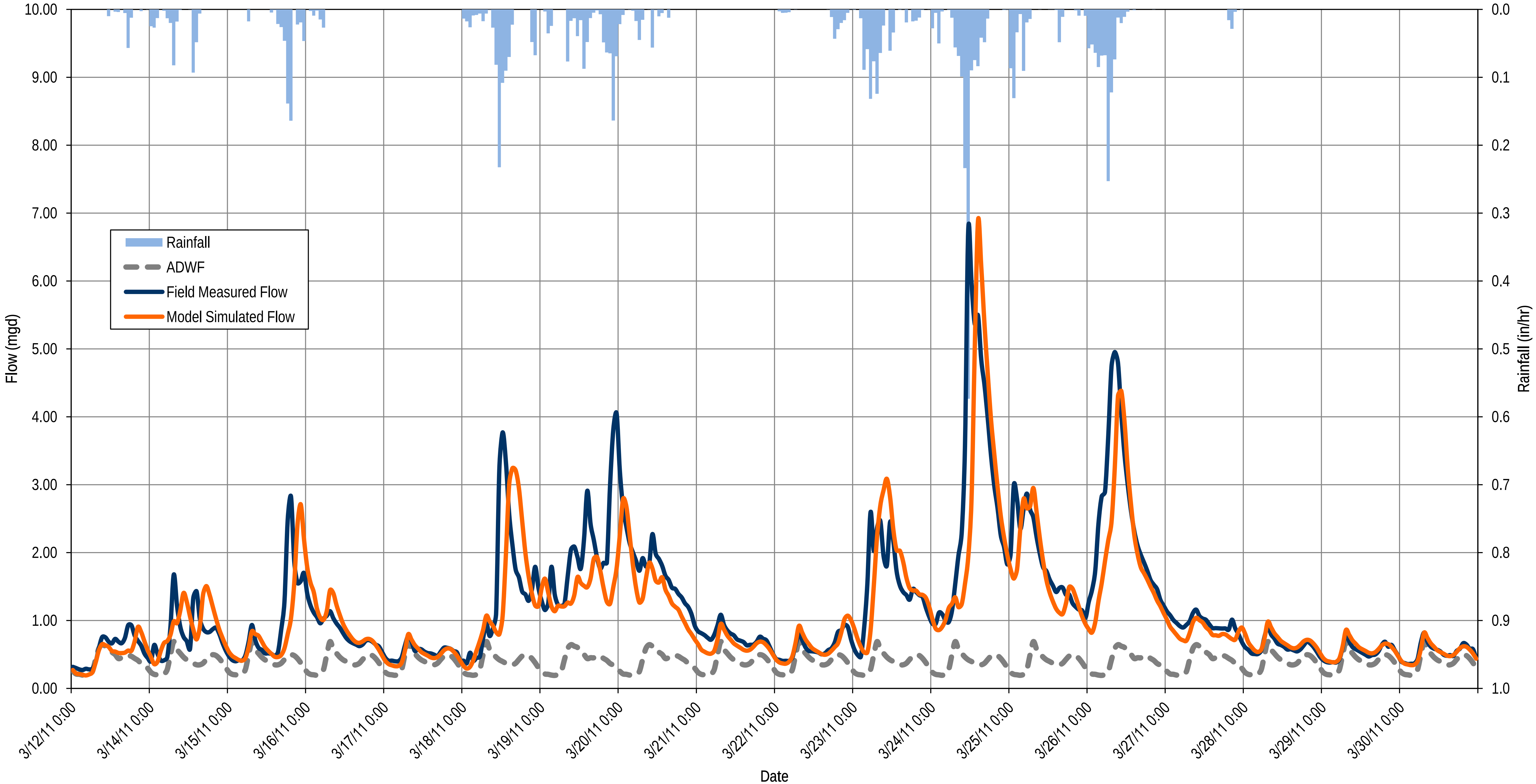


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54D WET WEATHER CALIBRATION



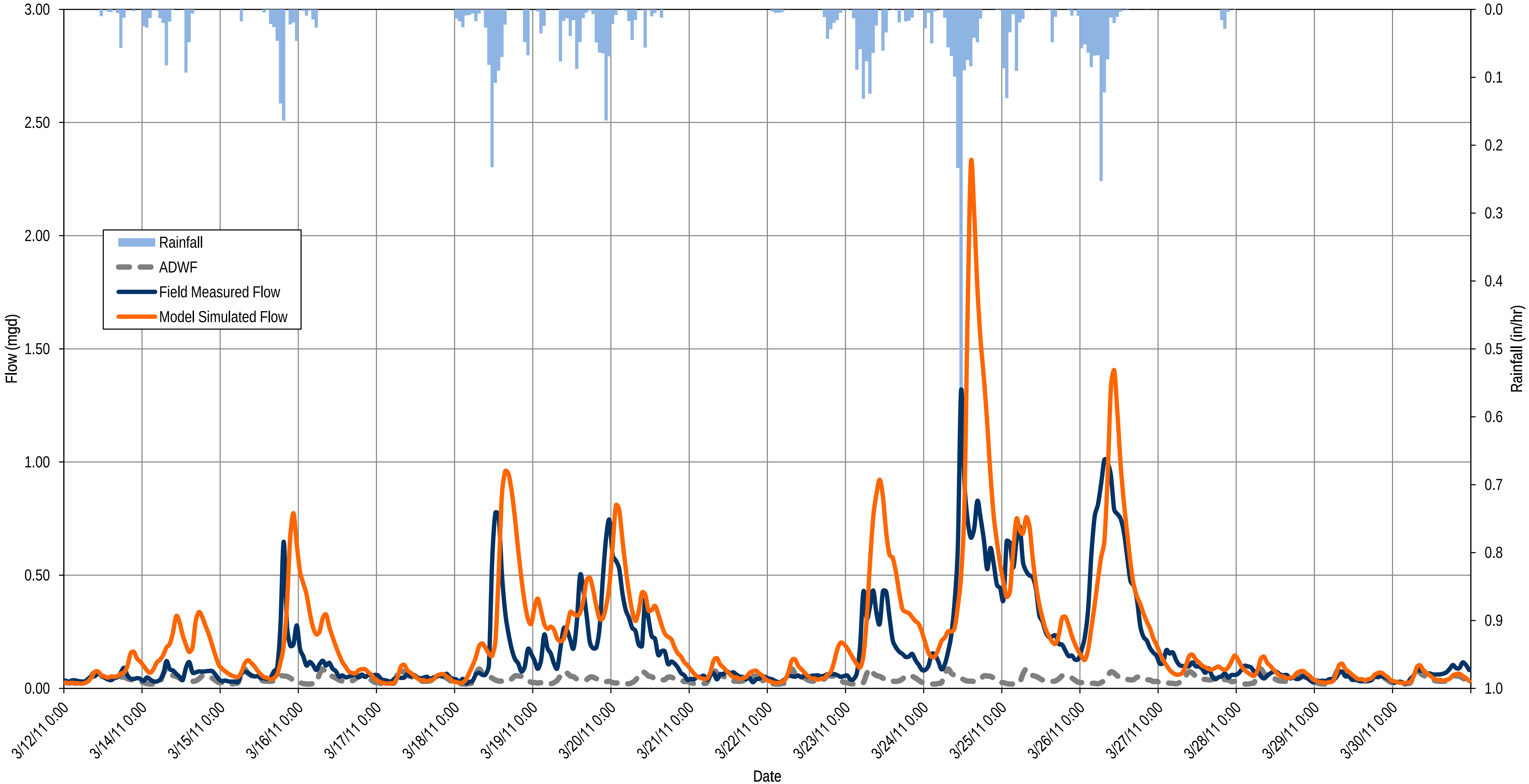
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54D.1 WET WEATHER CALIBRATION

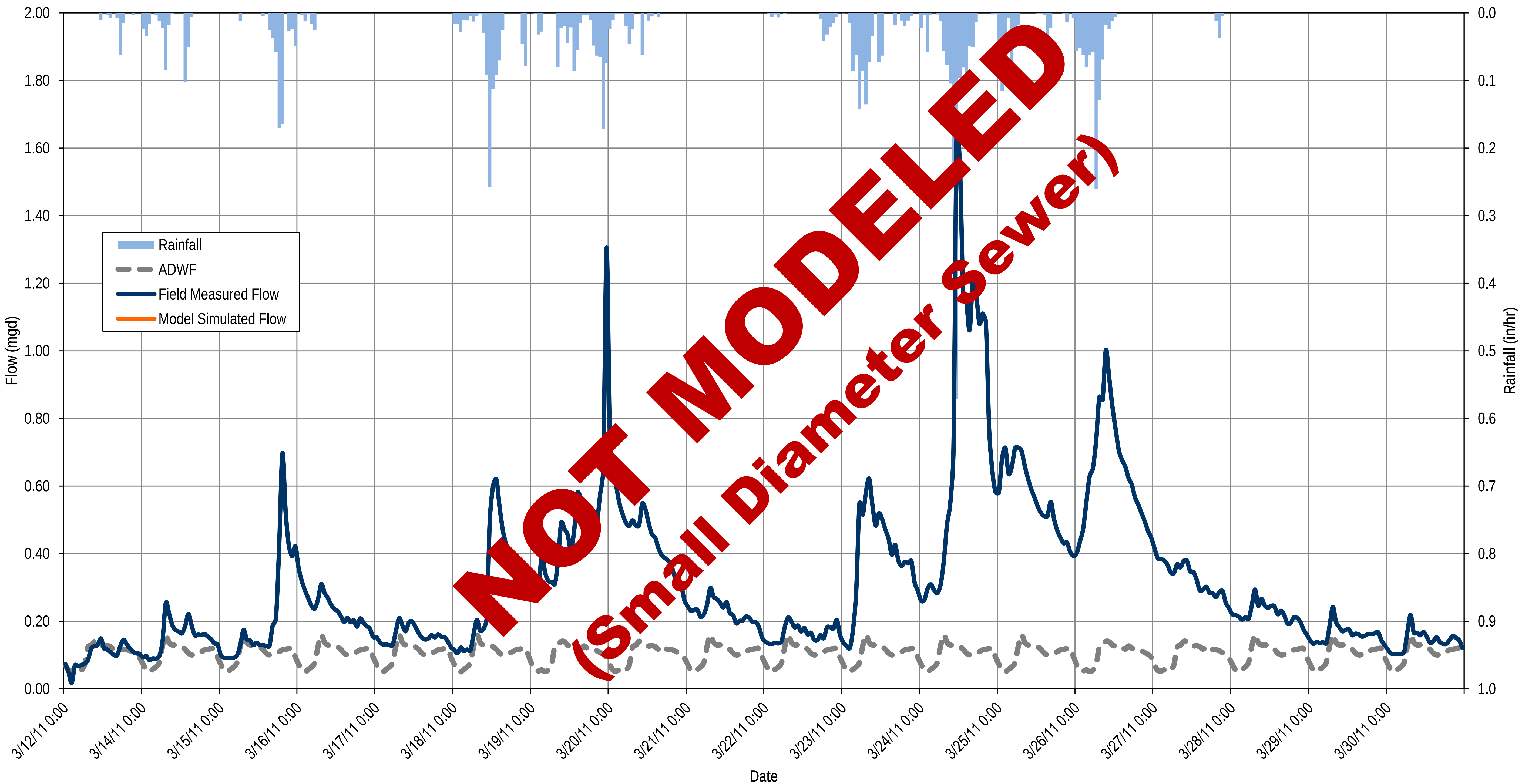


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

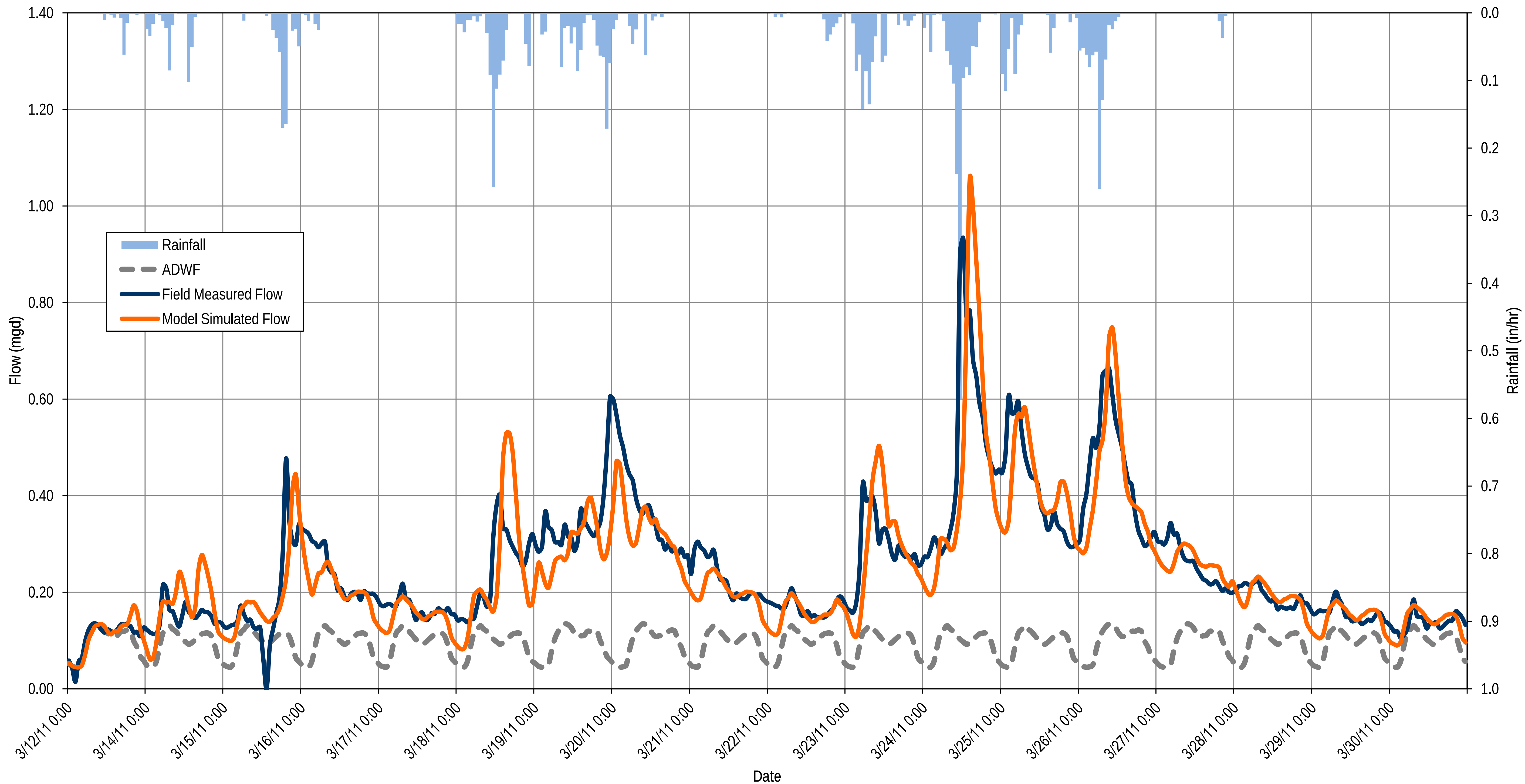
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-S5 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54-S6 WET WEATHER CALIBRATION



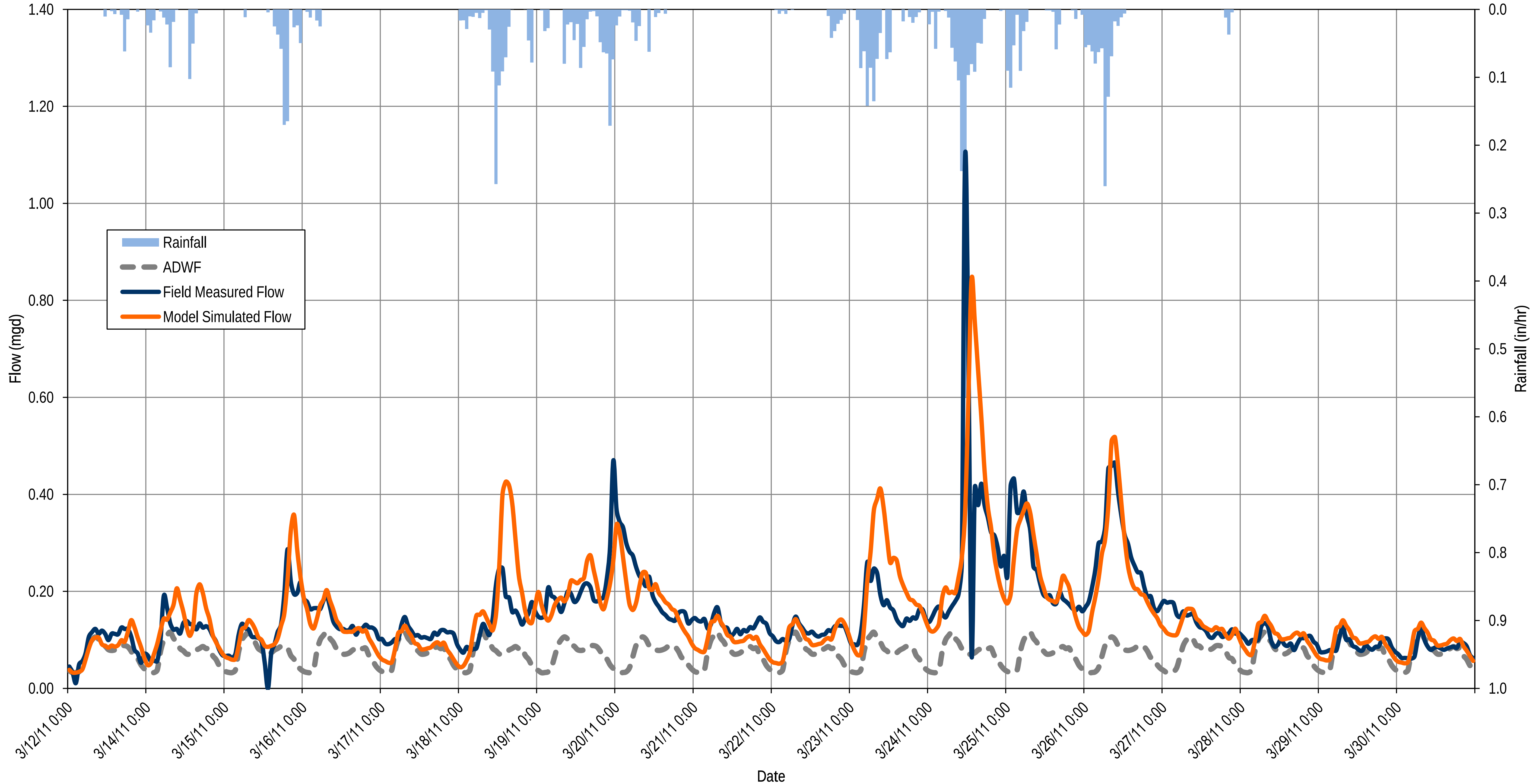
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S7 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

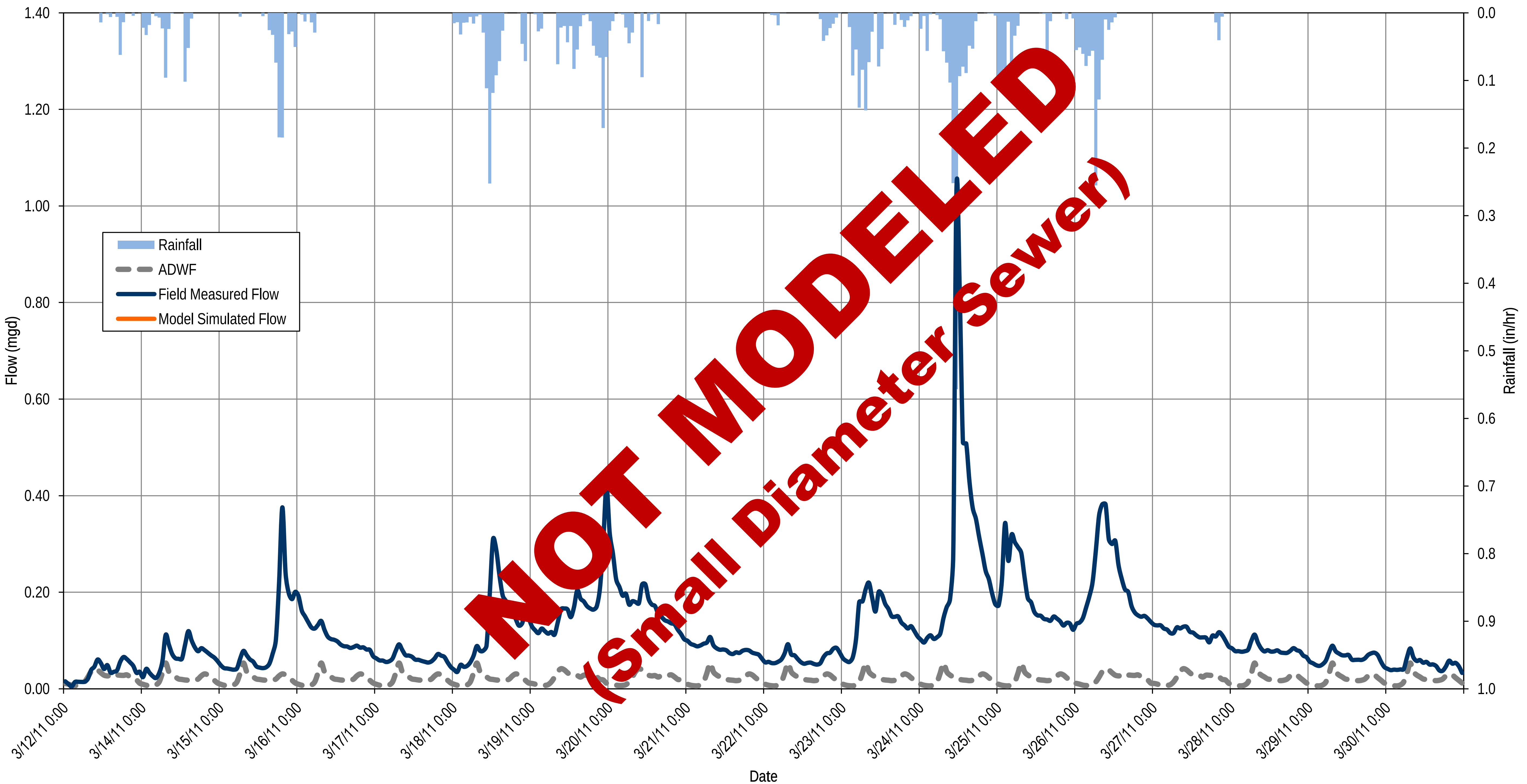
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S8 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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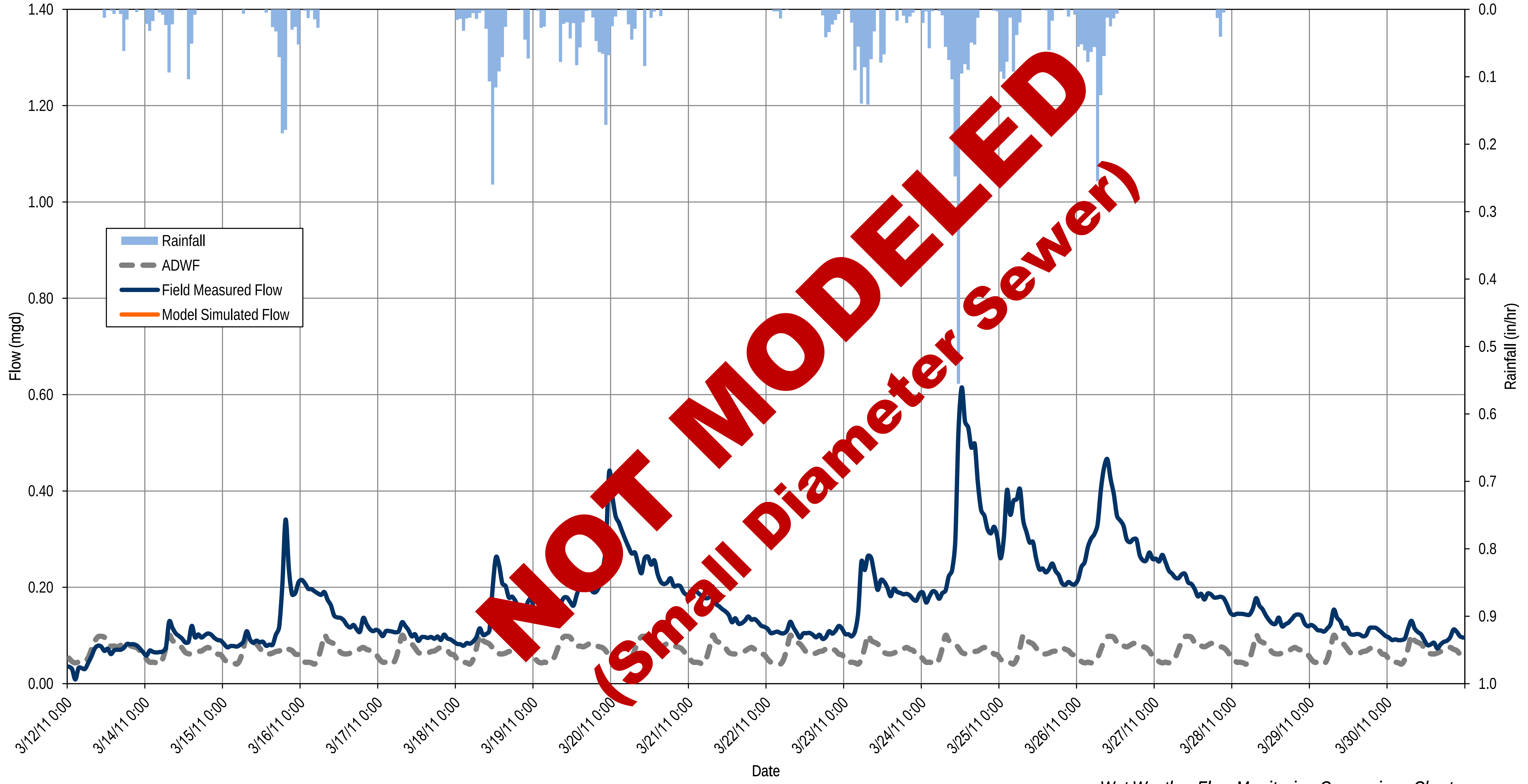
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54-S9 WET WEATHER CALIBRATION

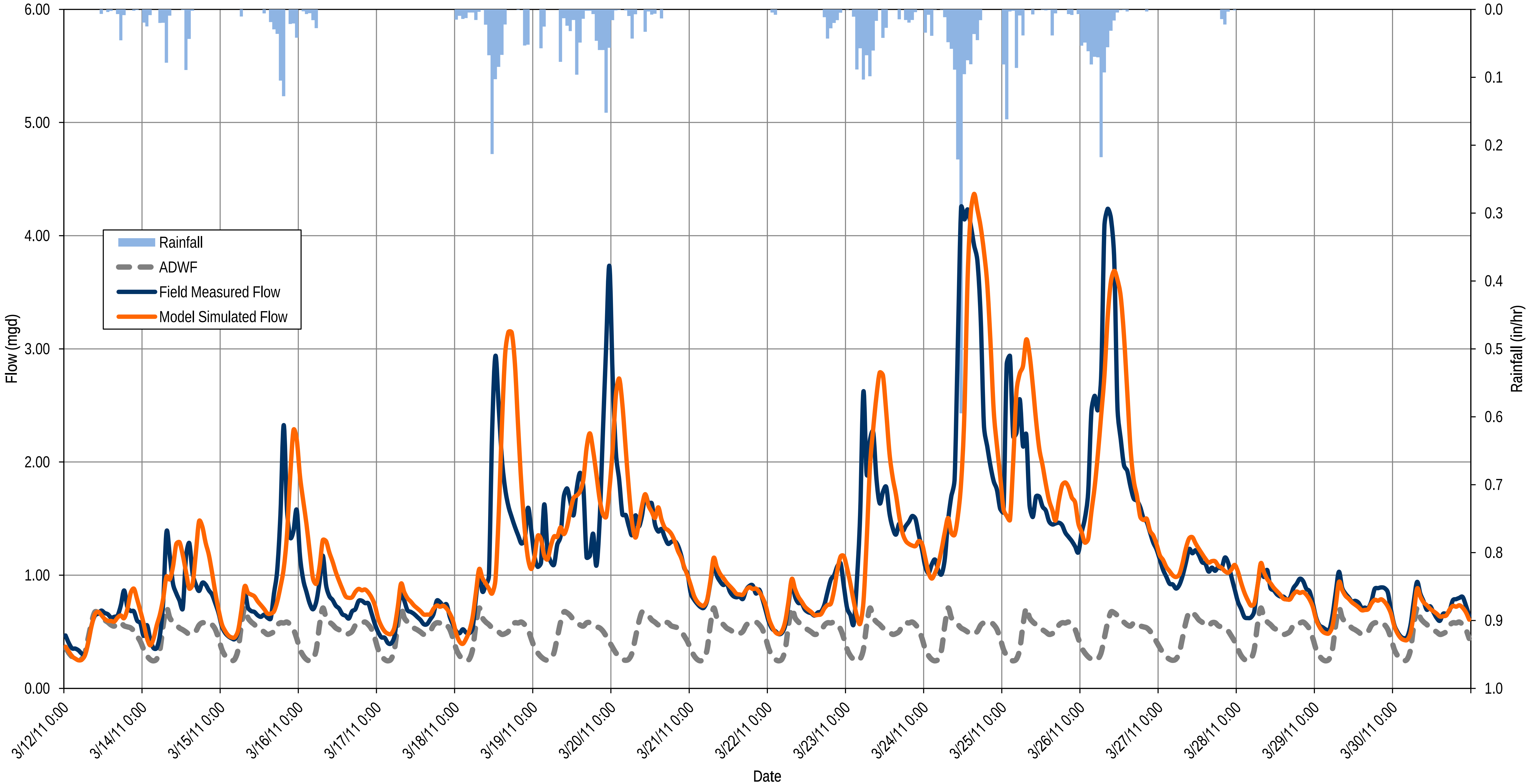


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54A WET WEATHER CALIBRATION



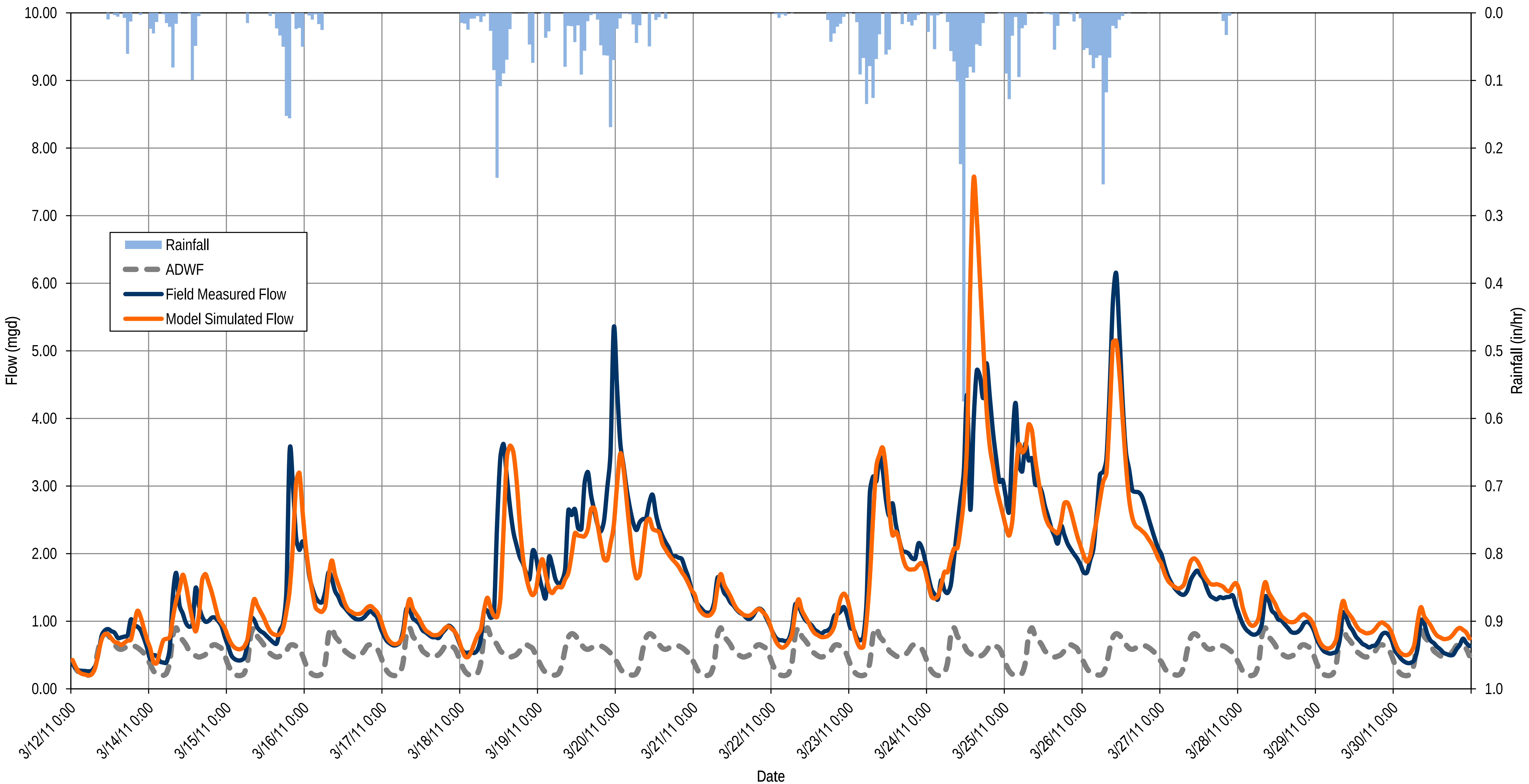
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 54C WET WEATHER CALIBRATION

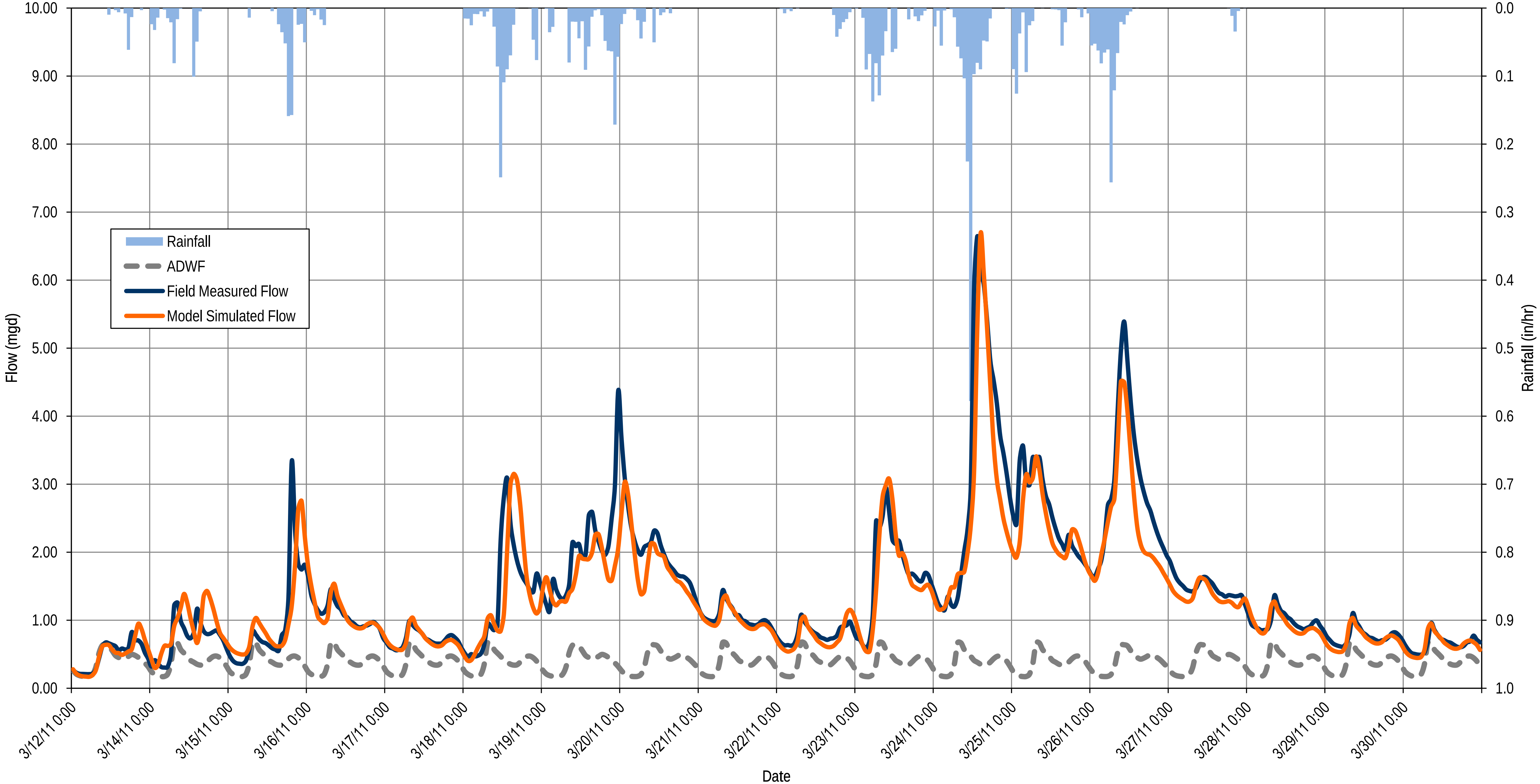


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 54C.1 WET WEATHER CALIBRATION



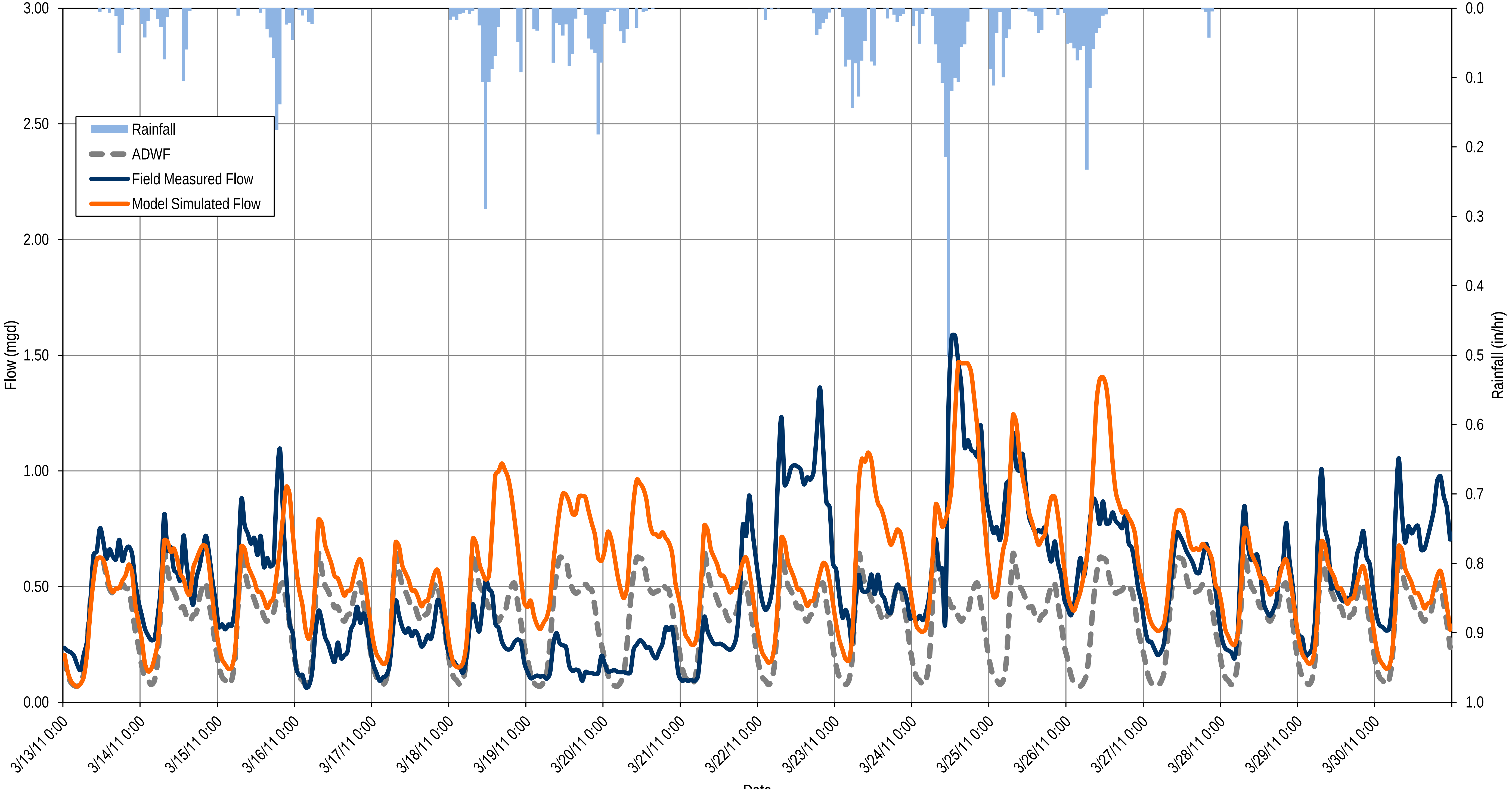
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_54.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56A WET WEATHER CALIBRATION

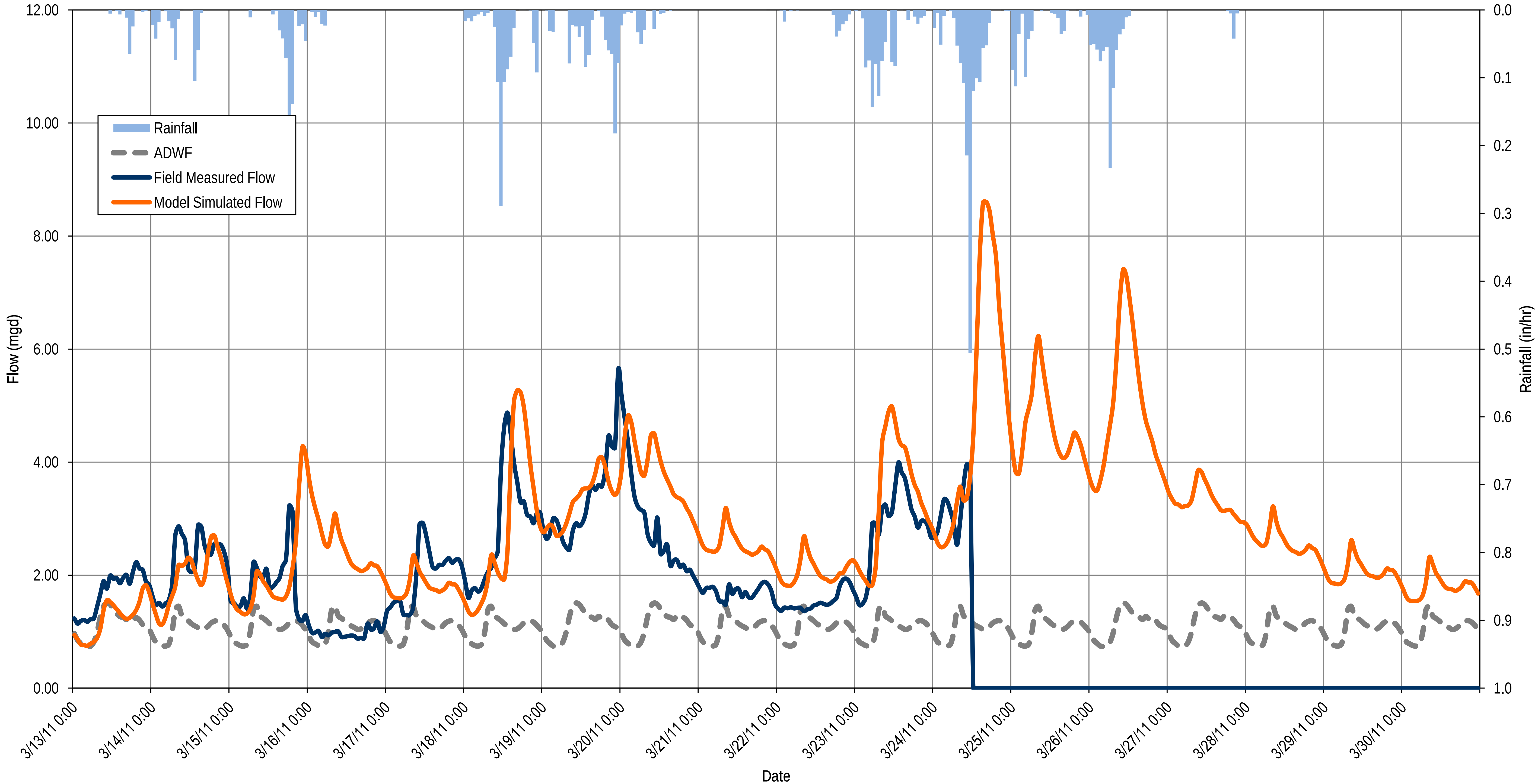


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 56A.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

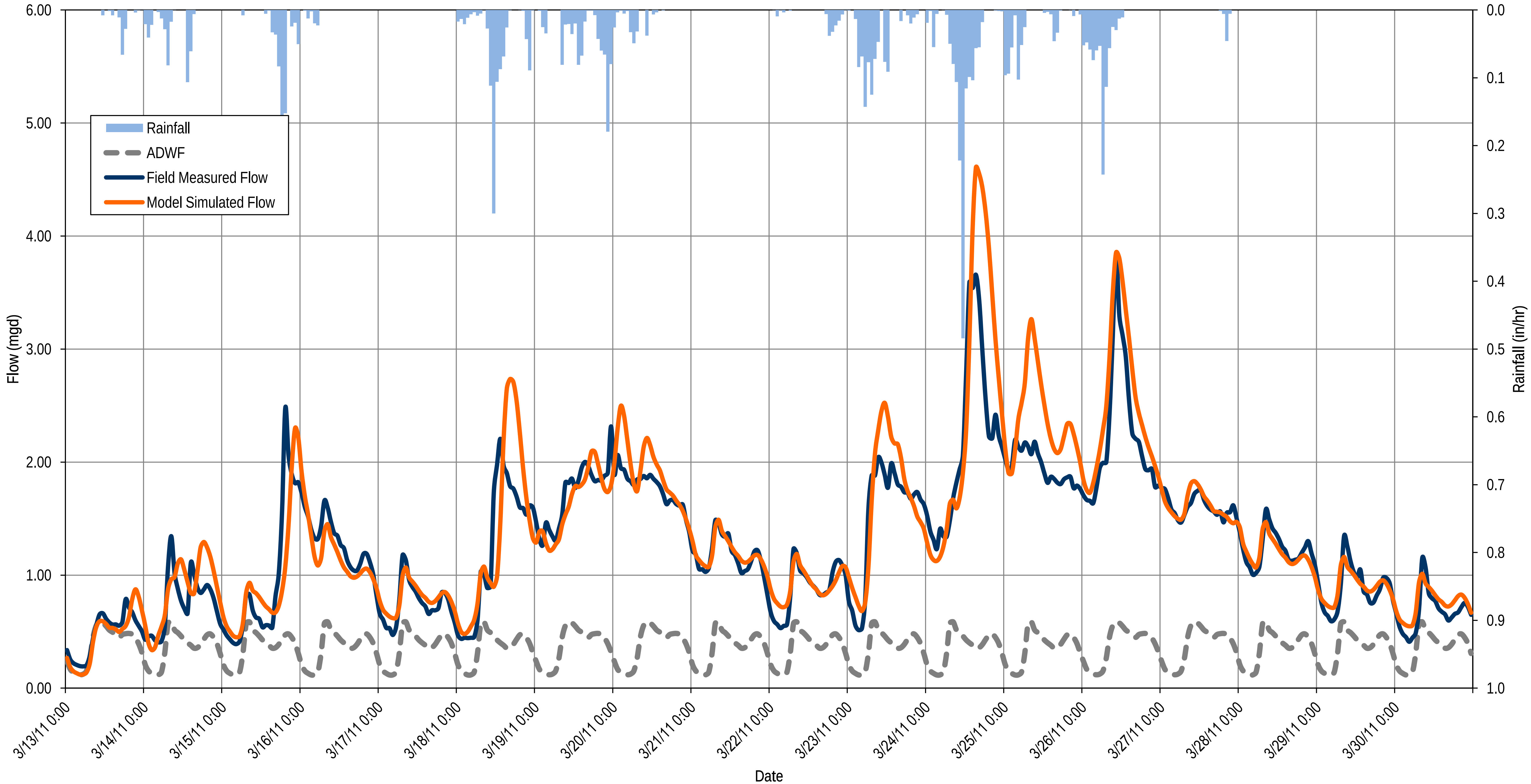
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

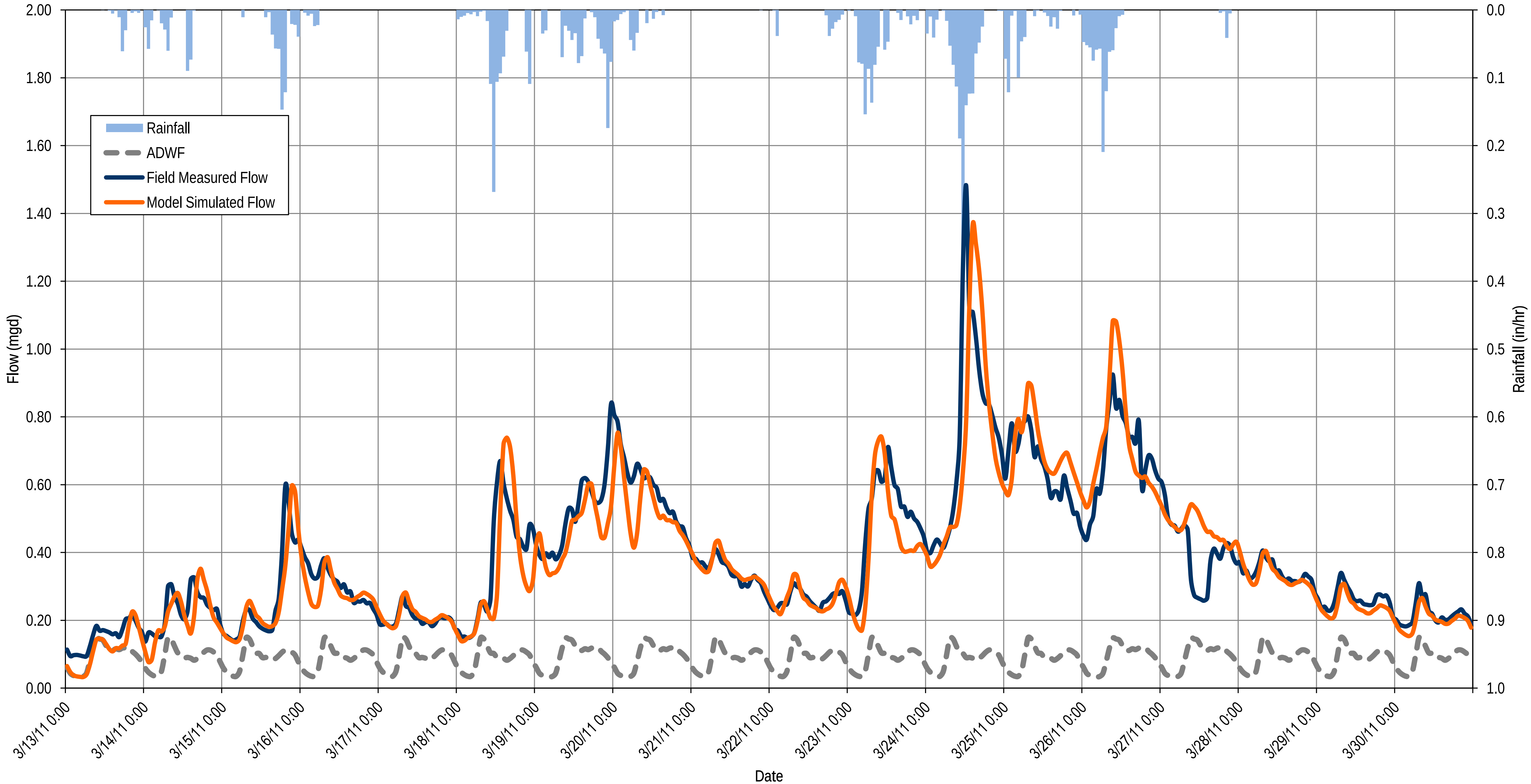
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56C WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart

(3/13/2011 - 3/30/2011 Rainfall Event)

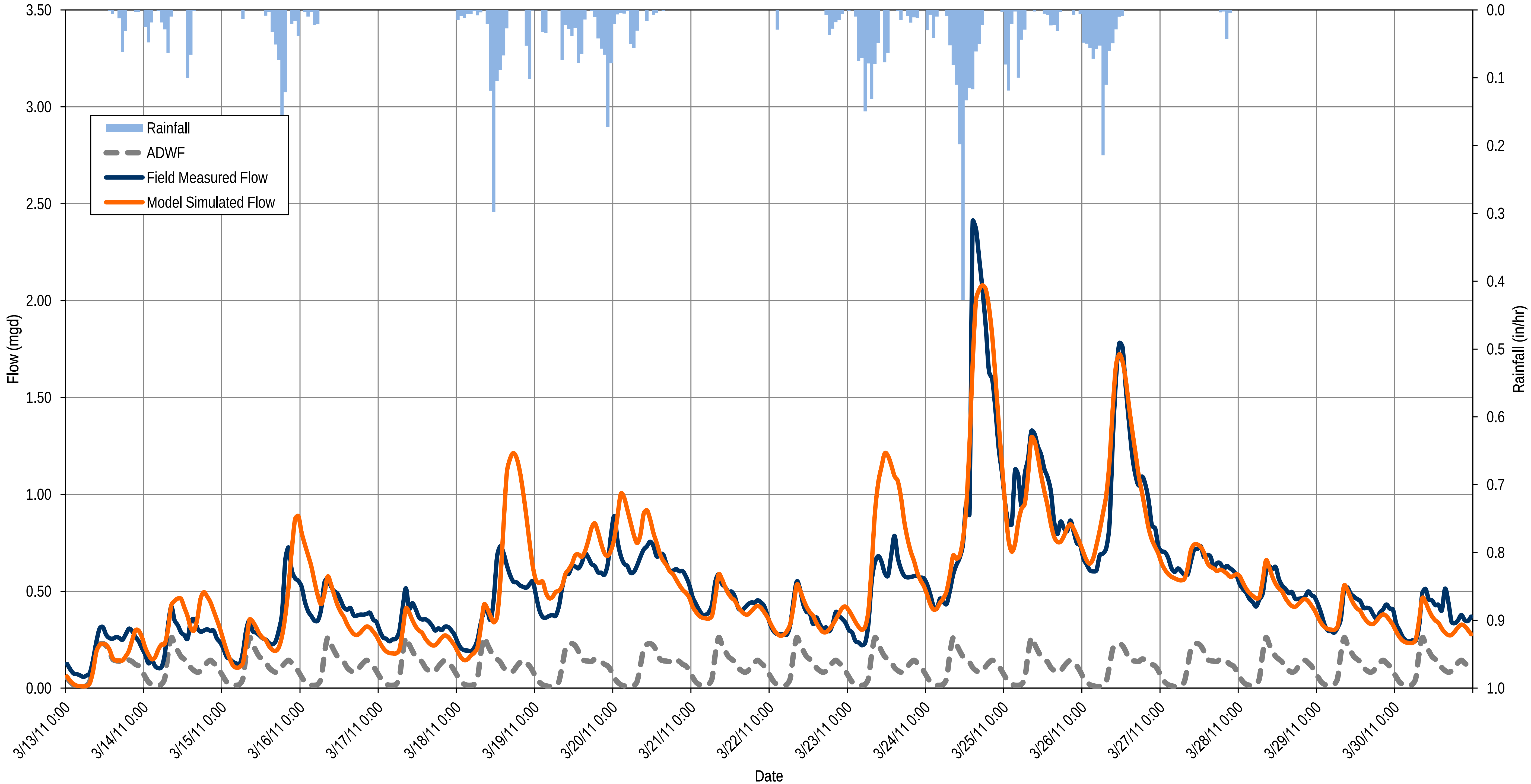
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56D WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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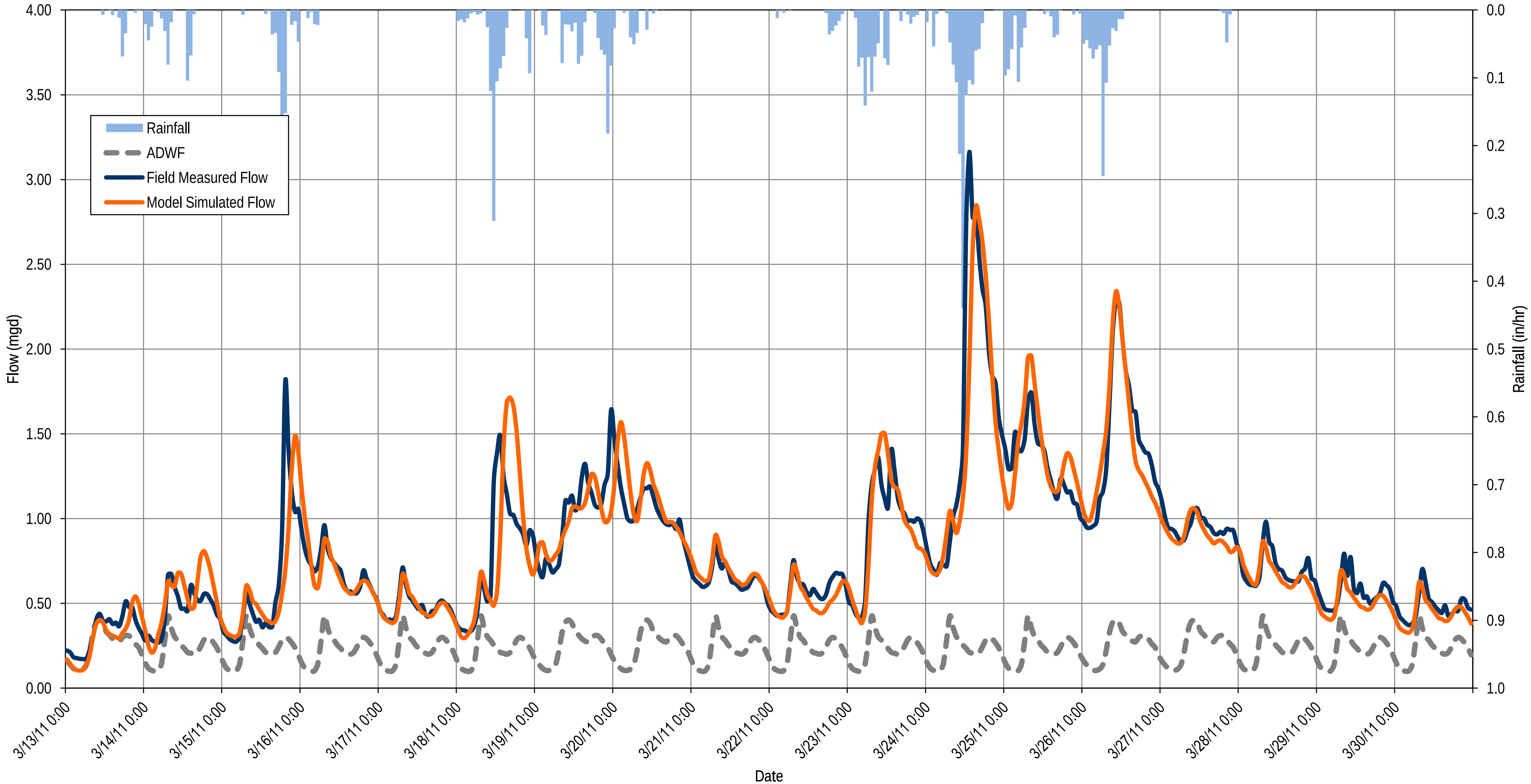
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 56E WET WEATHER CALIBRATION

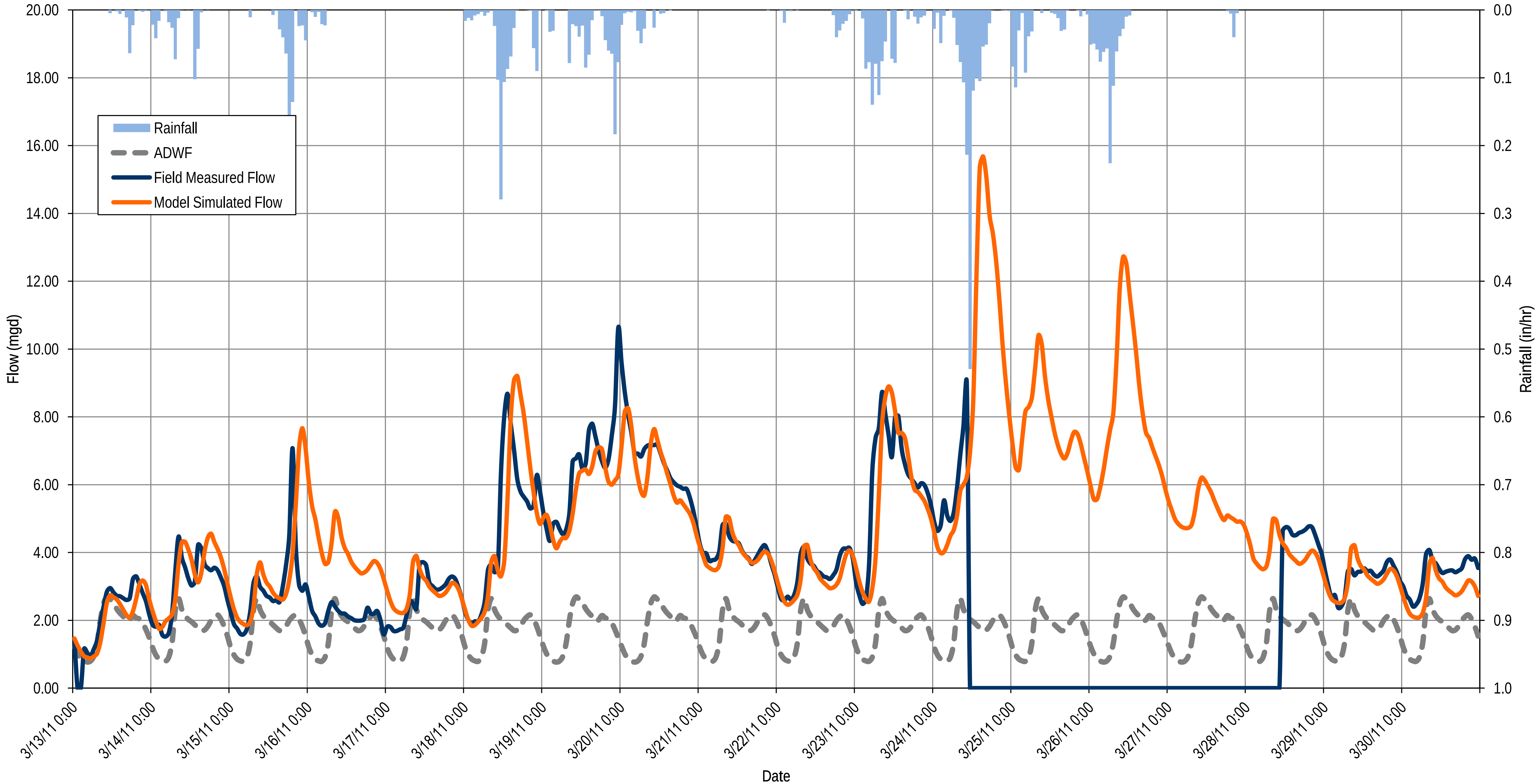


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 56-1 WET WEATHER CALIBRATION



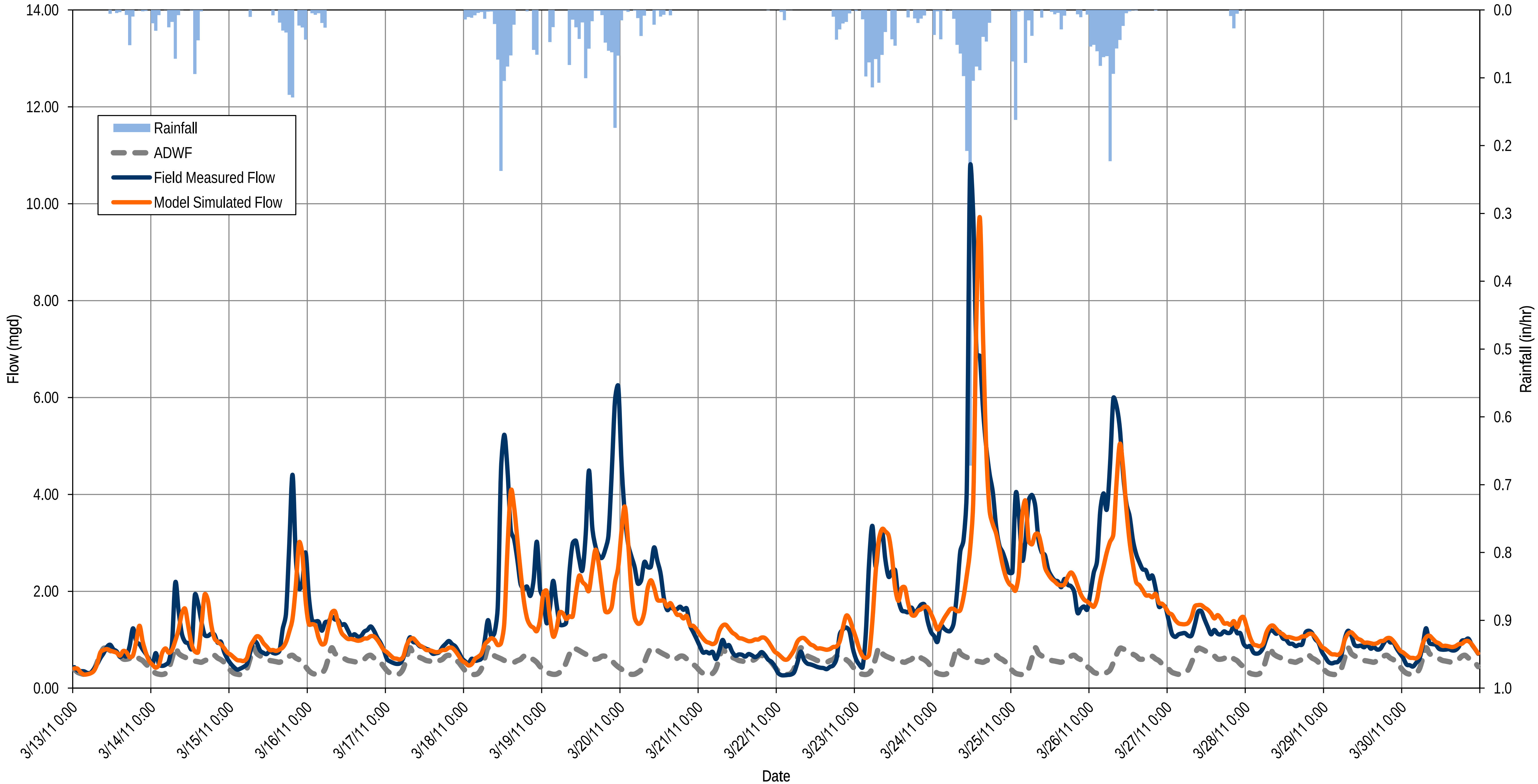
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_56.xlsb

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

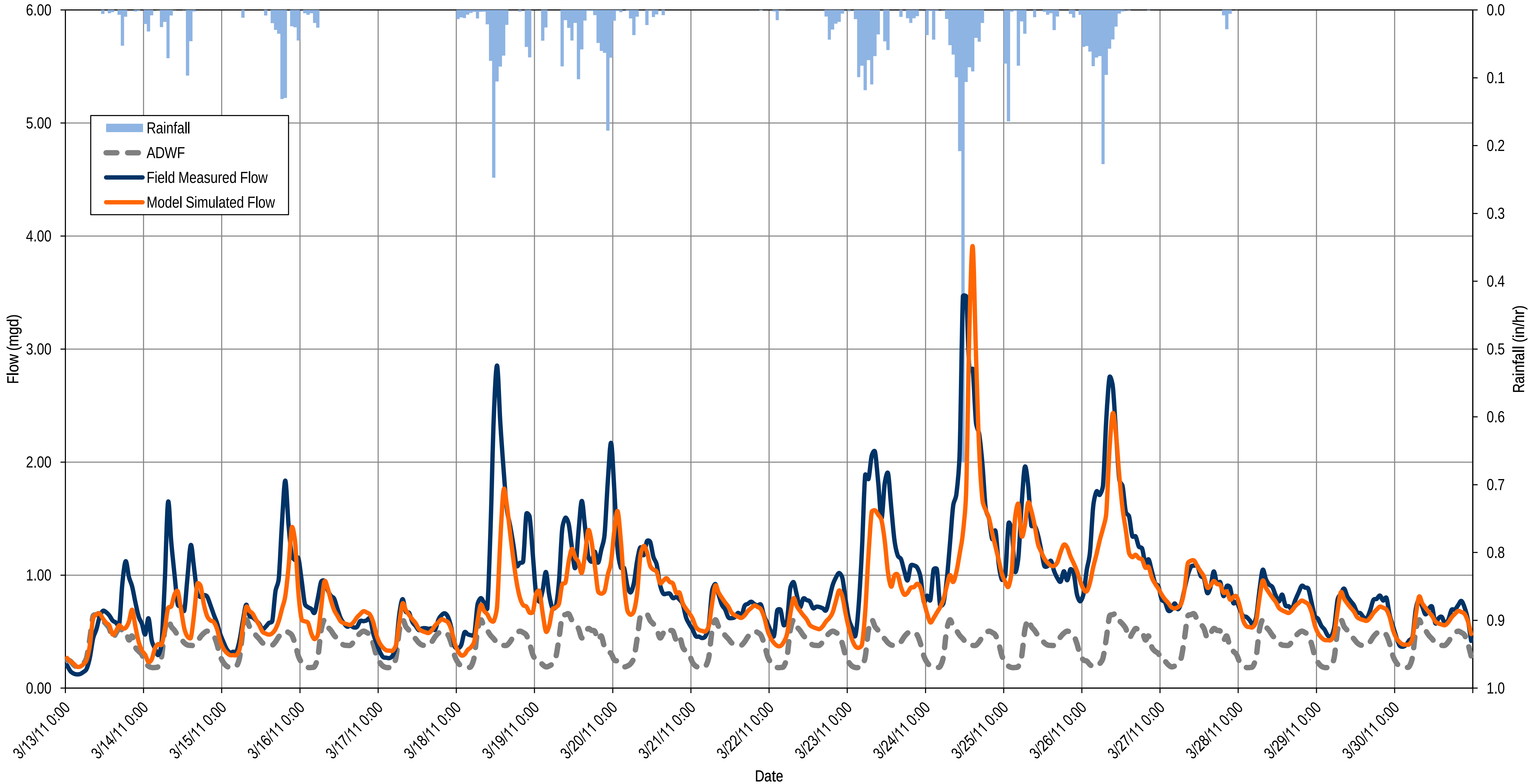
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_58.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58B WET WEATHER CALIBRATION

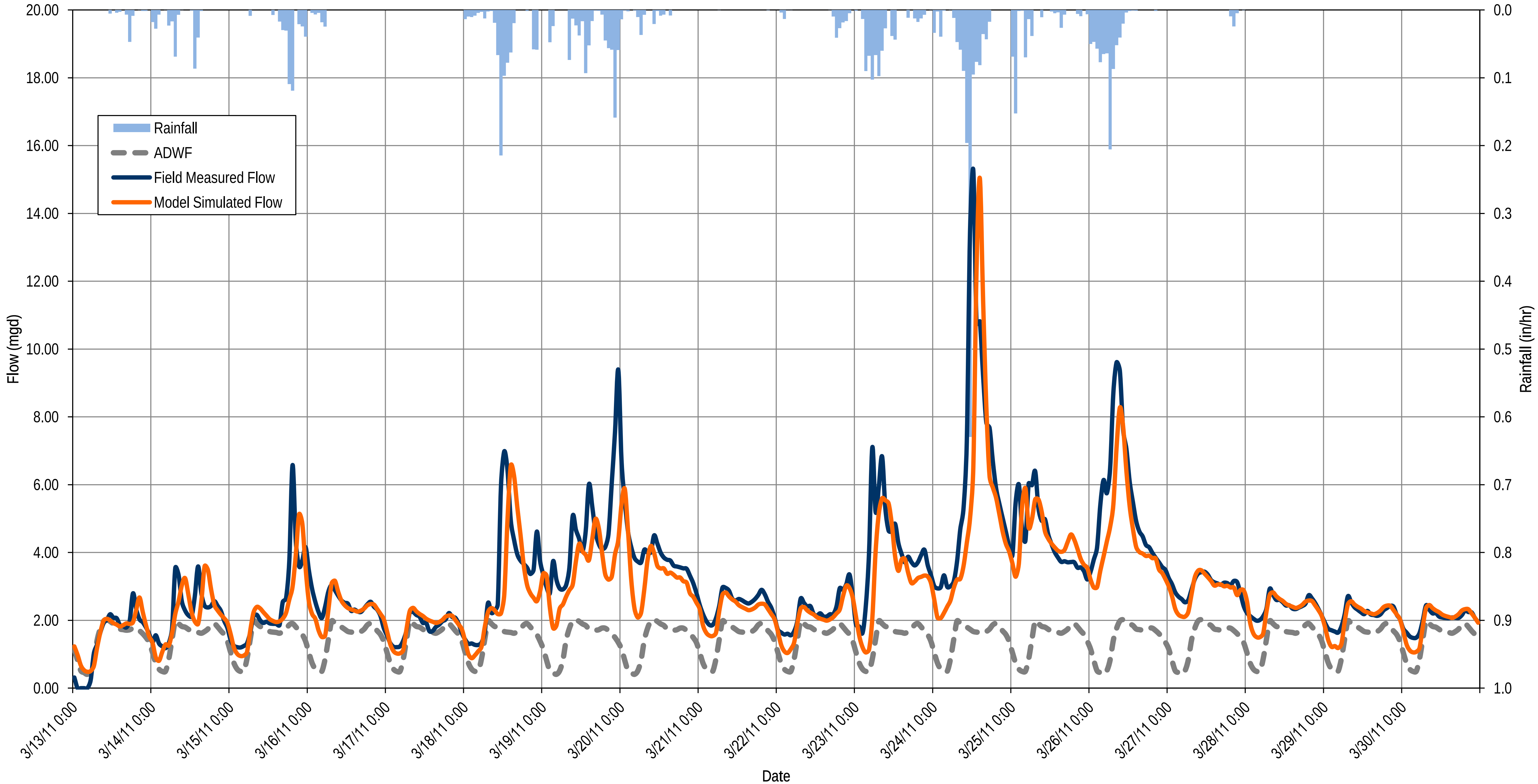


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 58-1 WET WEATHER CALIBRATION

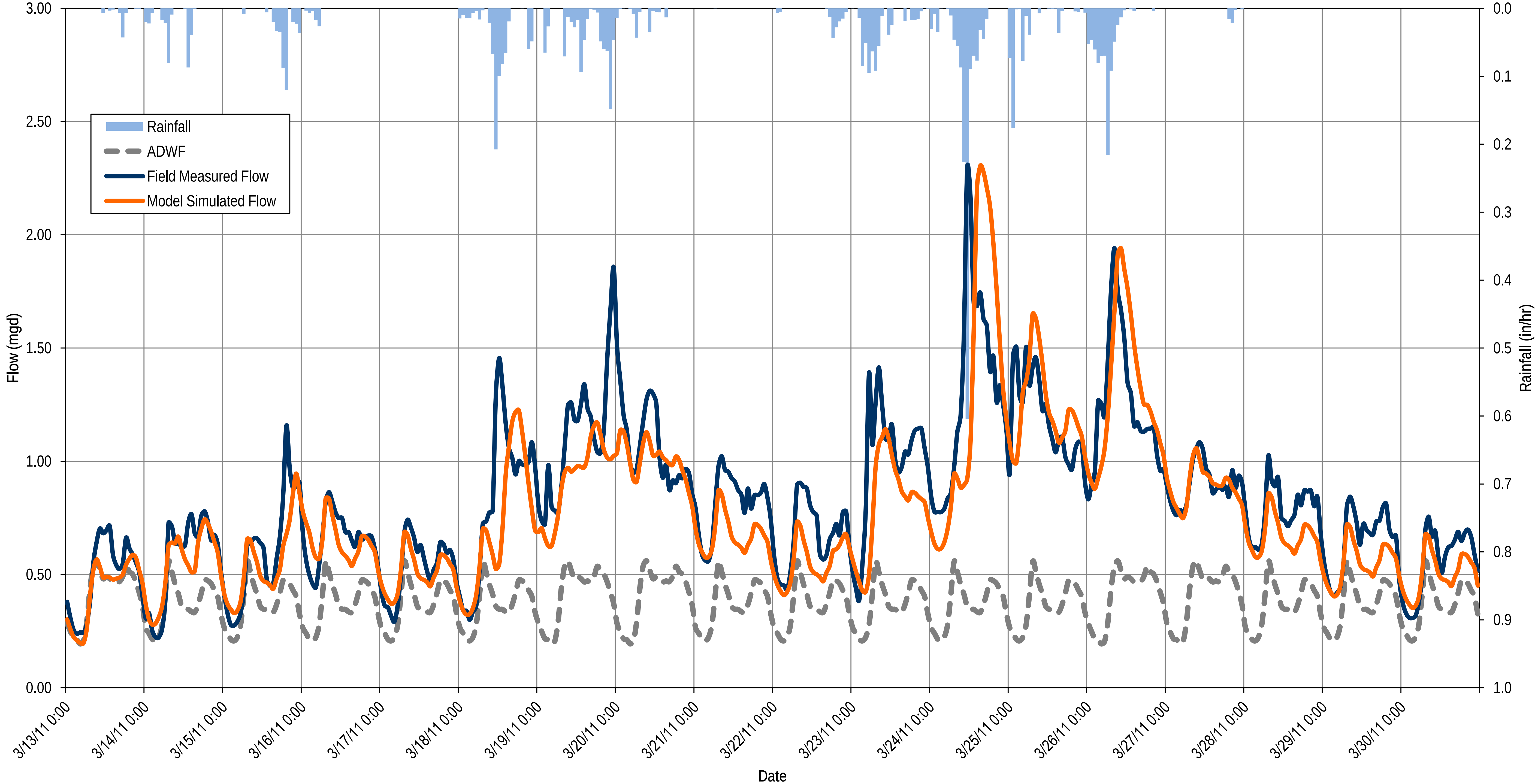


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_58.xlsx

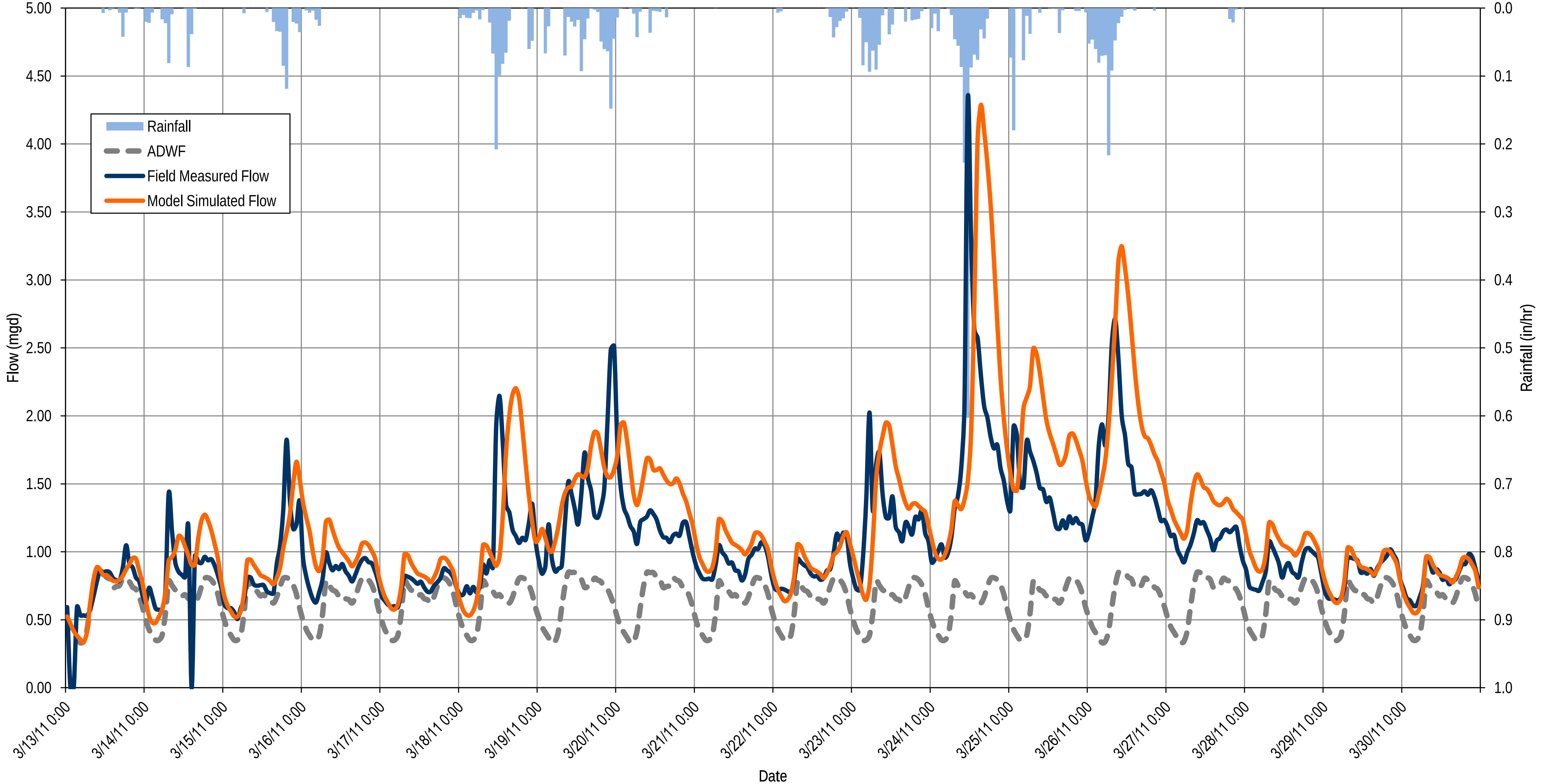
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 59A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_59.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 59-1 WET WEATHER CALIBRATION



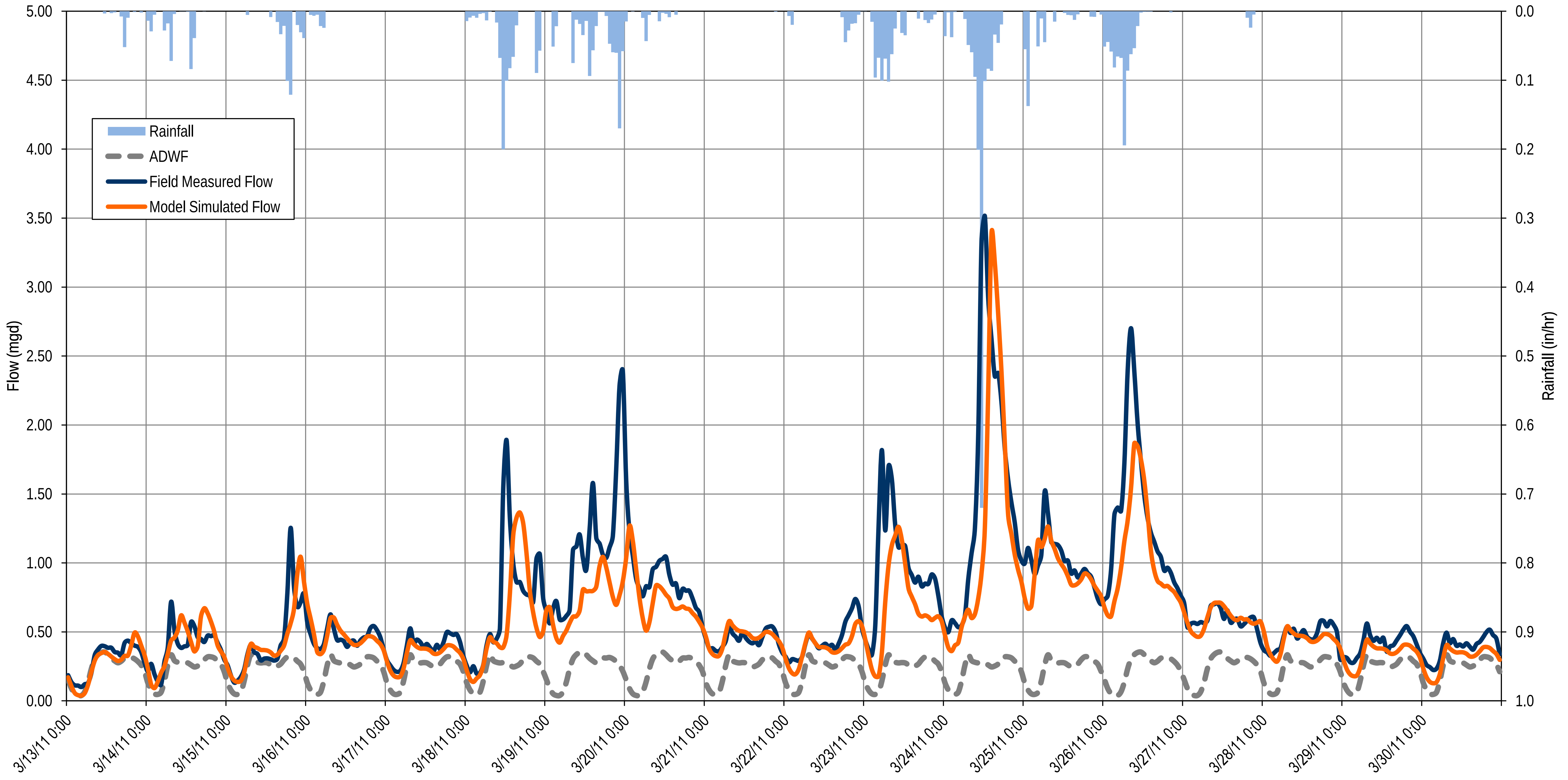
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_59.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

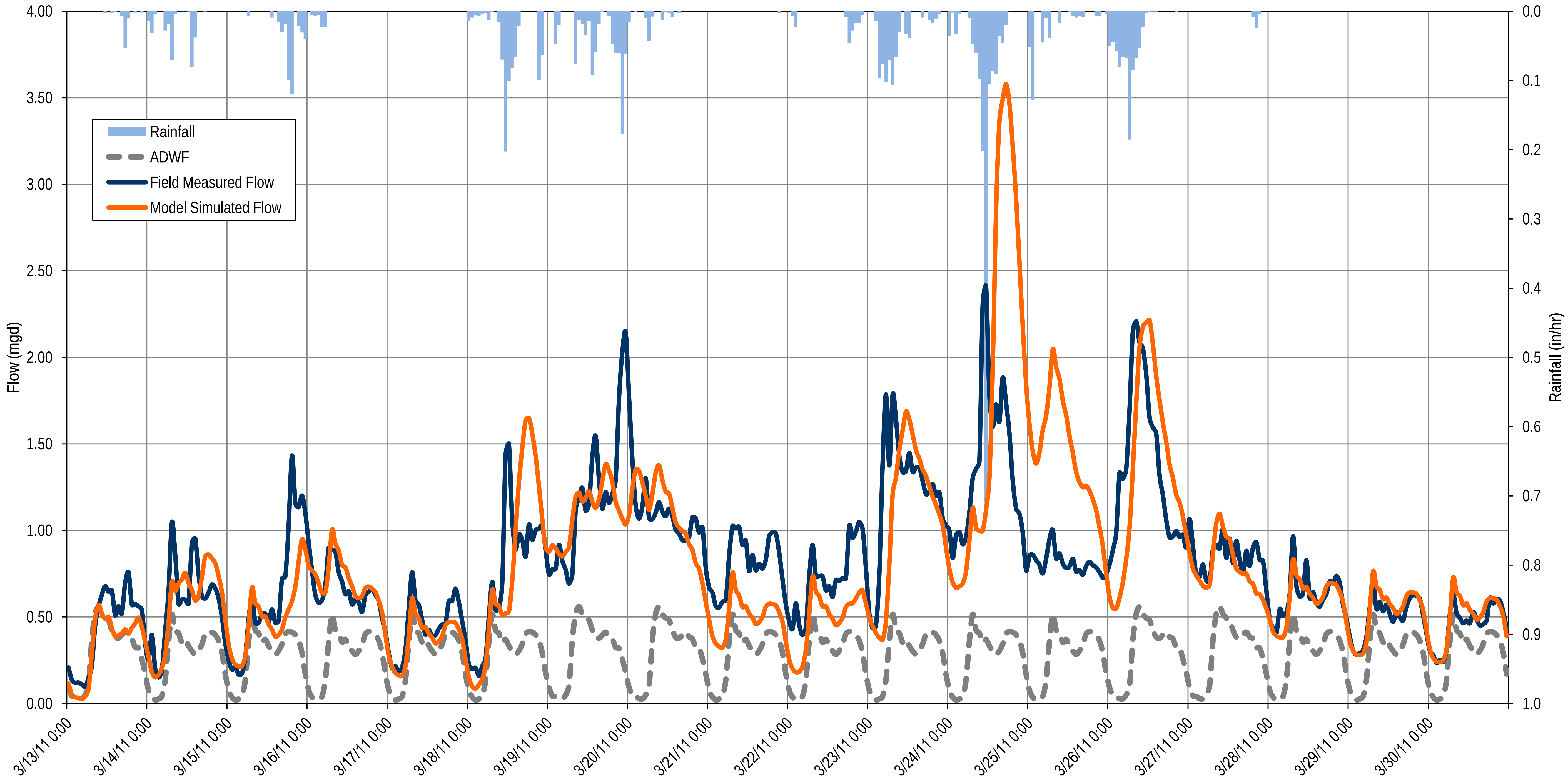
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_60.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

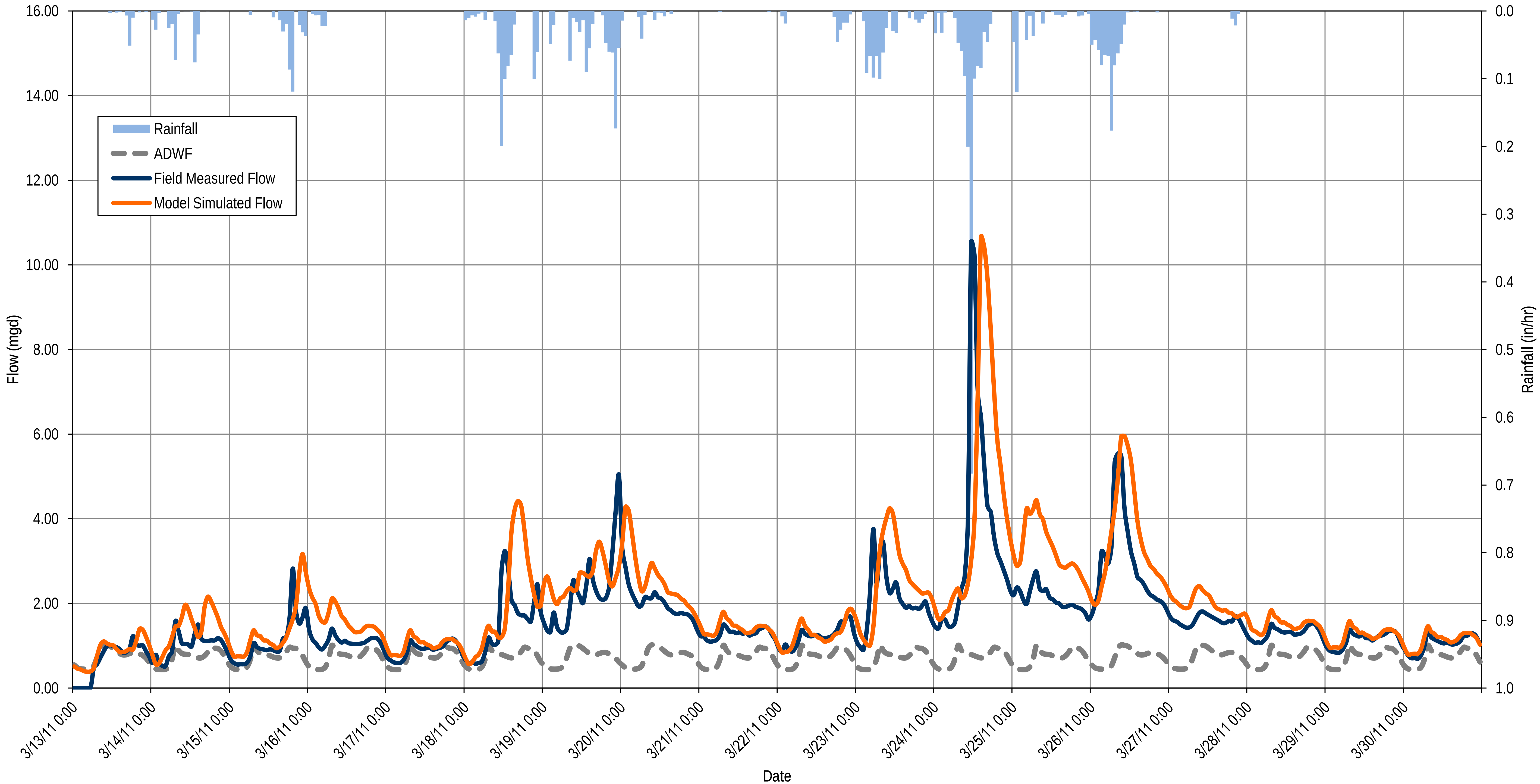
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_60.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 60-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

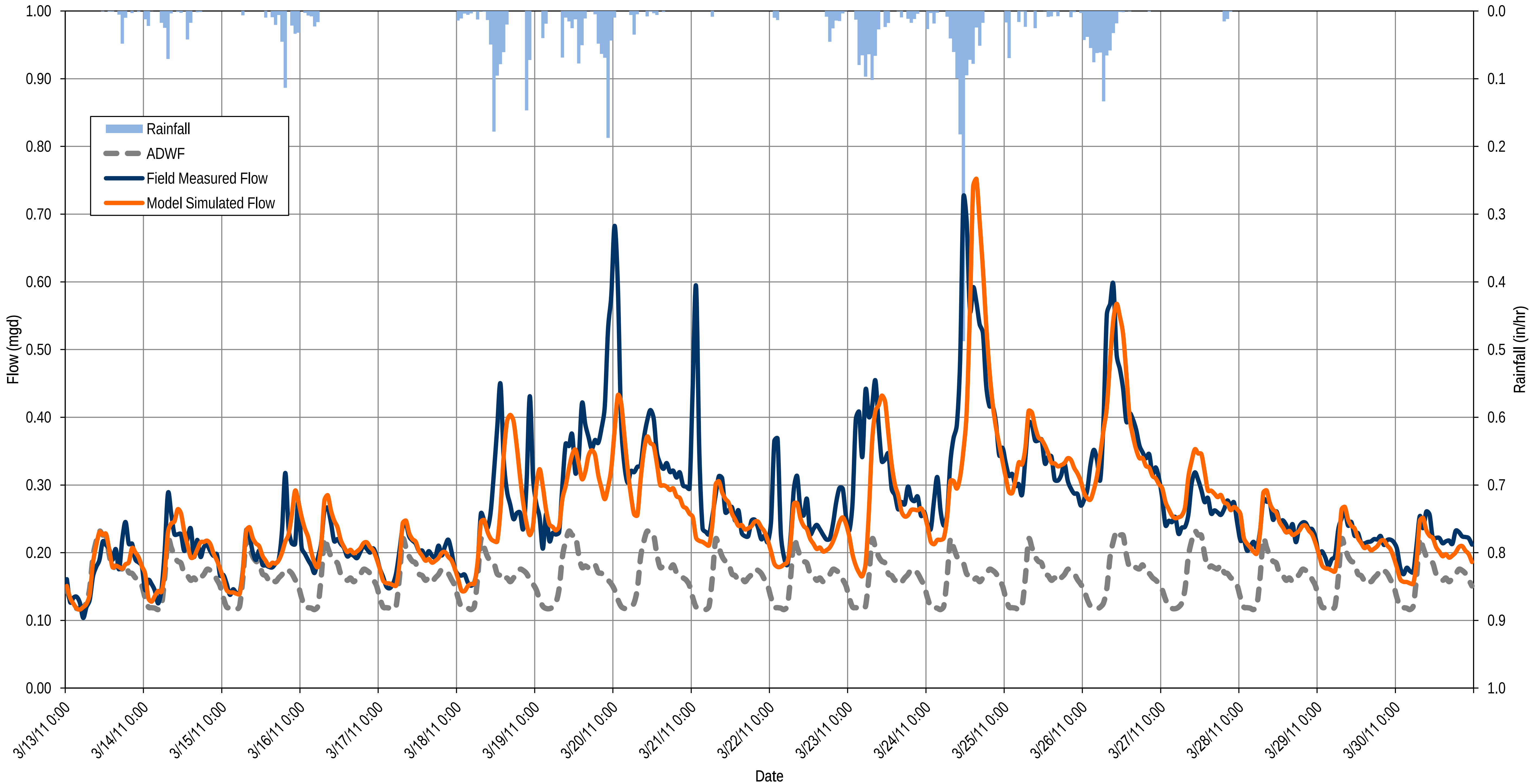
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_60.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 61A WET WEATHER CALIBRATION

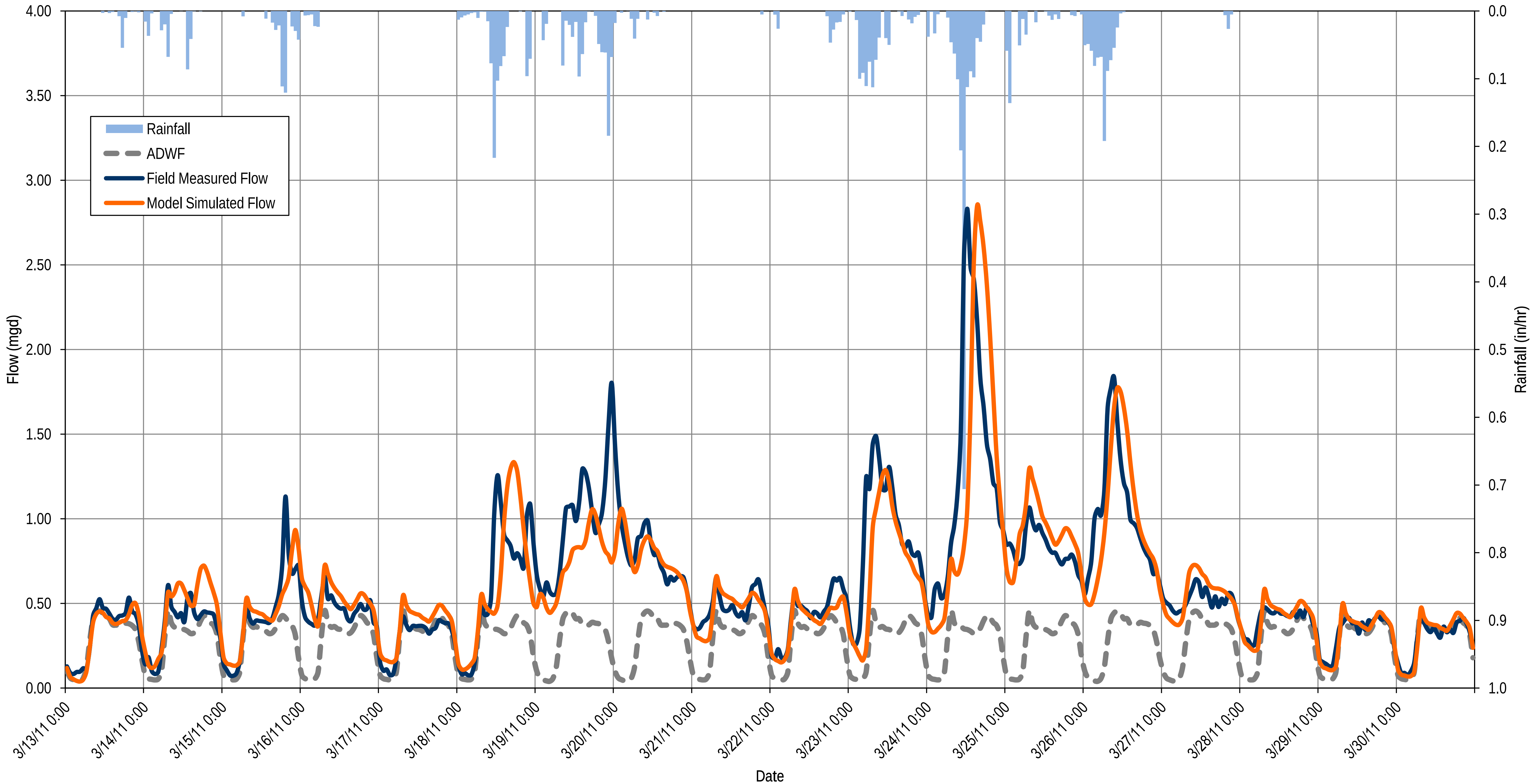


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_61.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 62A WET WEATHER CALIBRATION



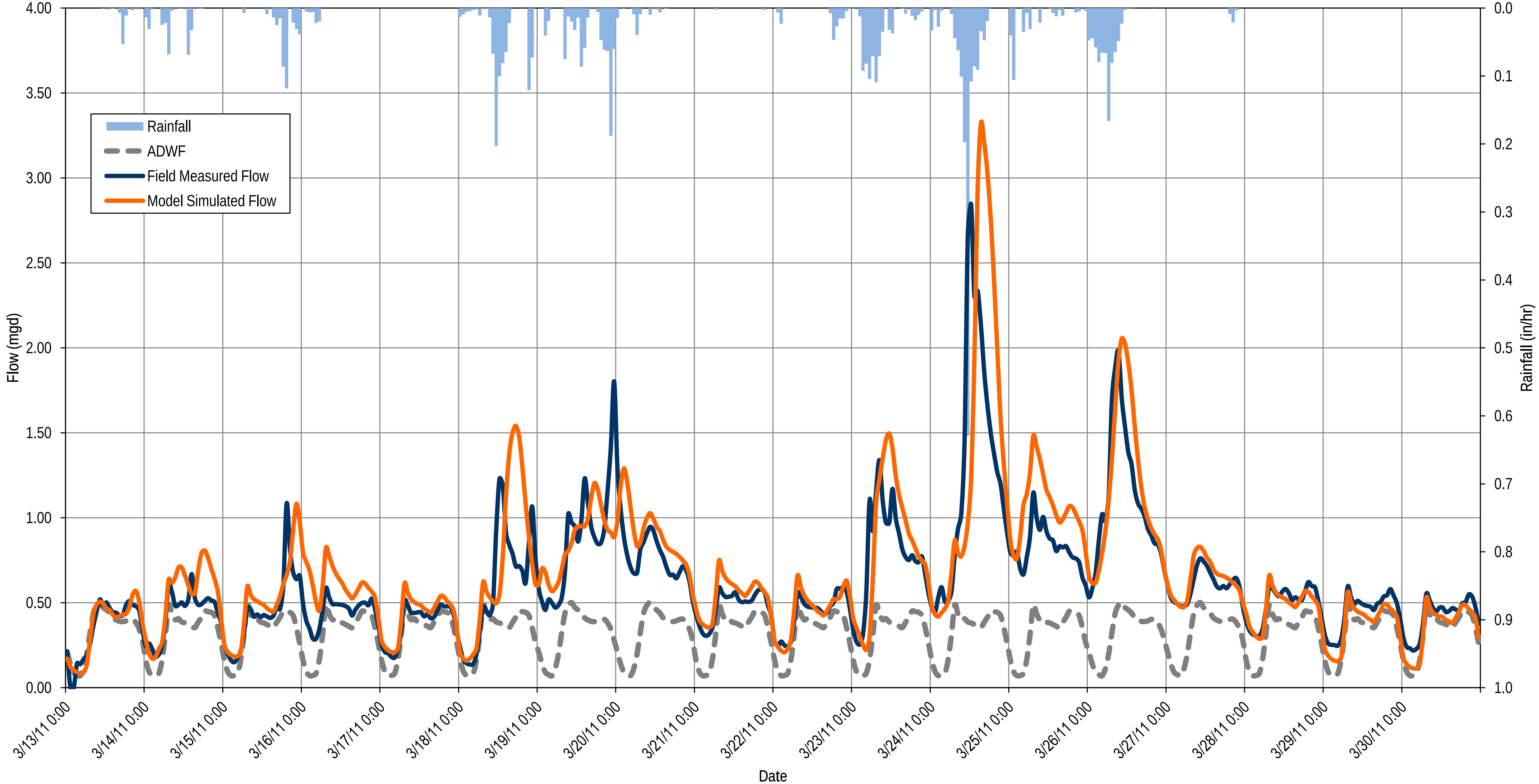
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_62.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 62-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

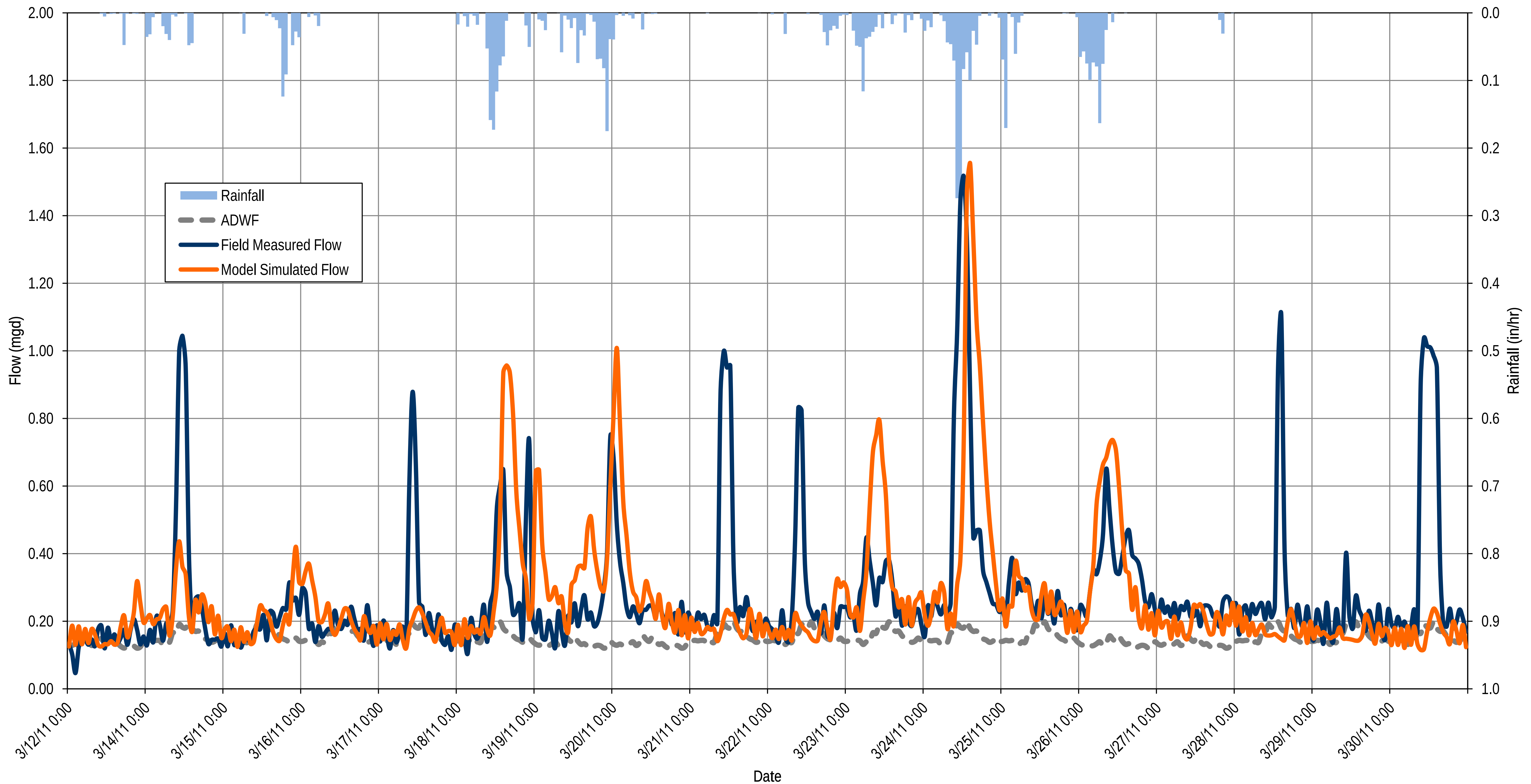
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_62.xlsx

City of Oakland

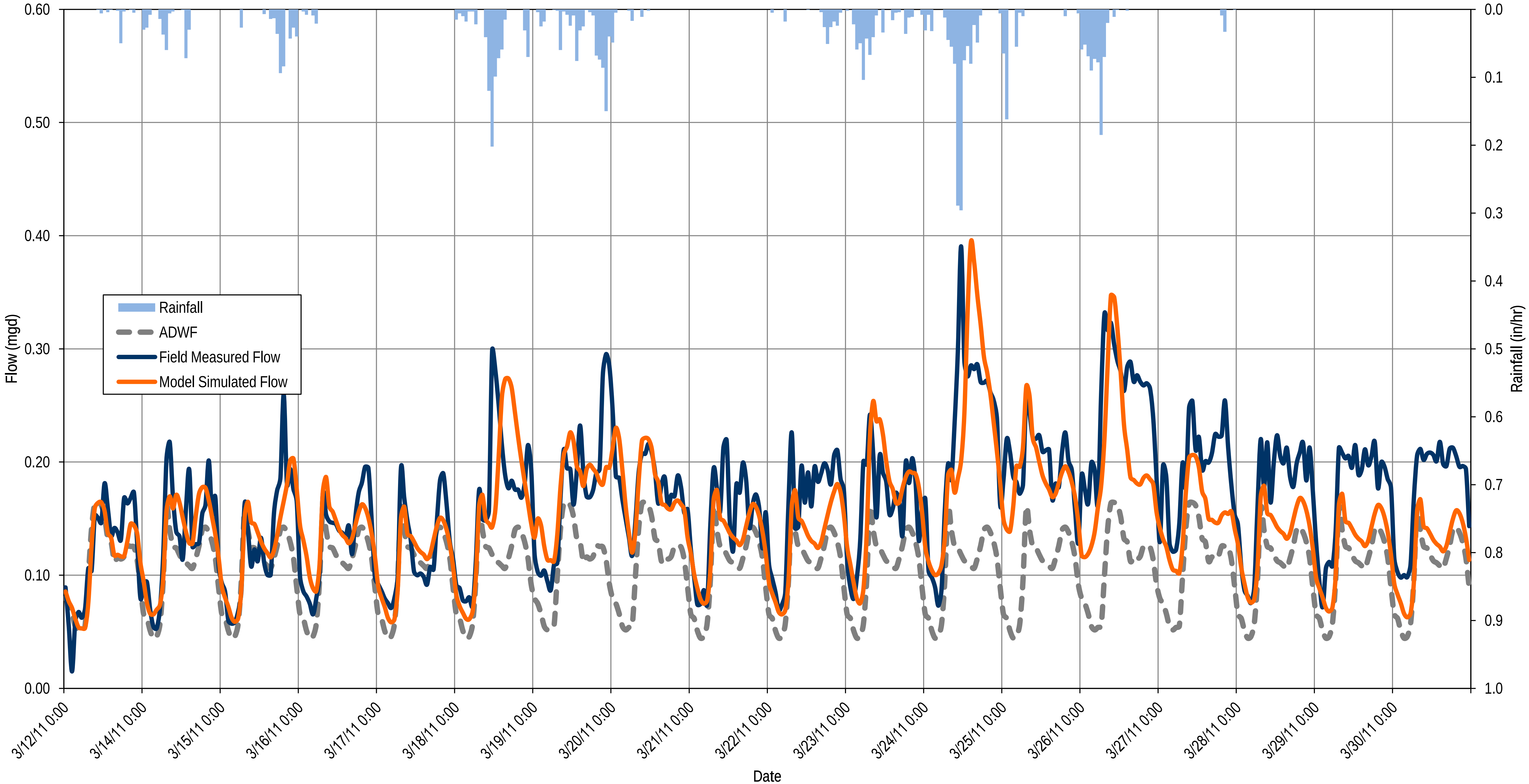
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 64-2 WET WEATHER CALIBRATION



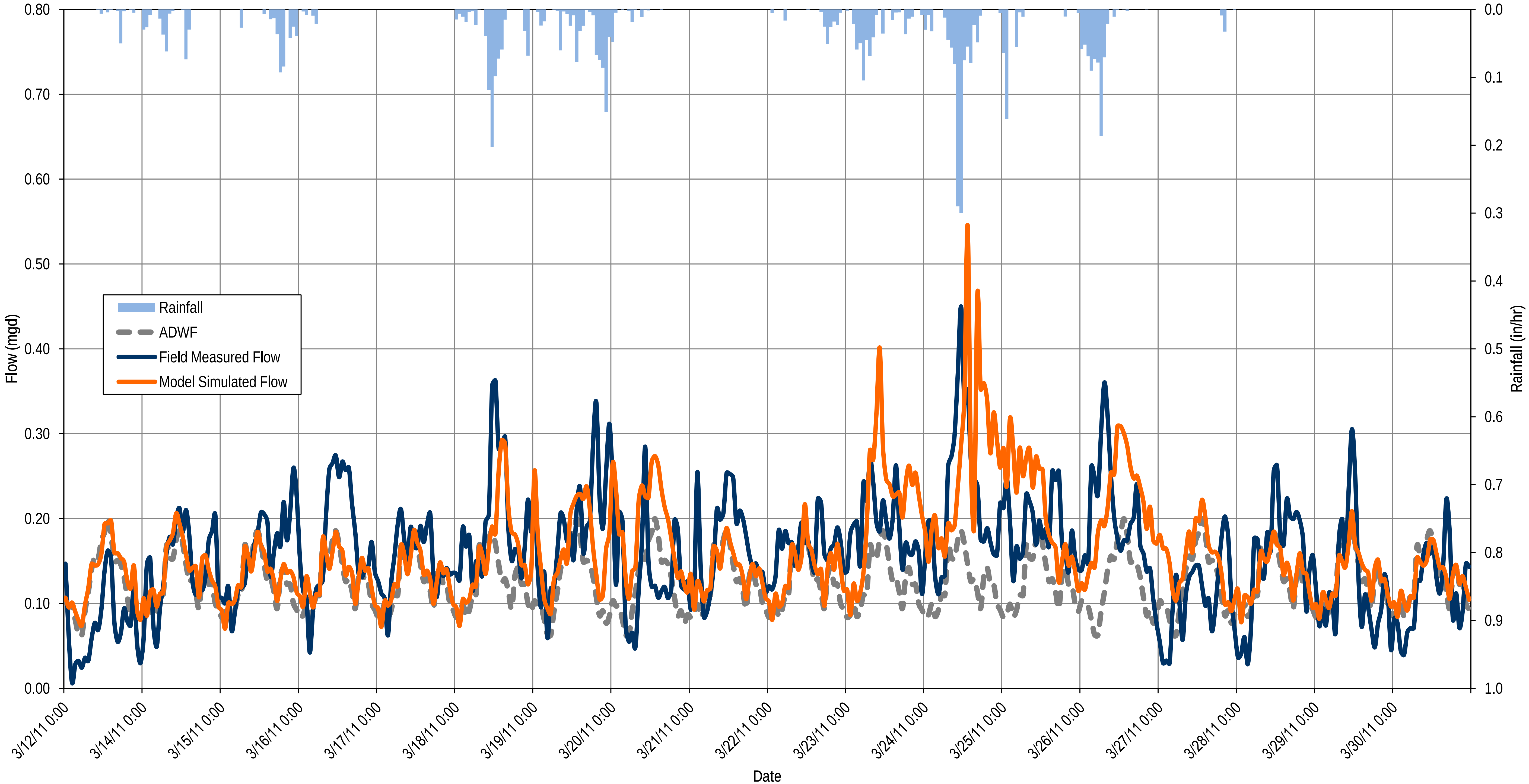
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-3 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

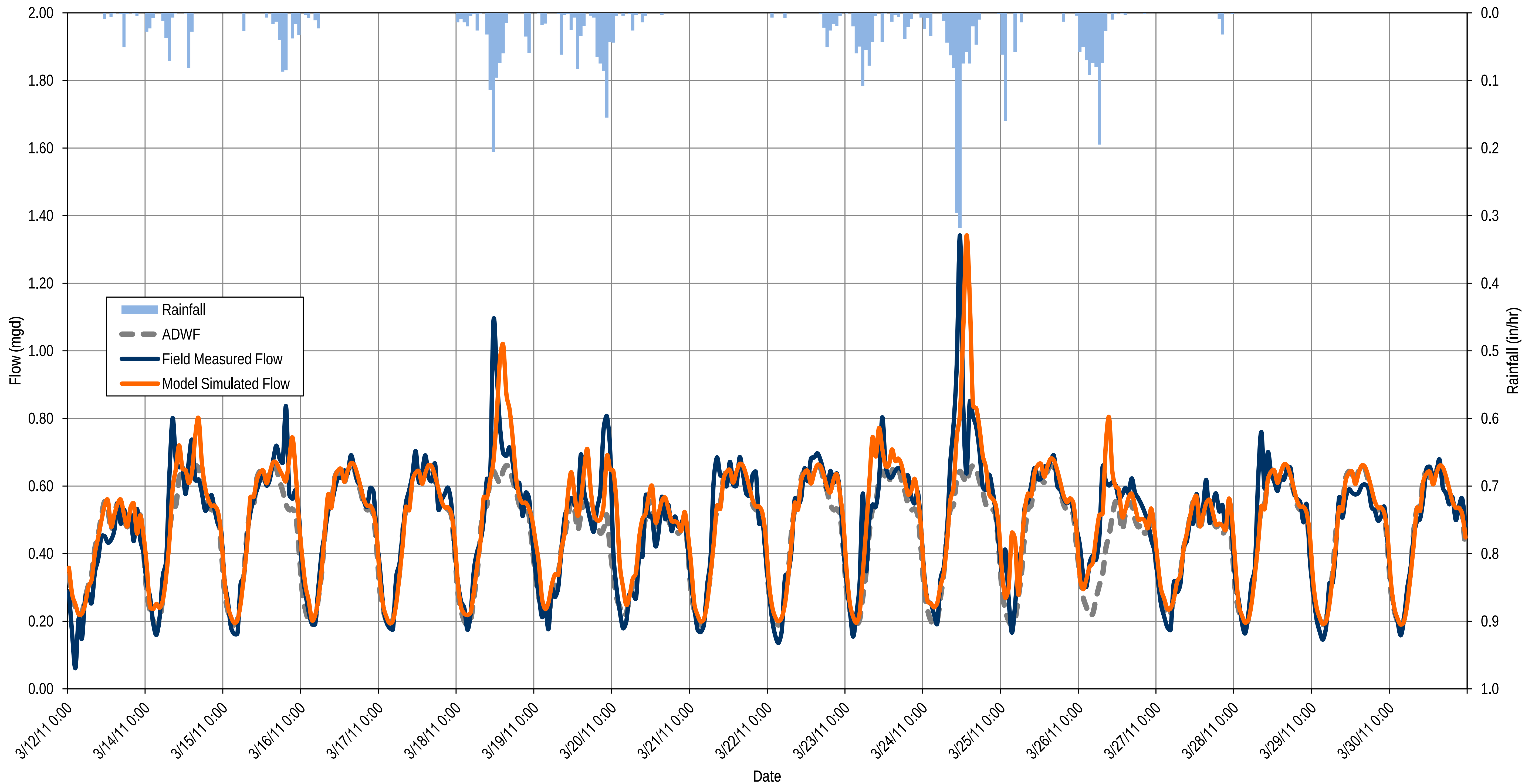
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-4 WET WEATHER CALIBRATION

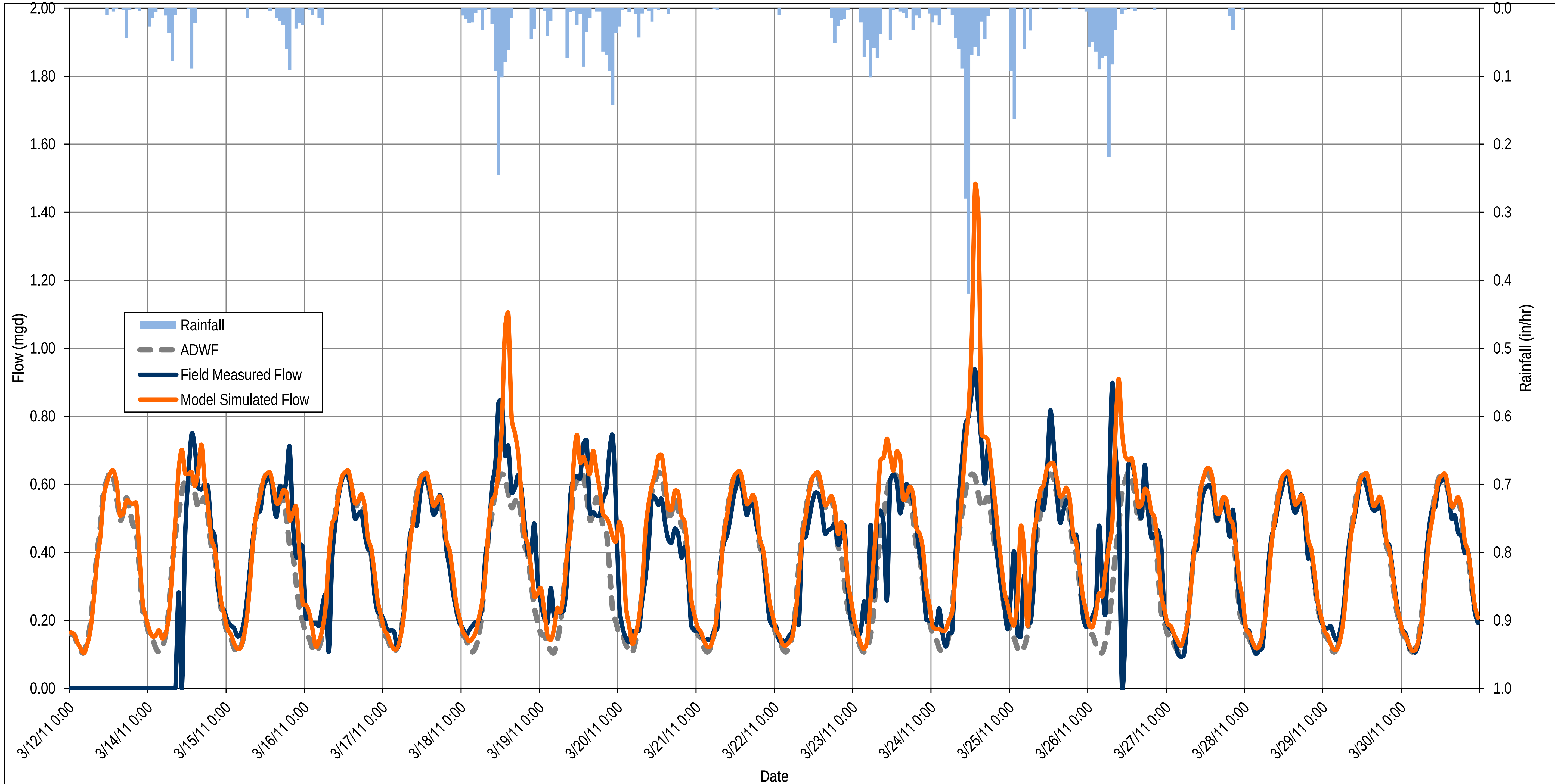


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

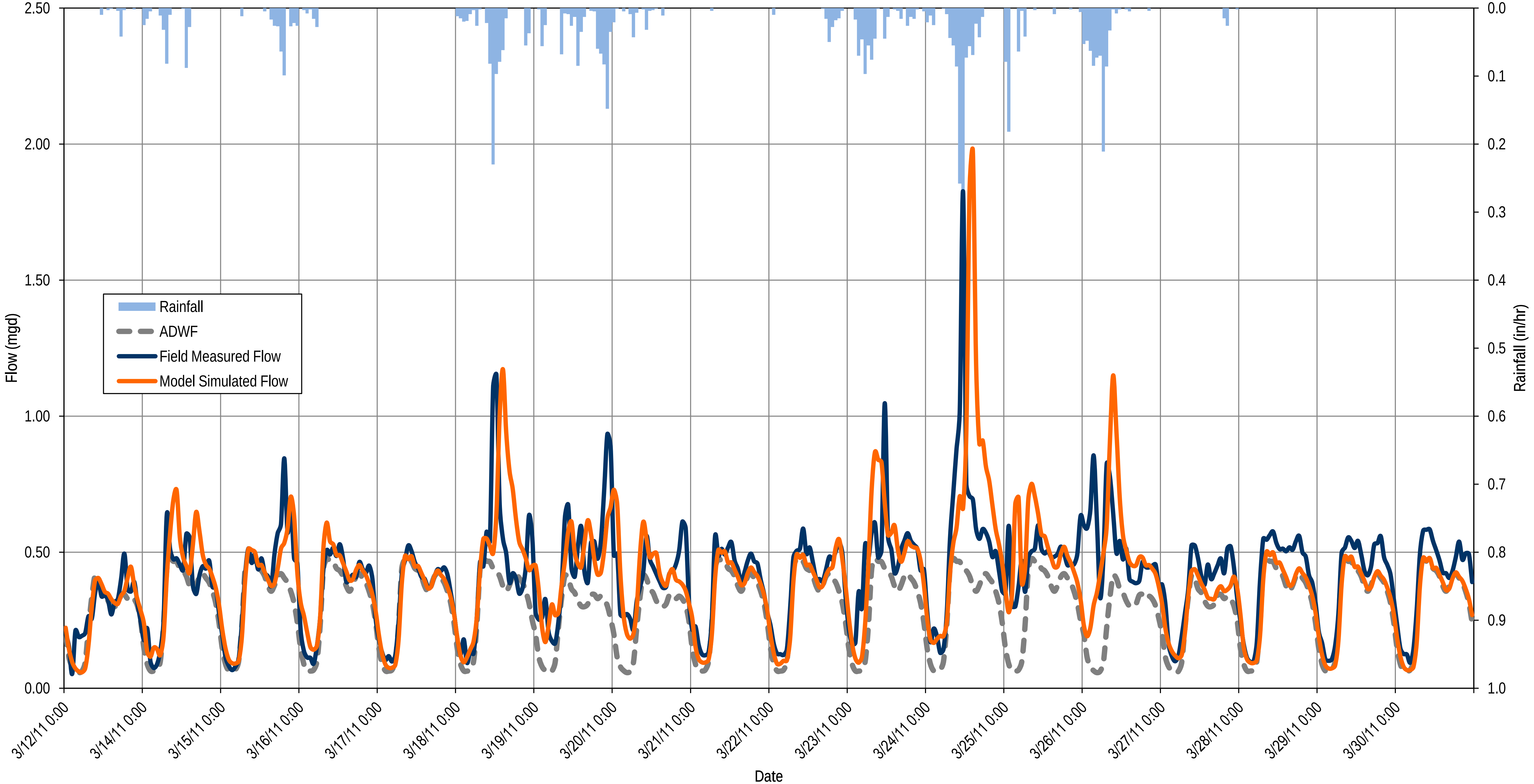
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 64-5 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 64-6 WET WEATHER CALIBRATION



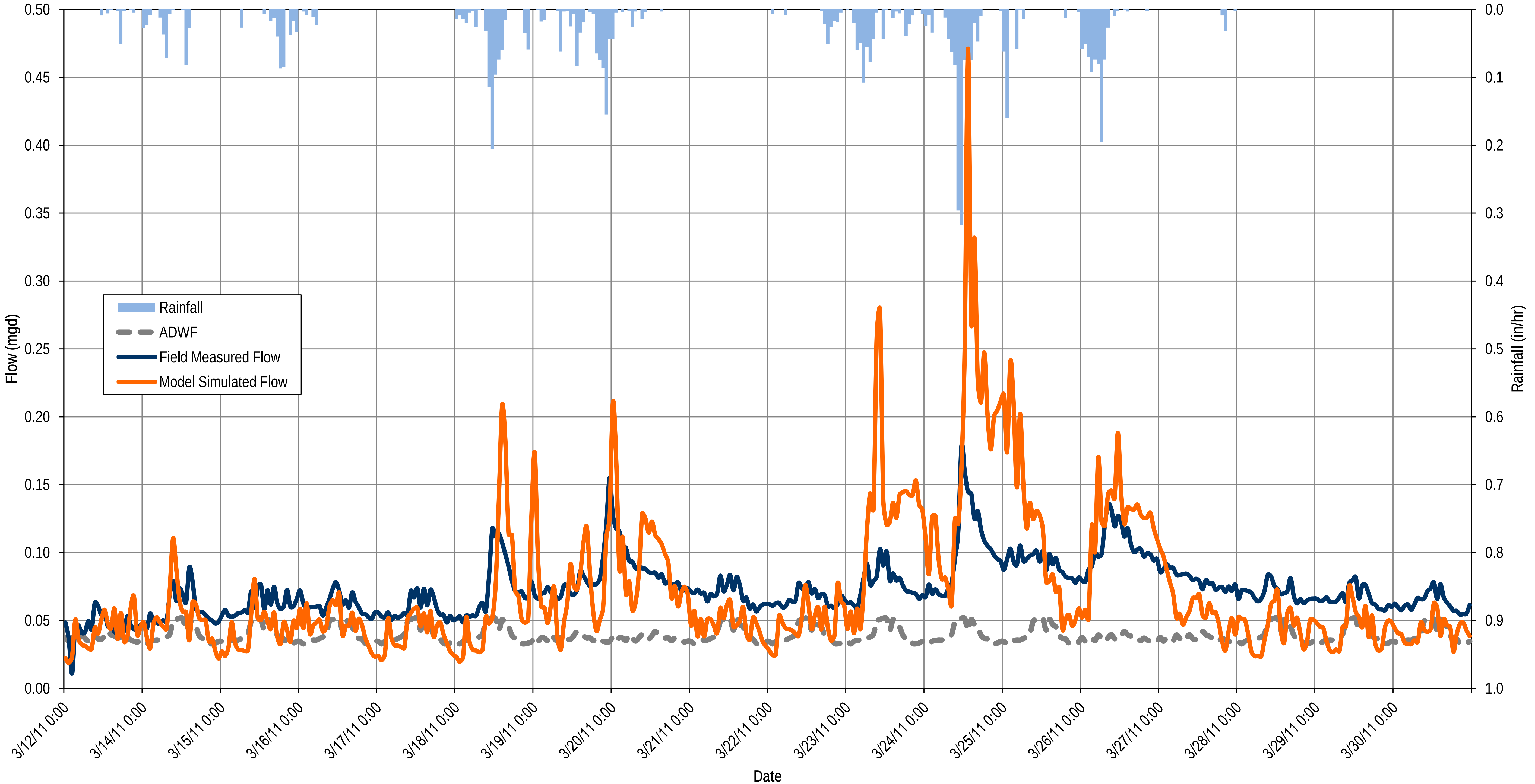
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-7 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

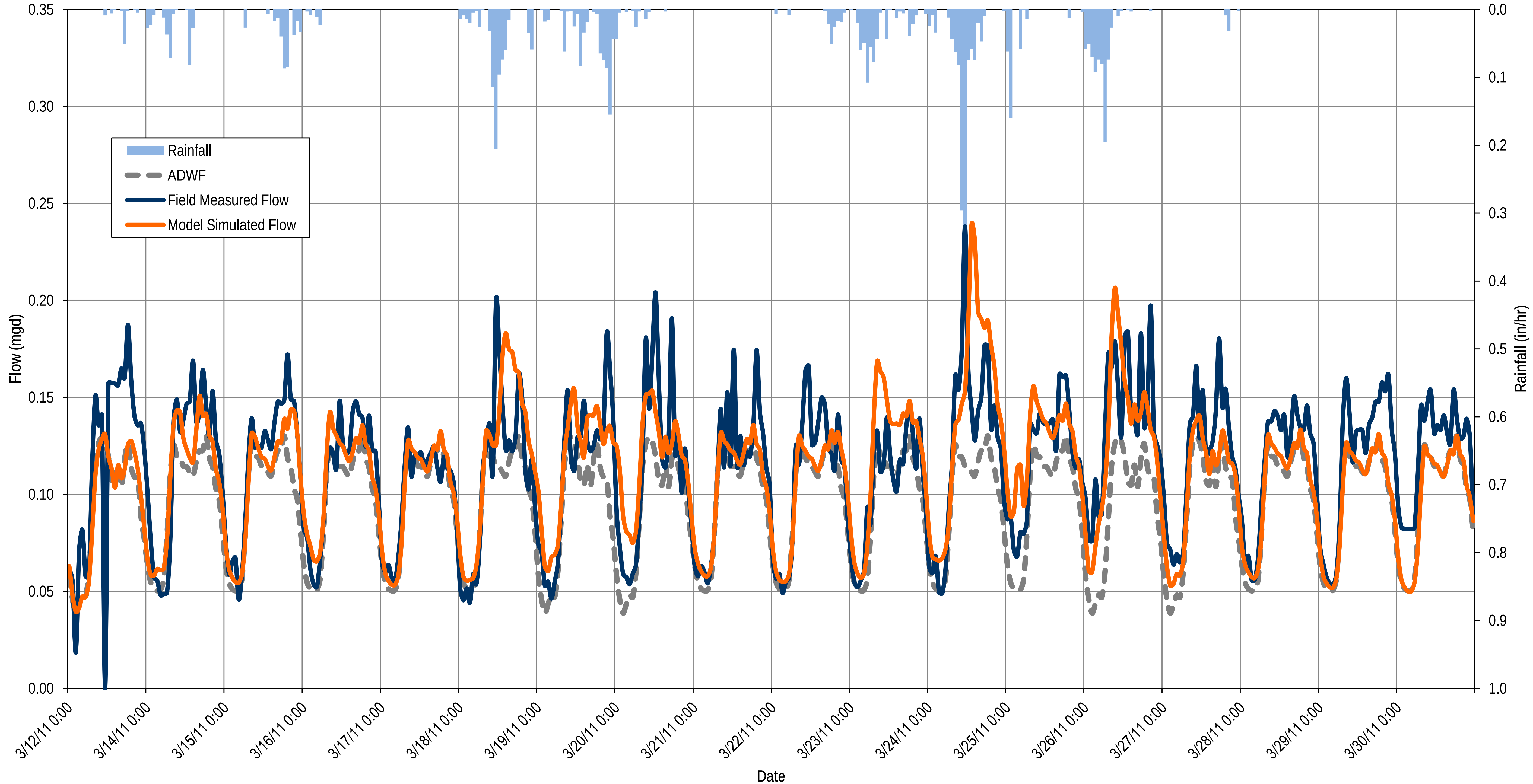
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_64.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 64-8 WET WEATHER CALIBRATION

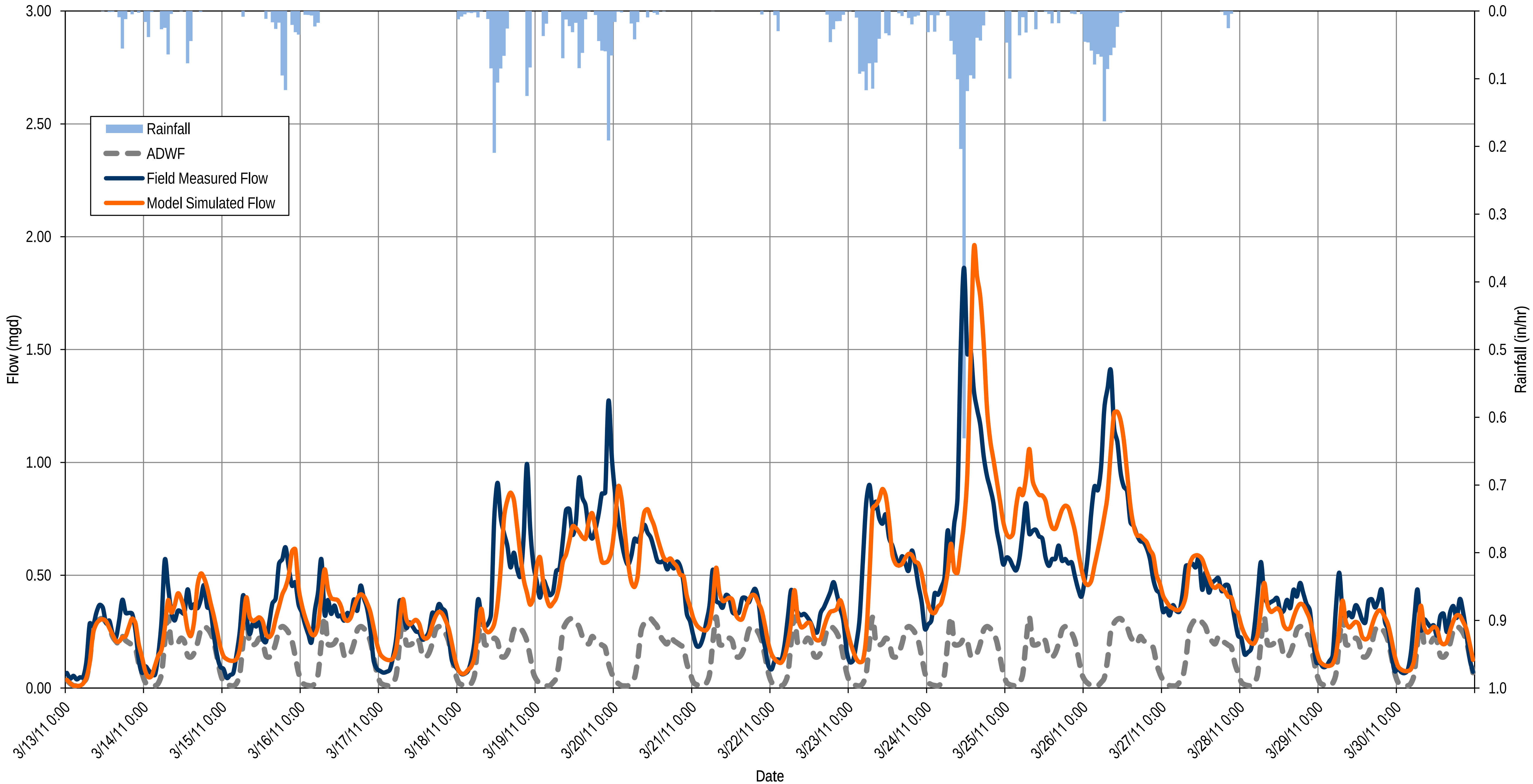


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80A WET WEATHER CALIBRATION

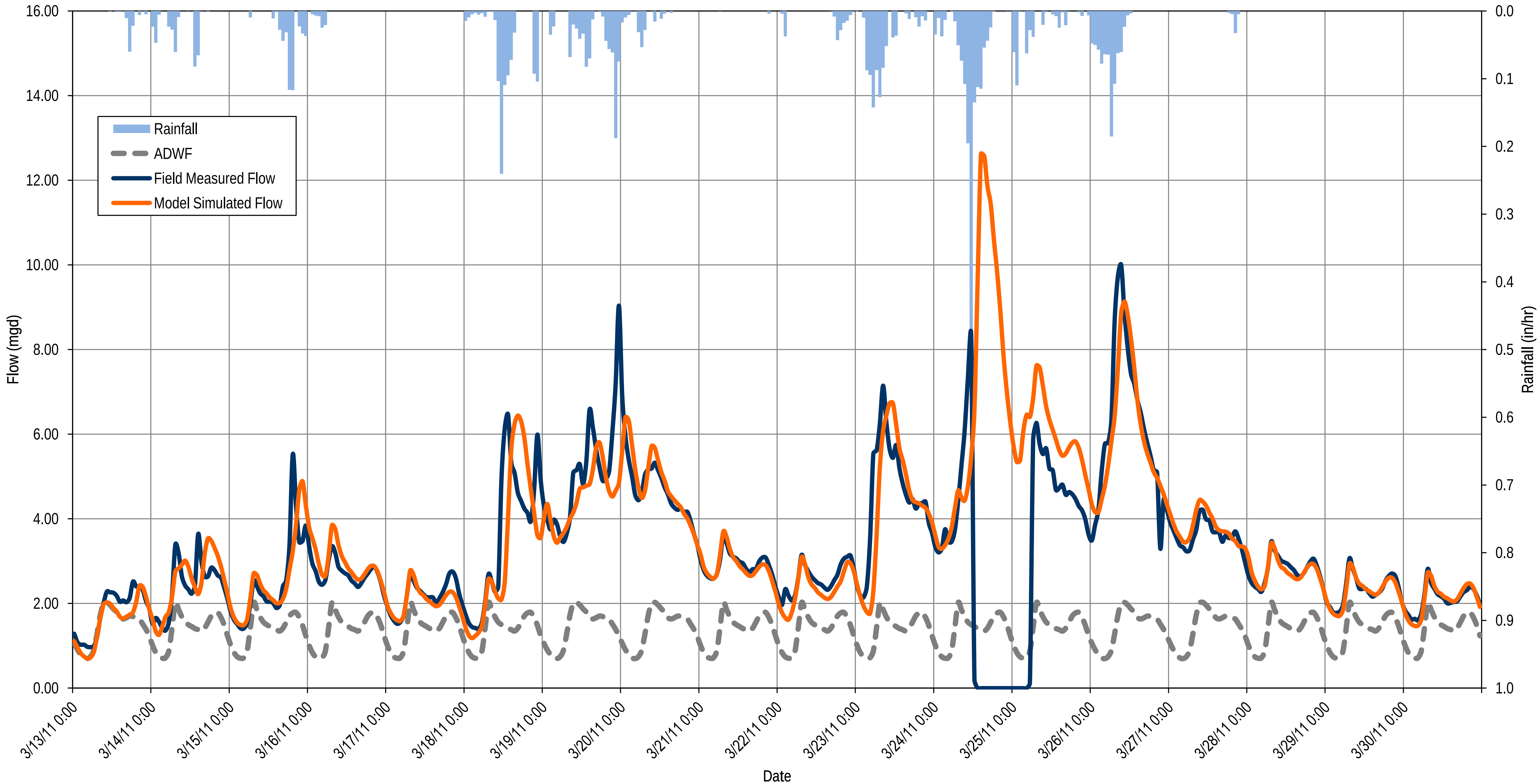


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

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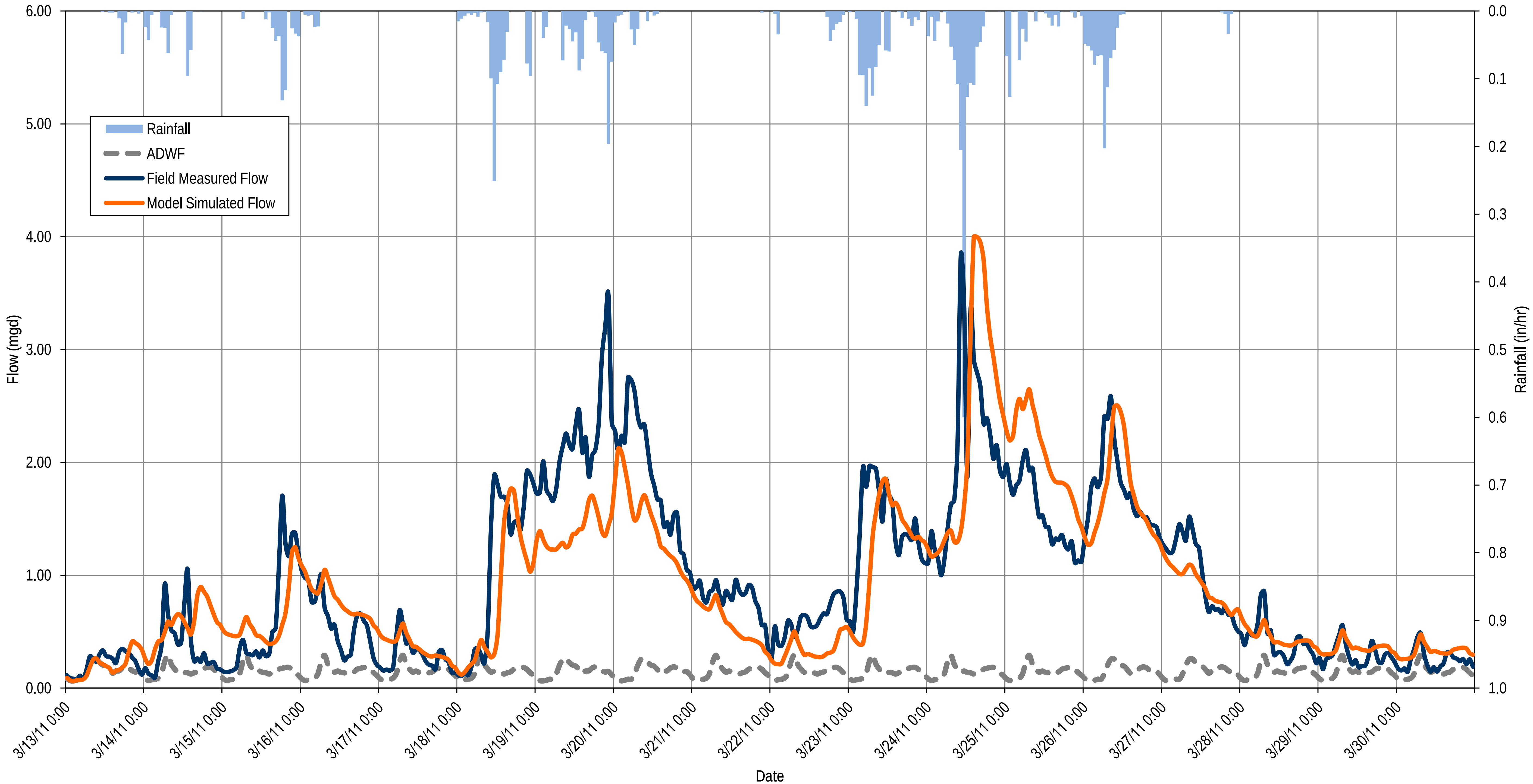
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_80.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 80C WET WEATHER CALIBRATION



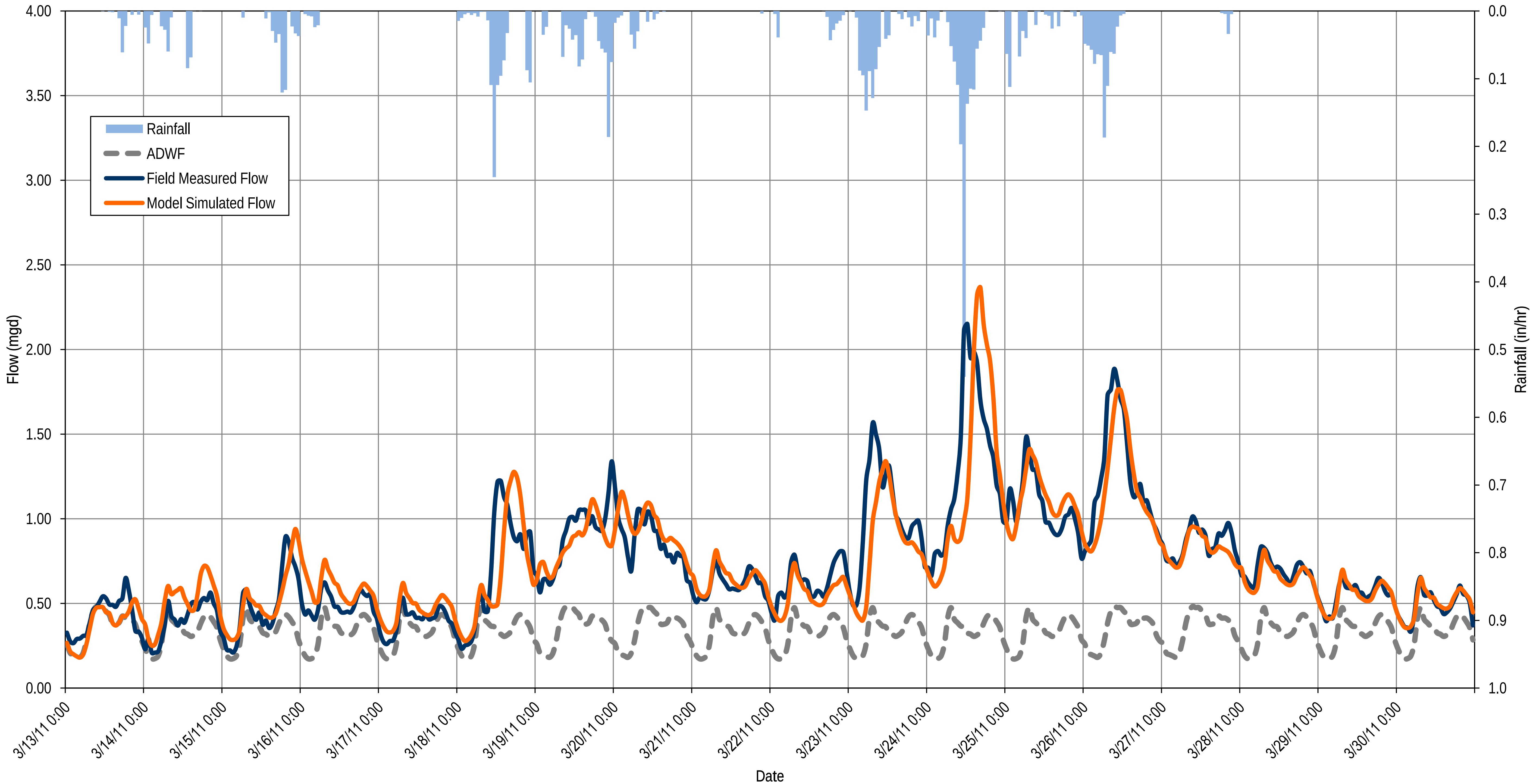
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_80.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80D WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

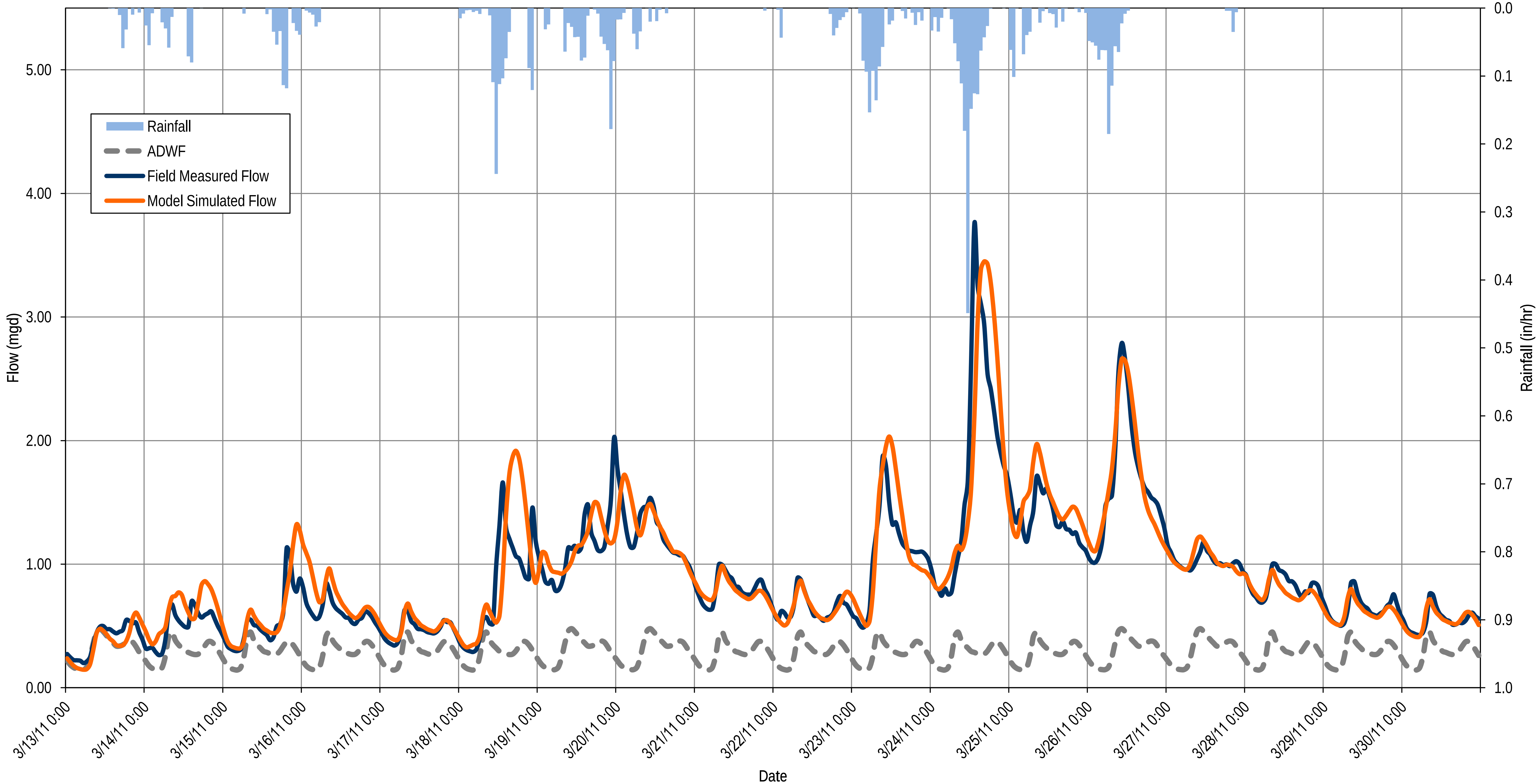
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_80.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80E WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

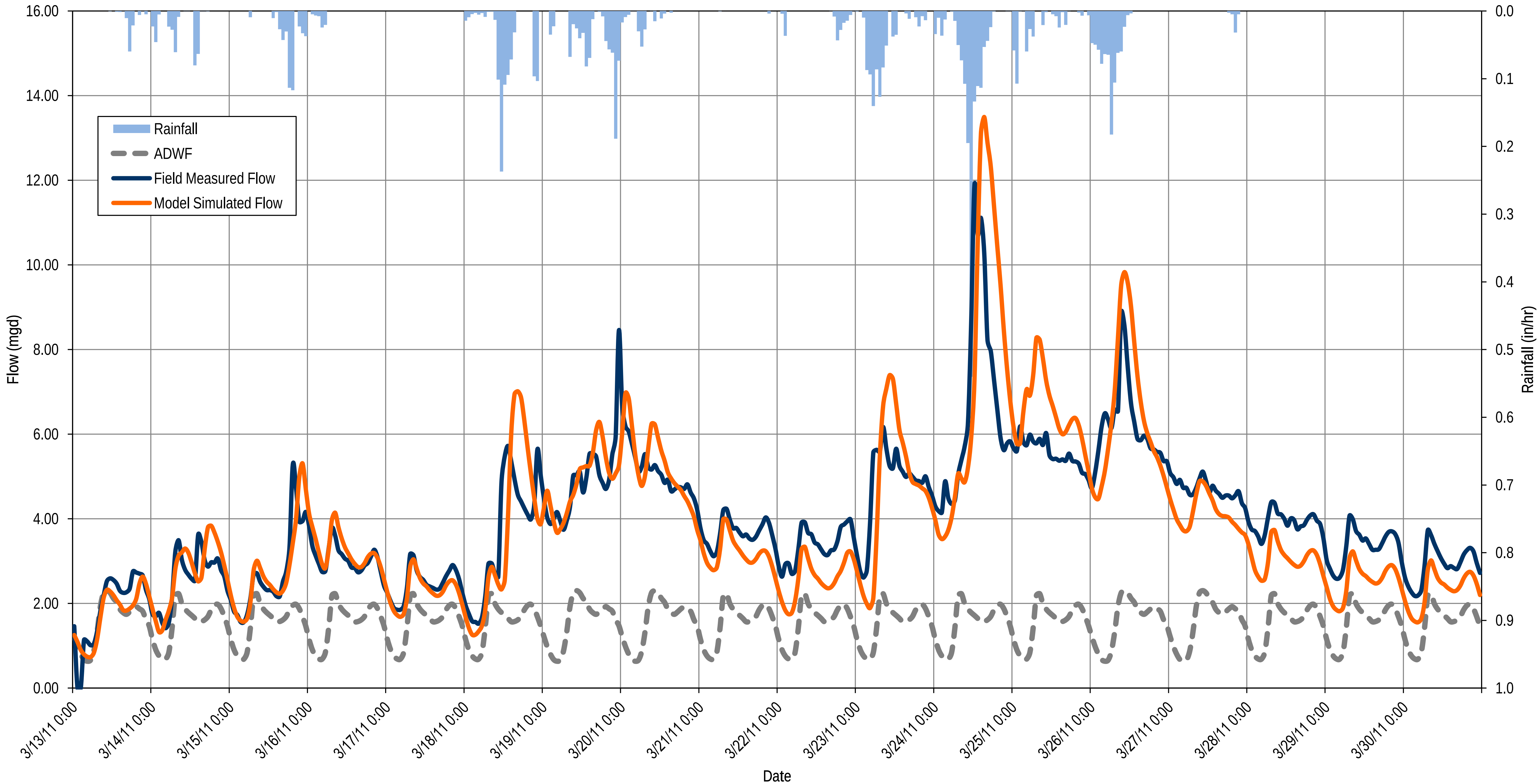
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_80.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

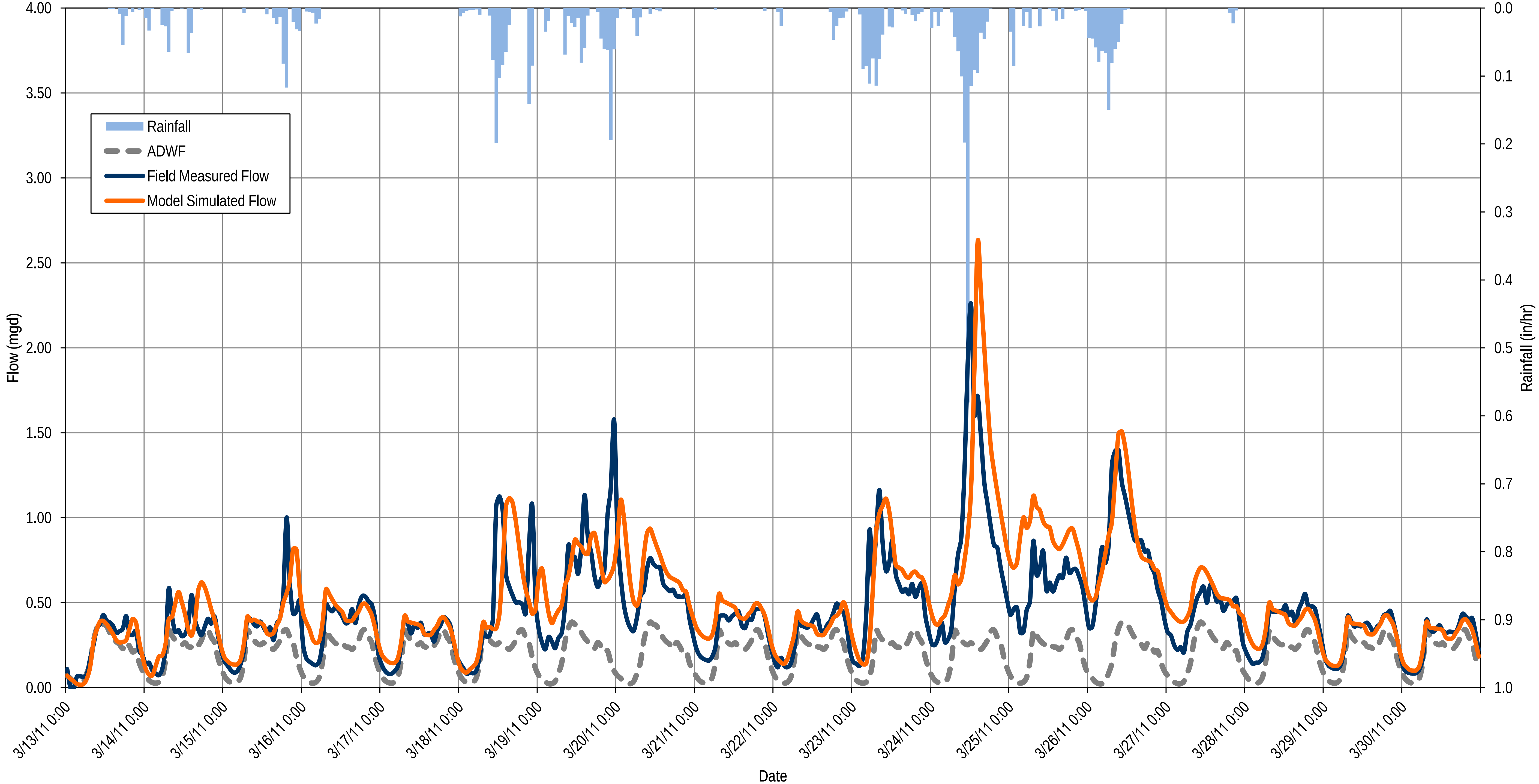
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_80.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 80-2 WET WEATHER CALIBRATION

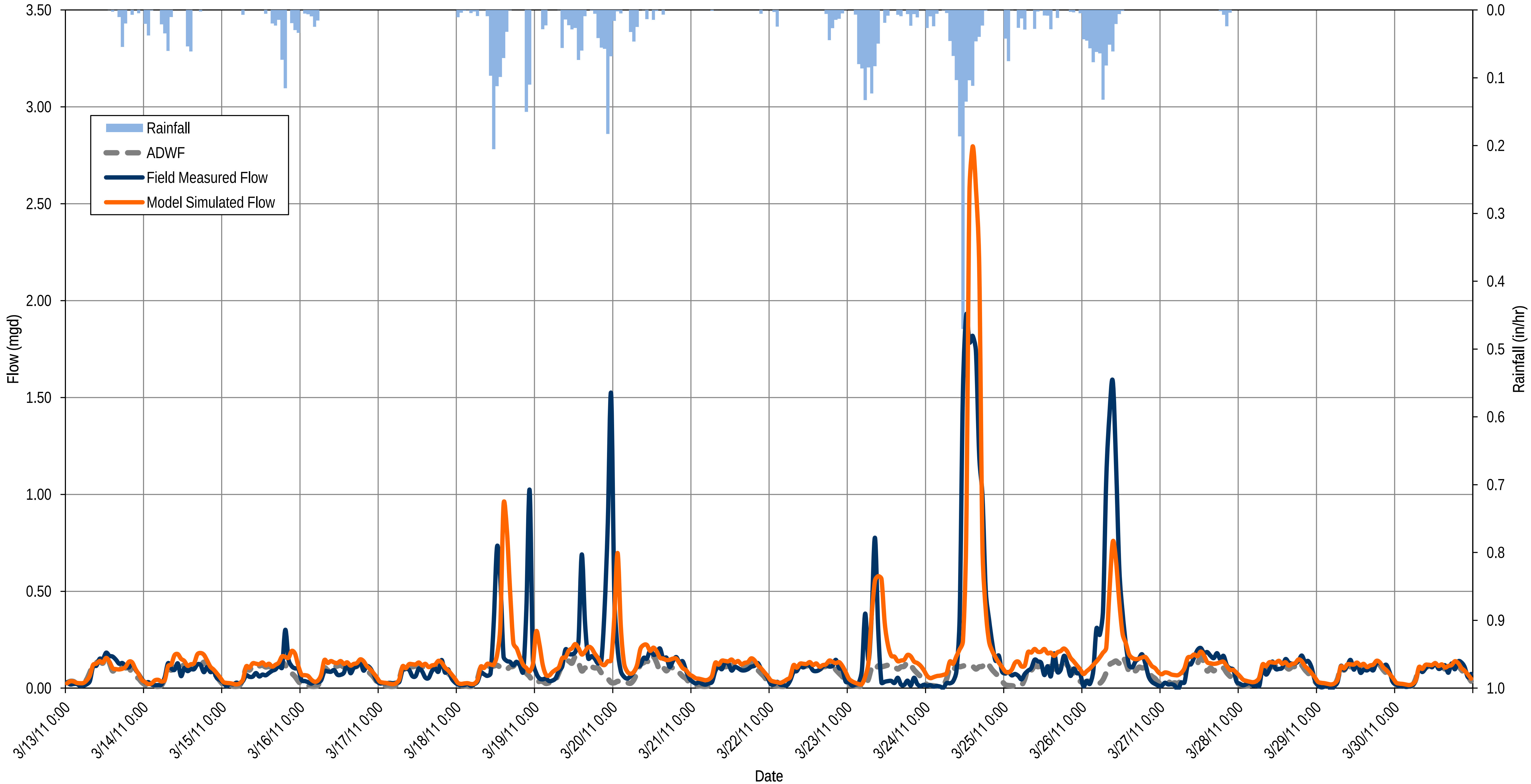


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

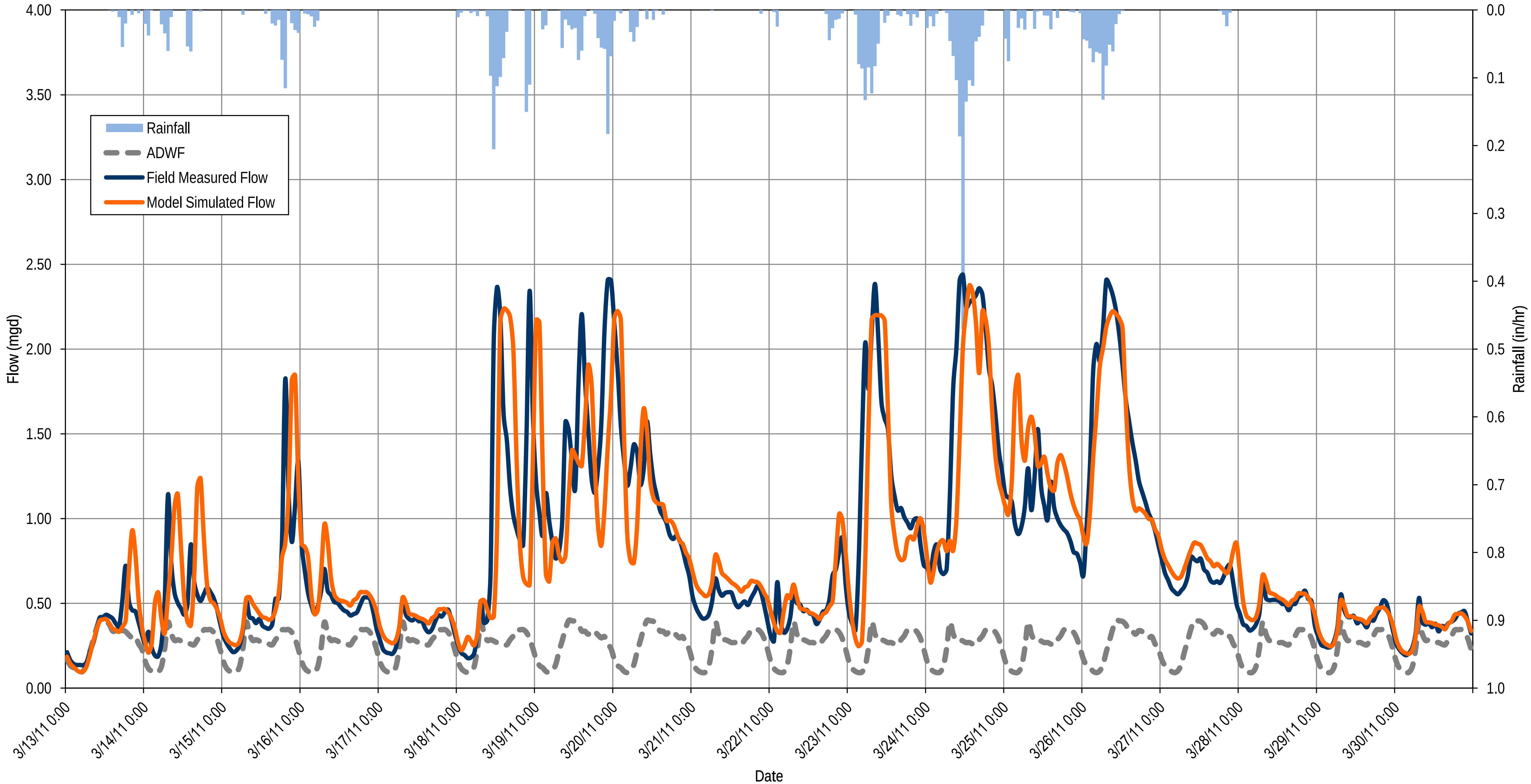
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_81.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81A.1 WET WEATHER CALIBRATION

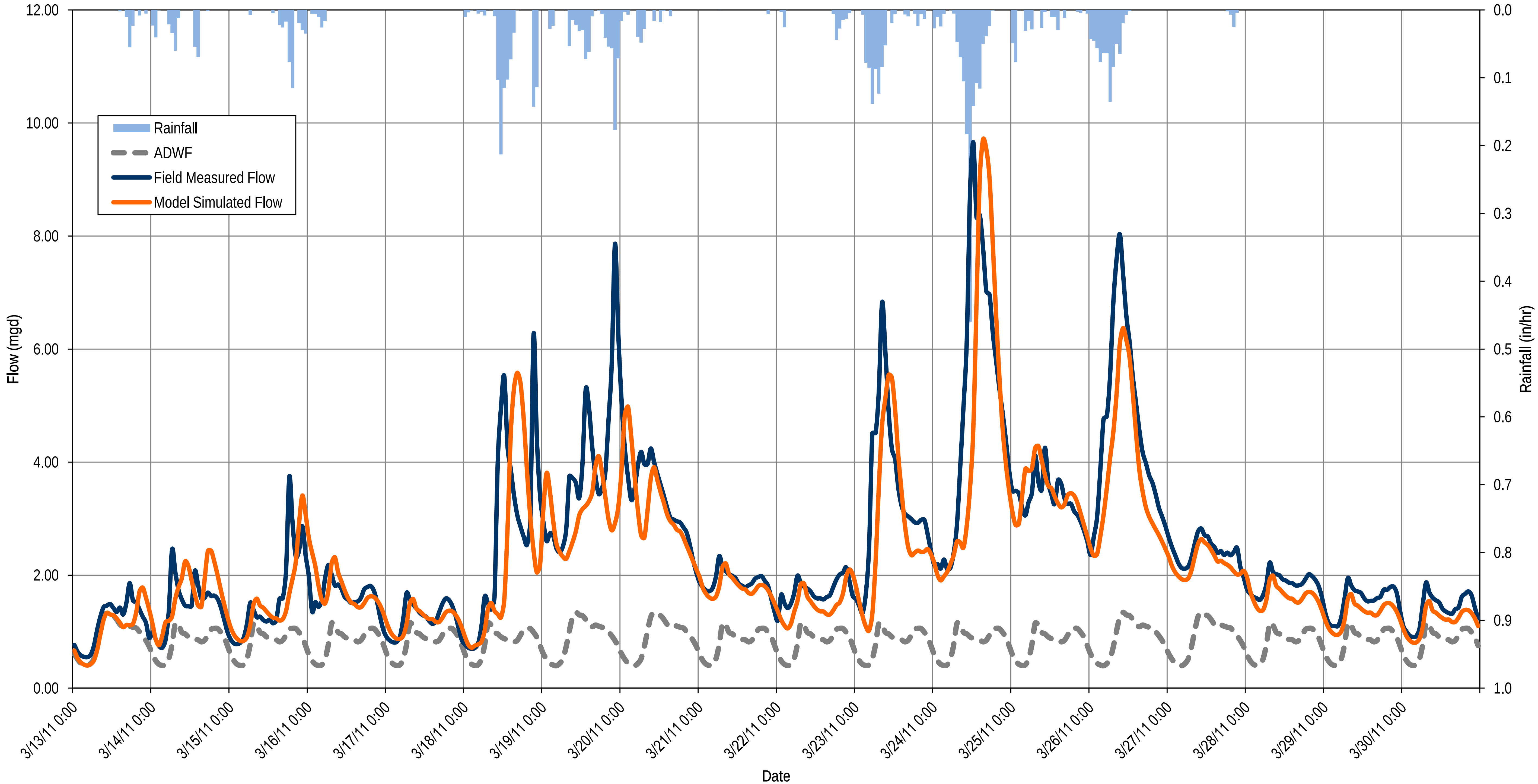


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_81.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 81B WET WEATHER CALIBRATION

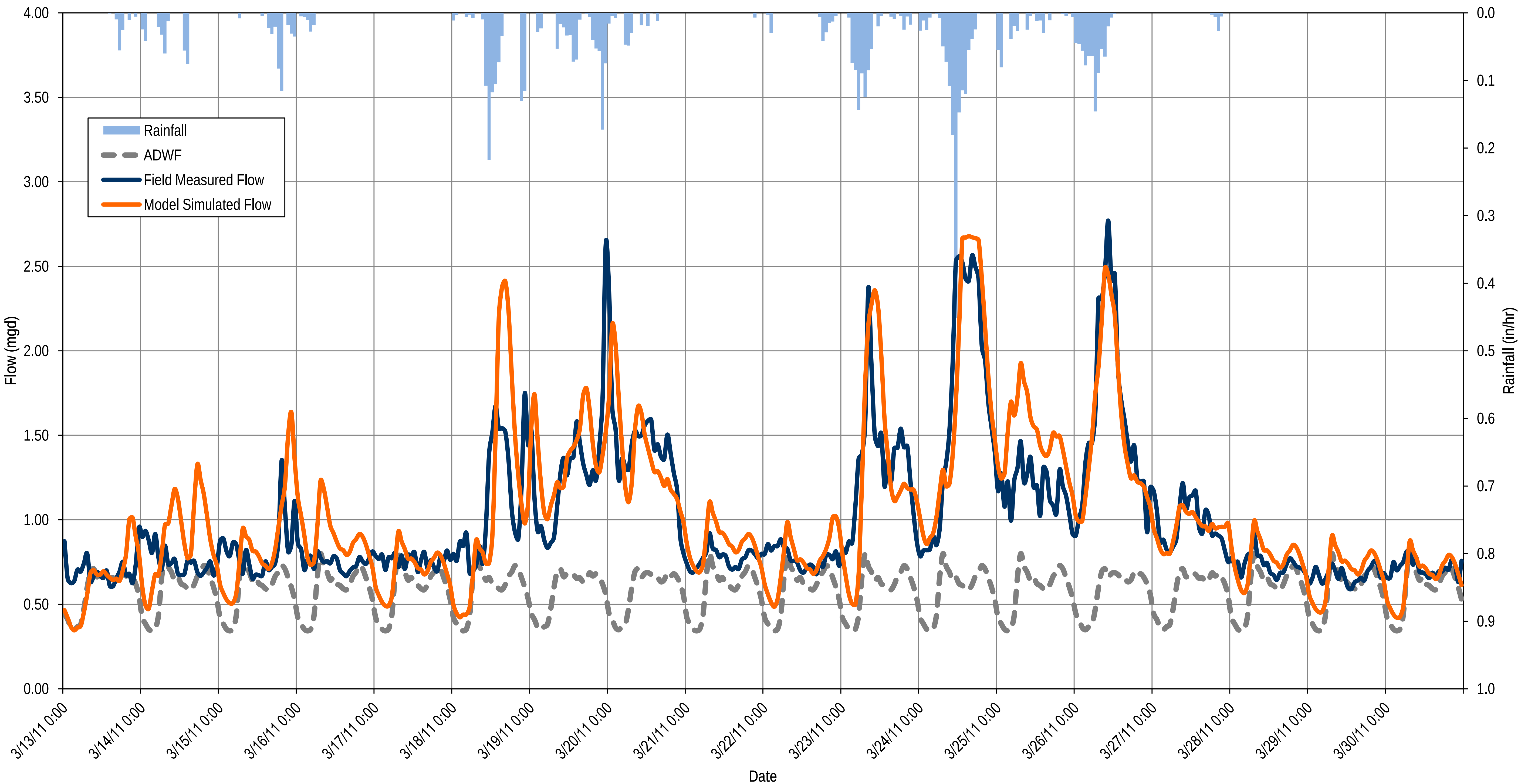


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81C WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

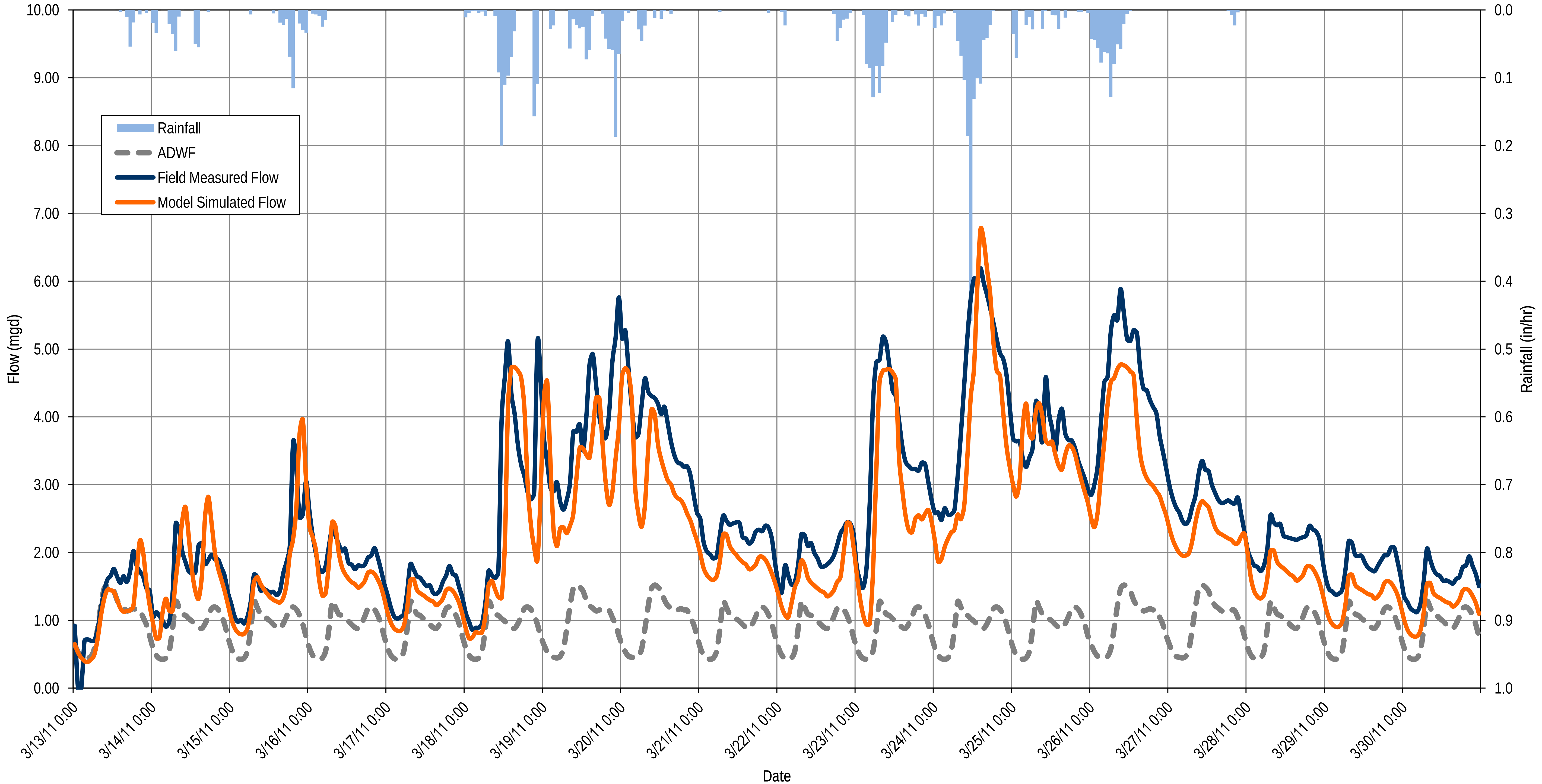
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_81.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-1 WET WEATHER CALIBRATION



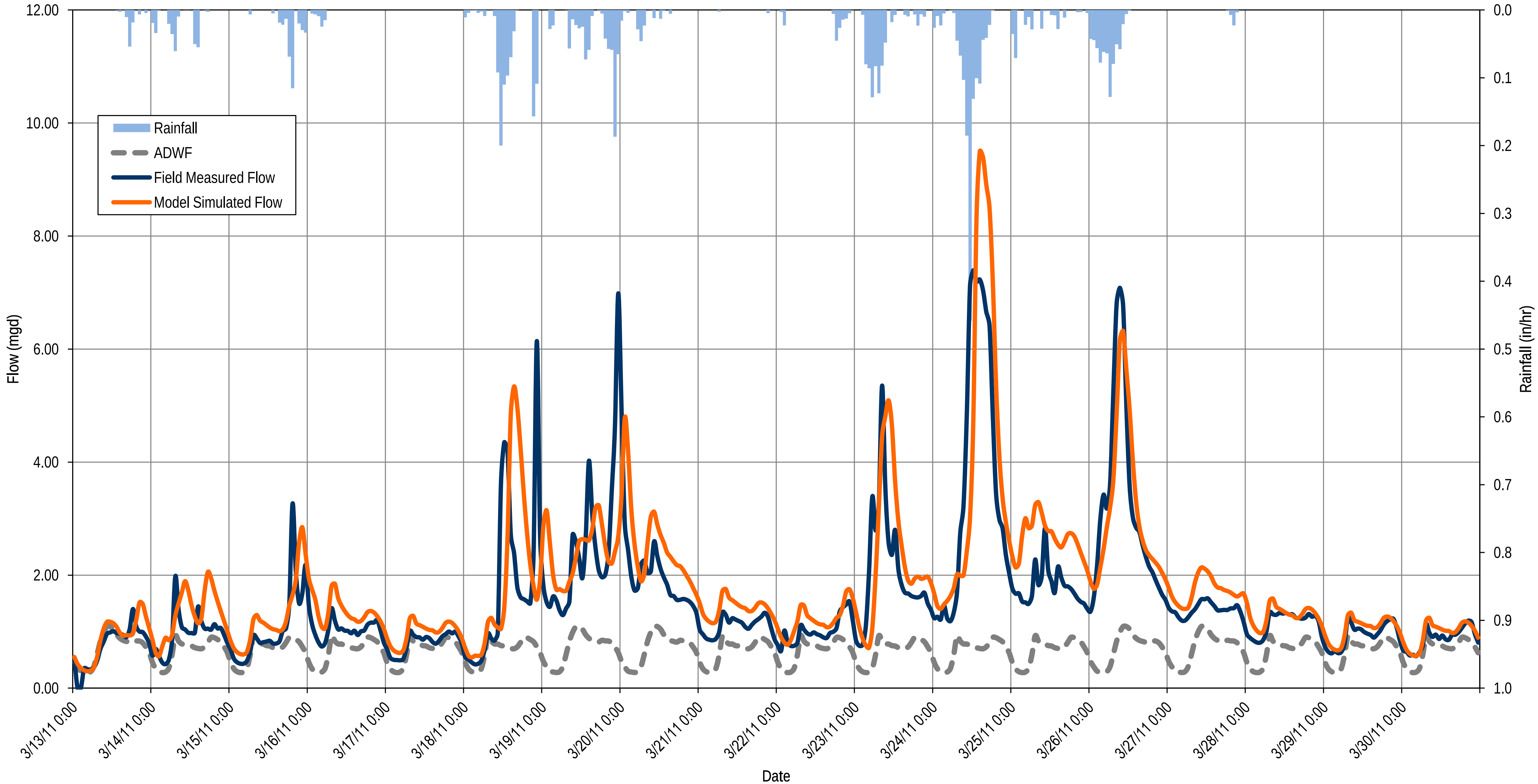
Wet Weather Flow Monitoring Comparison Chart

(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

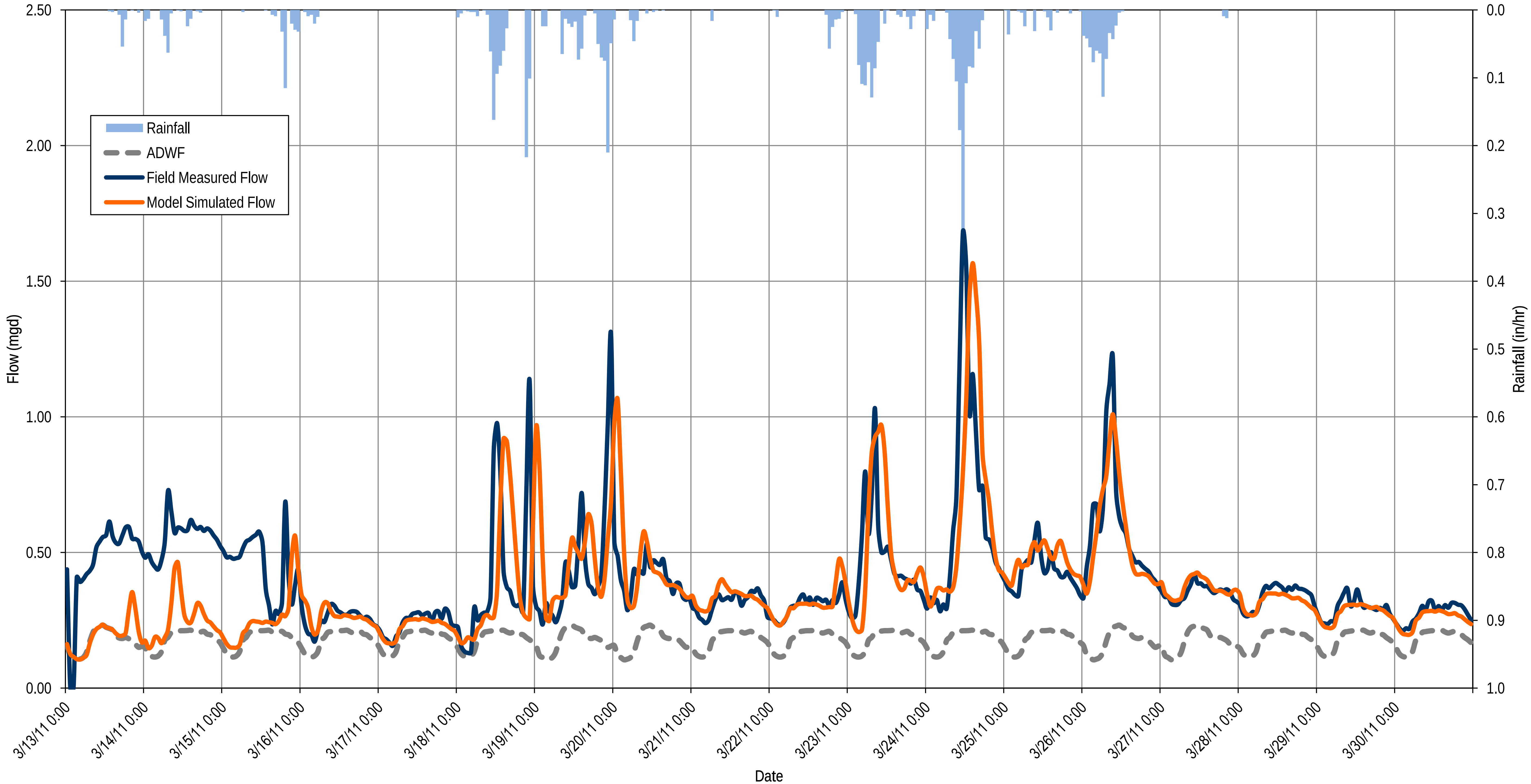
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_81.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 81-3 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

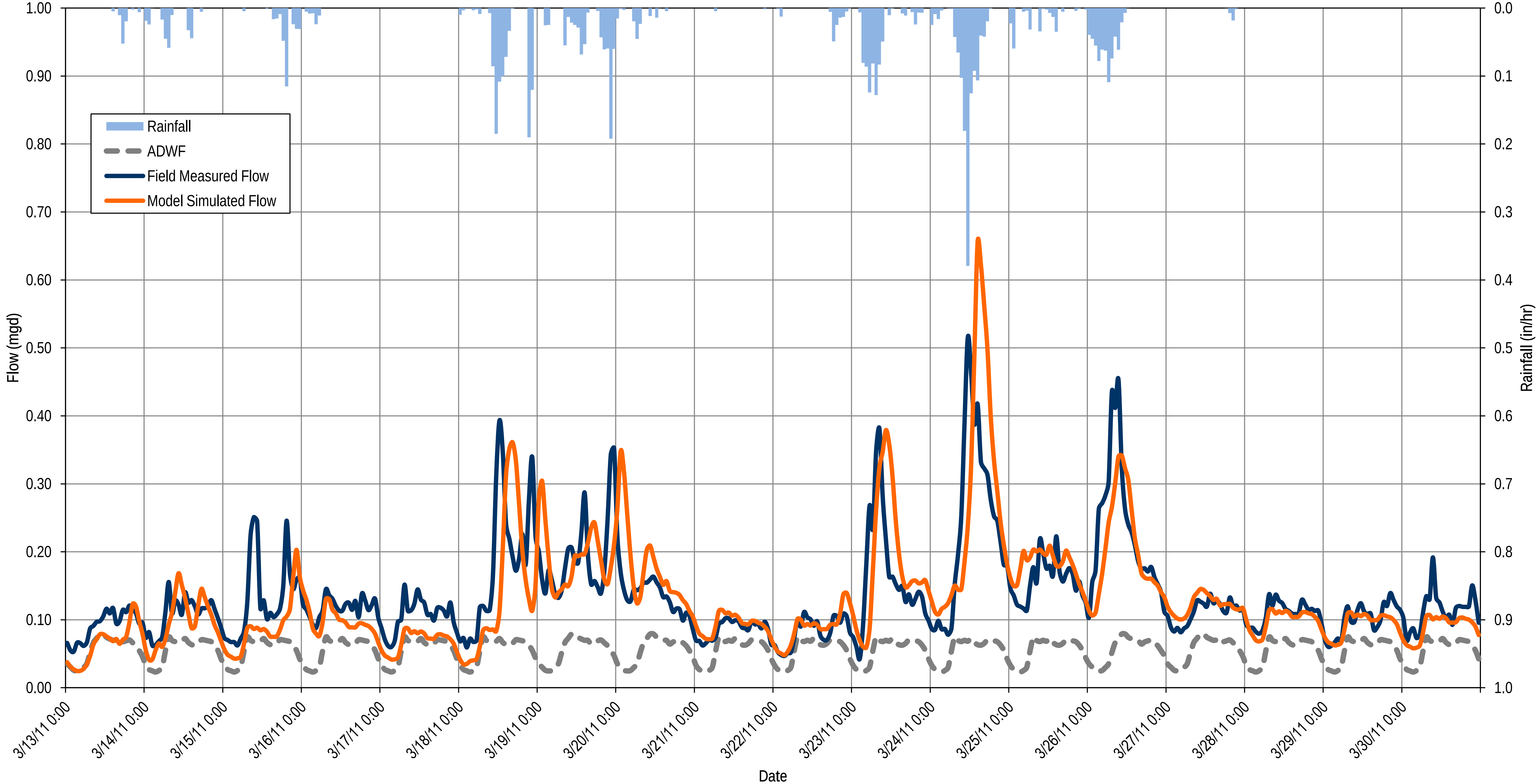
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_81.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82A WET WEATHER CALIBRATION

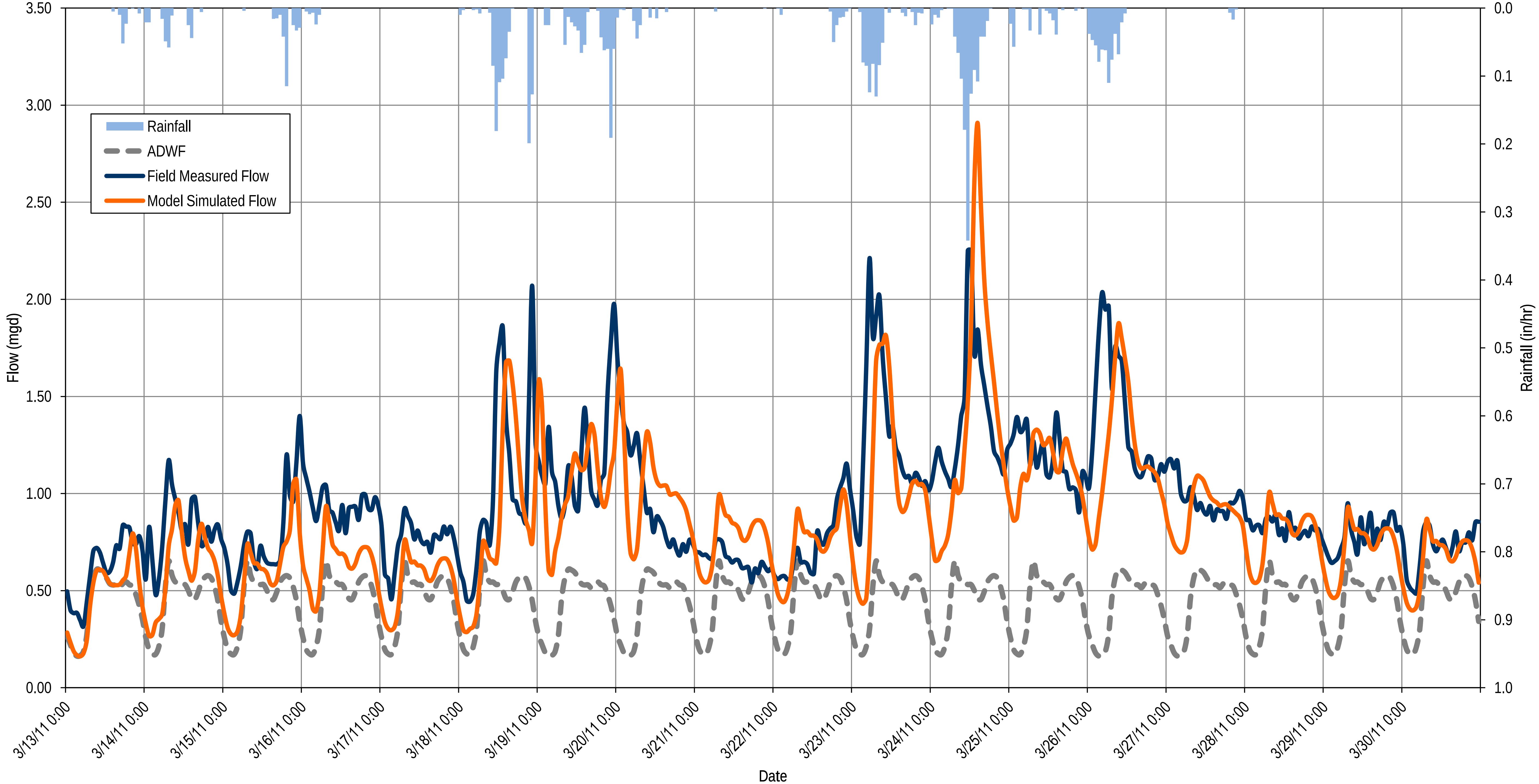


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_82.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 82B WET WEATHER CALIBRATION

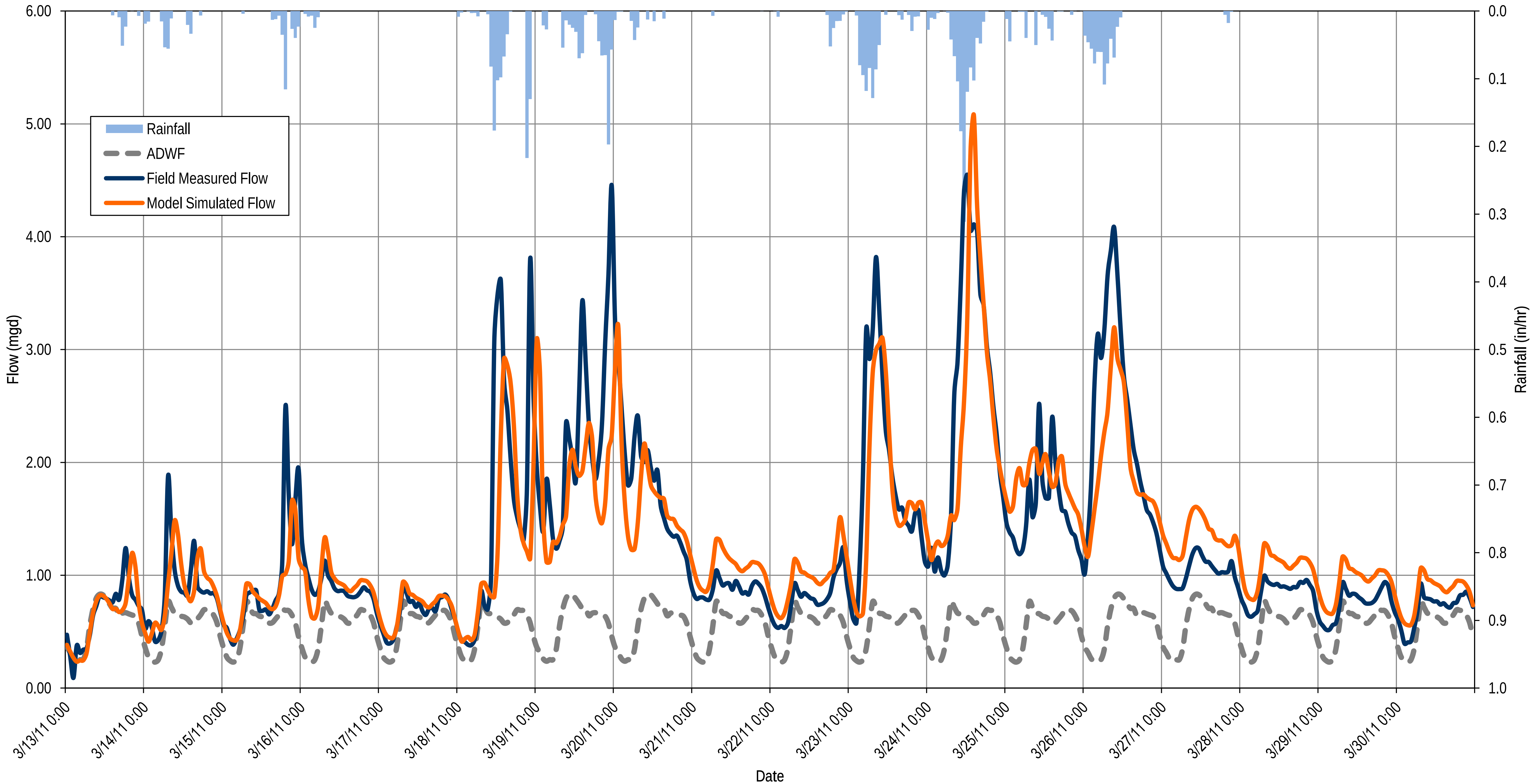


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82U-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

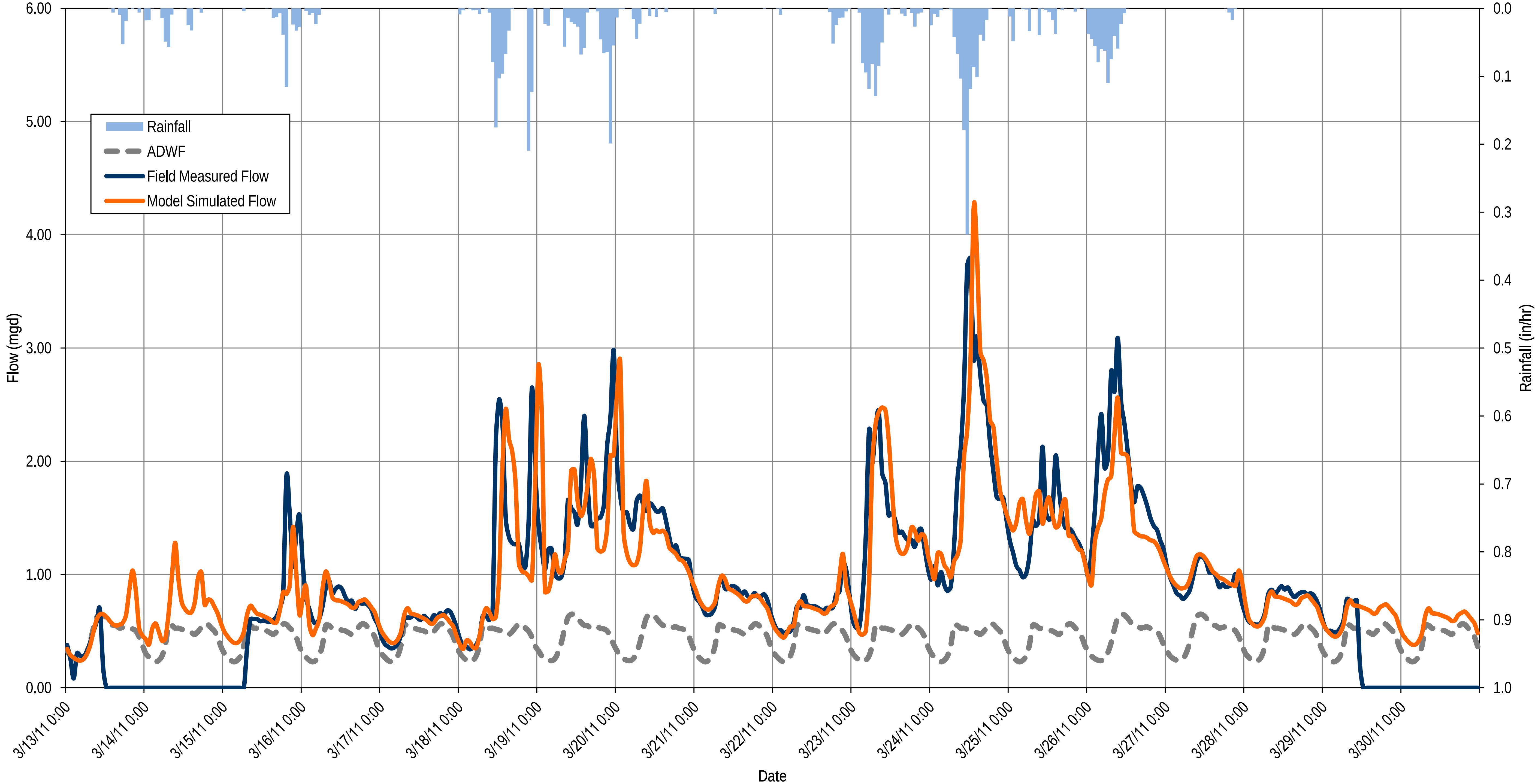
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_82.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 82L-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

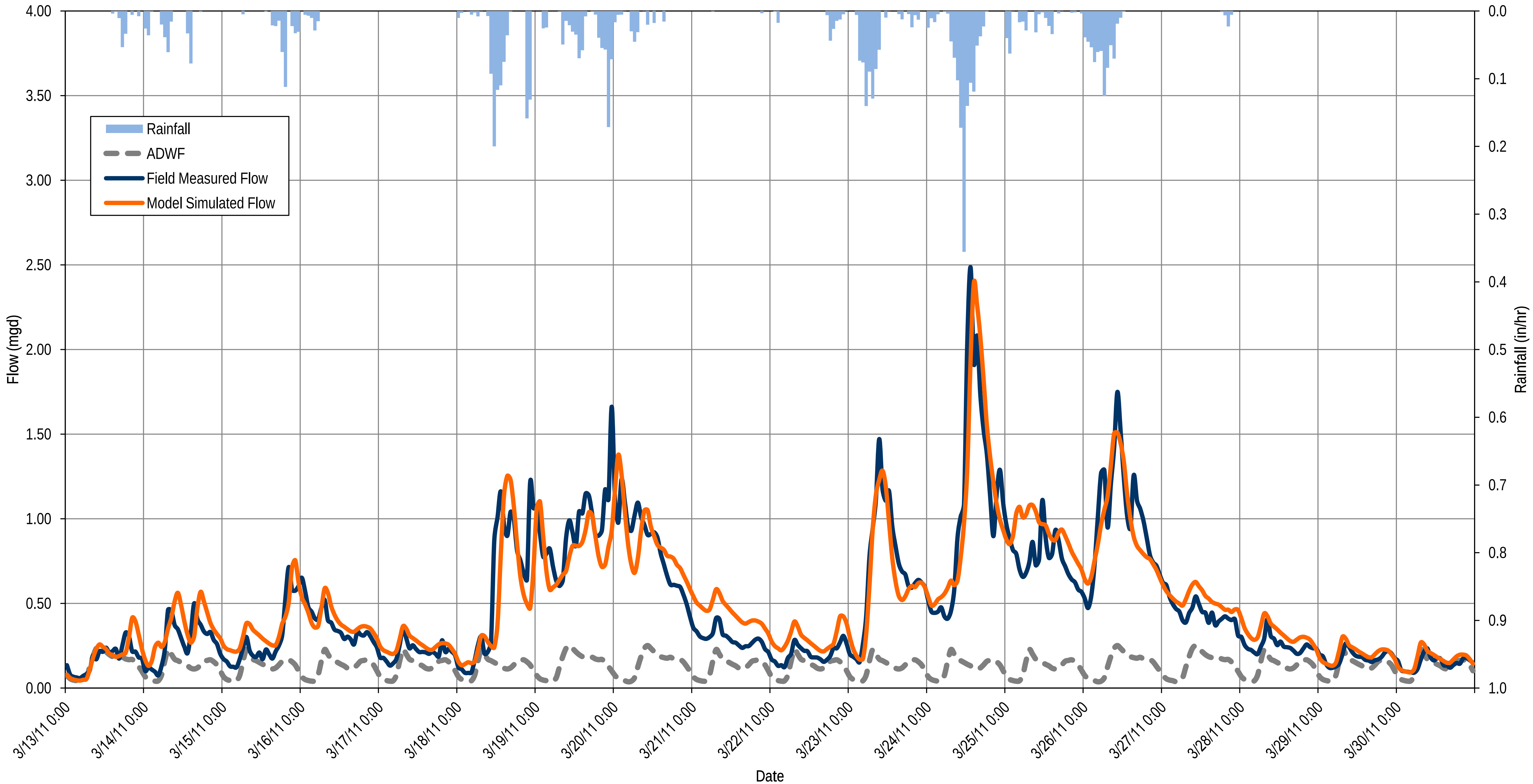
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_82.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

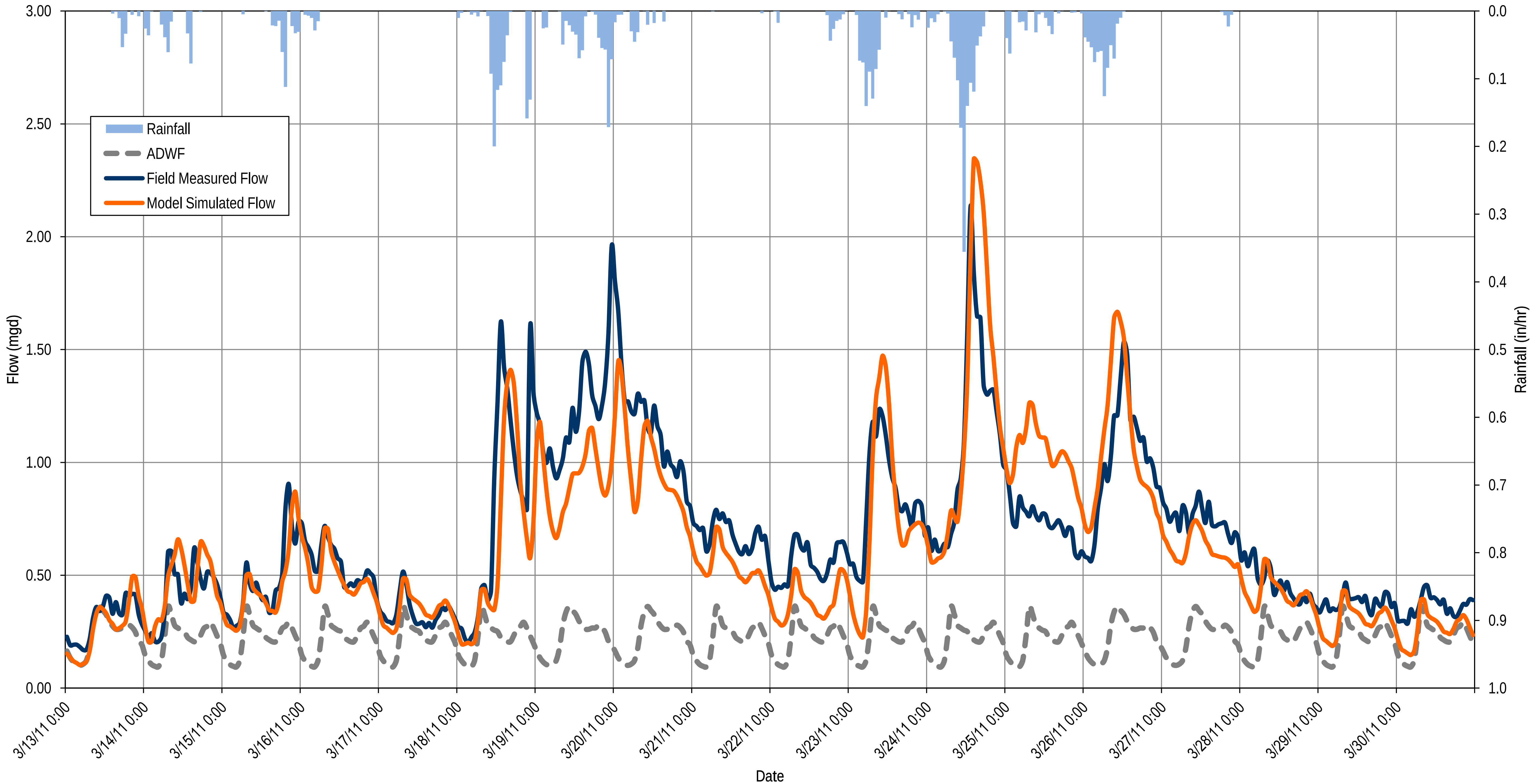
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

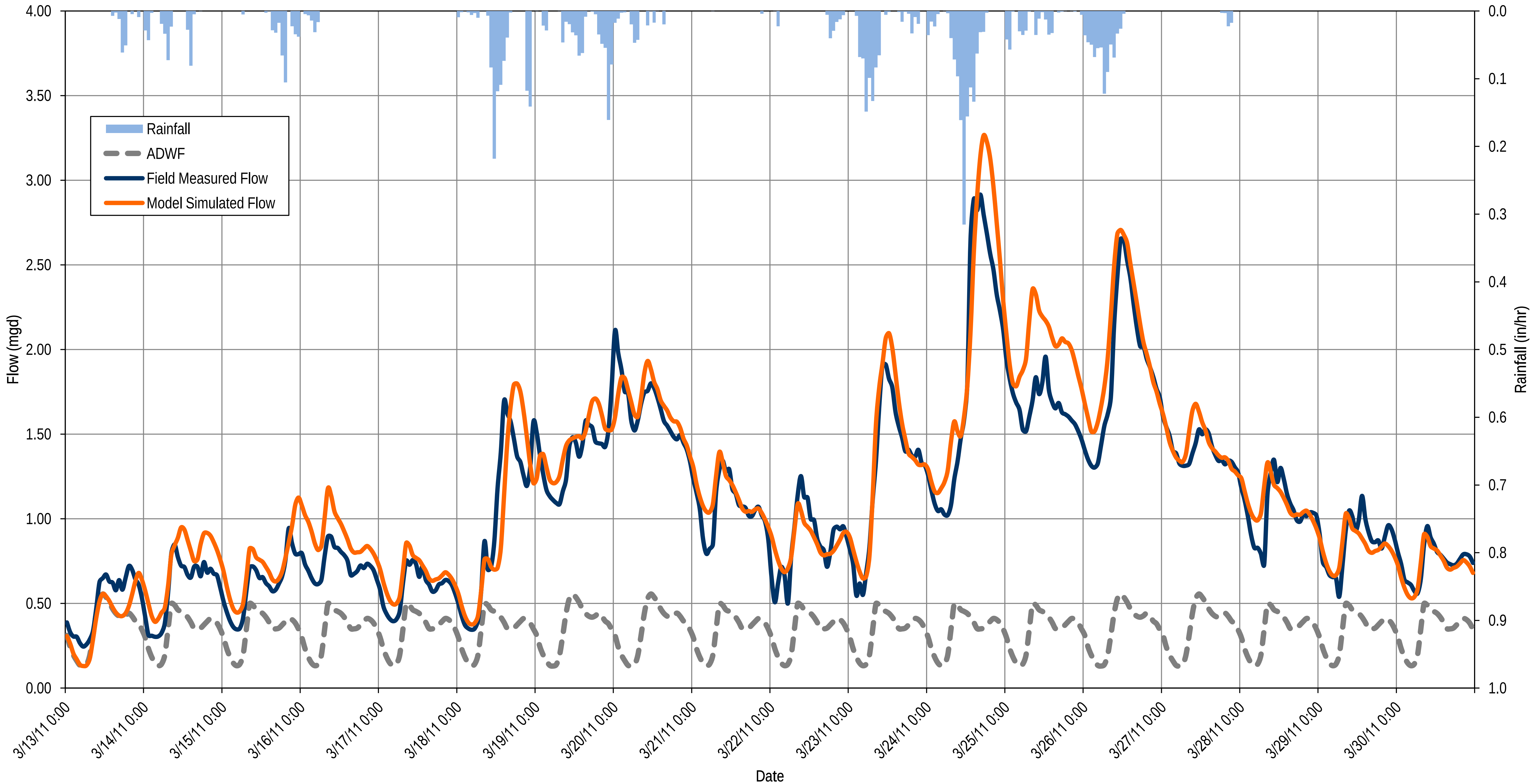
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83B.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 83C WET WEATHER CALIBRATION



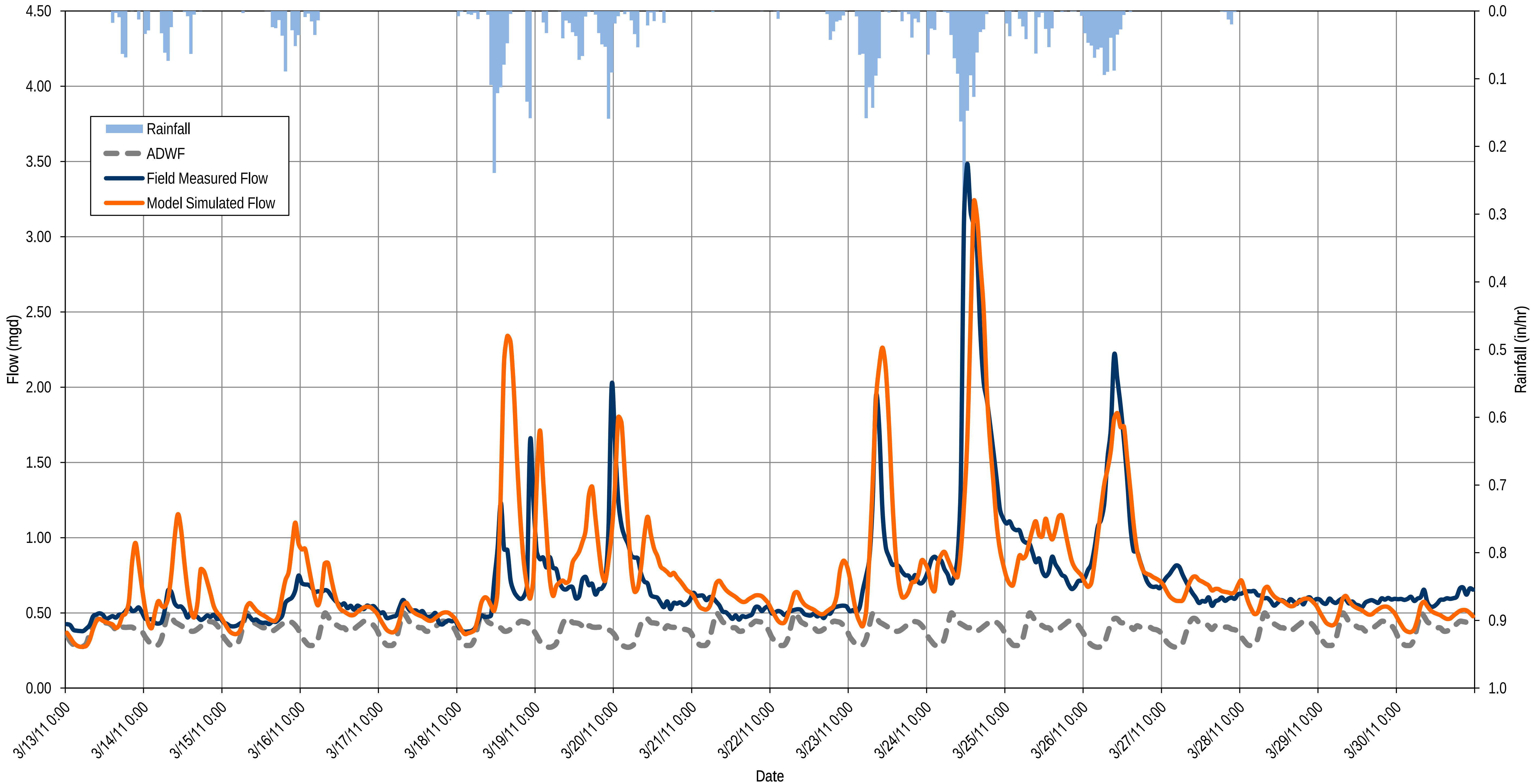
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83D WET WEATHER CALIBRATION

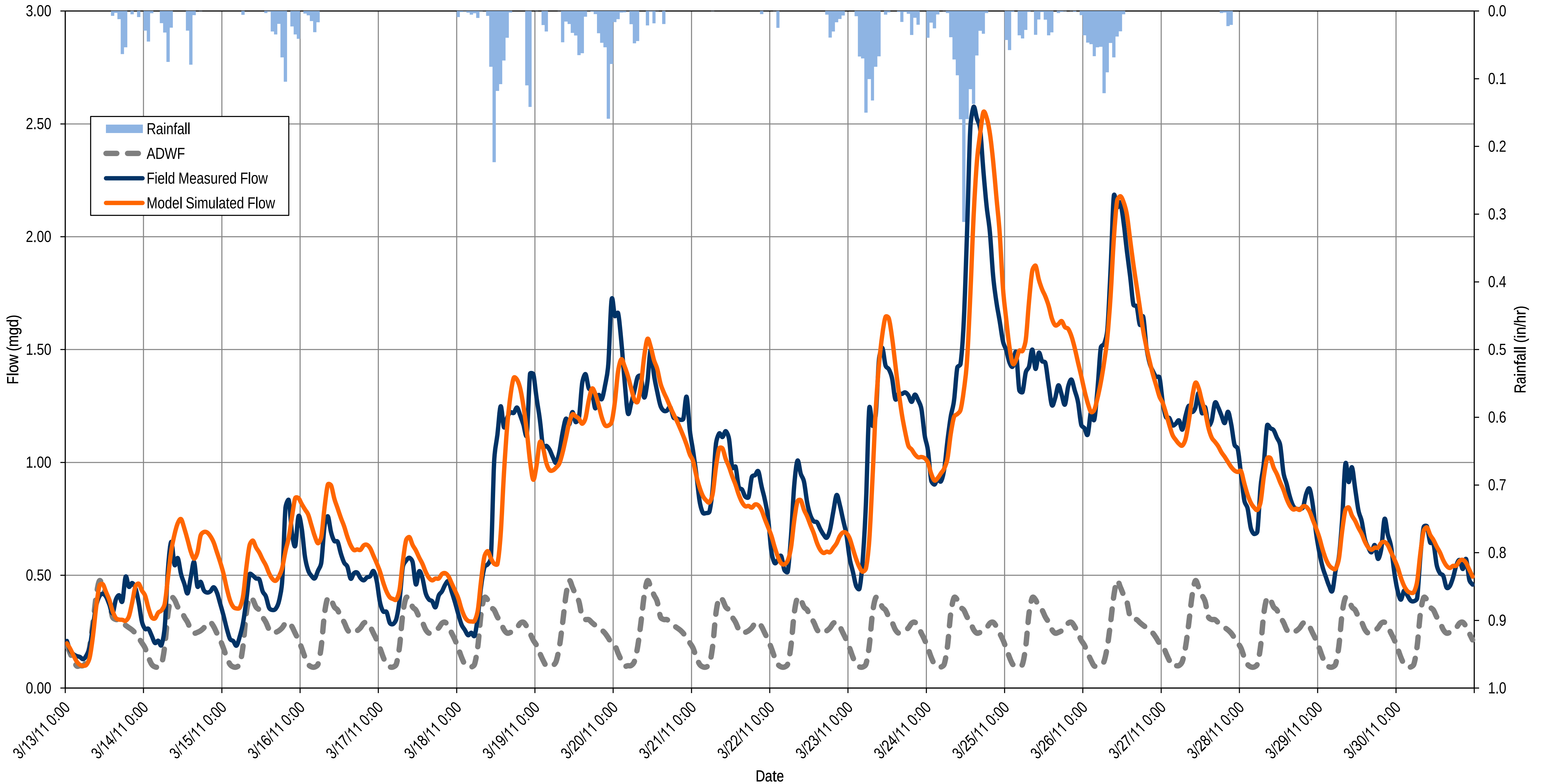


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83E WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

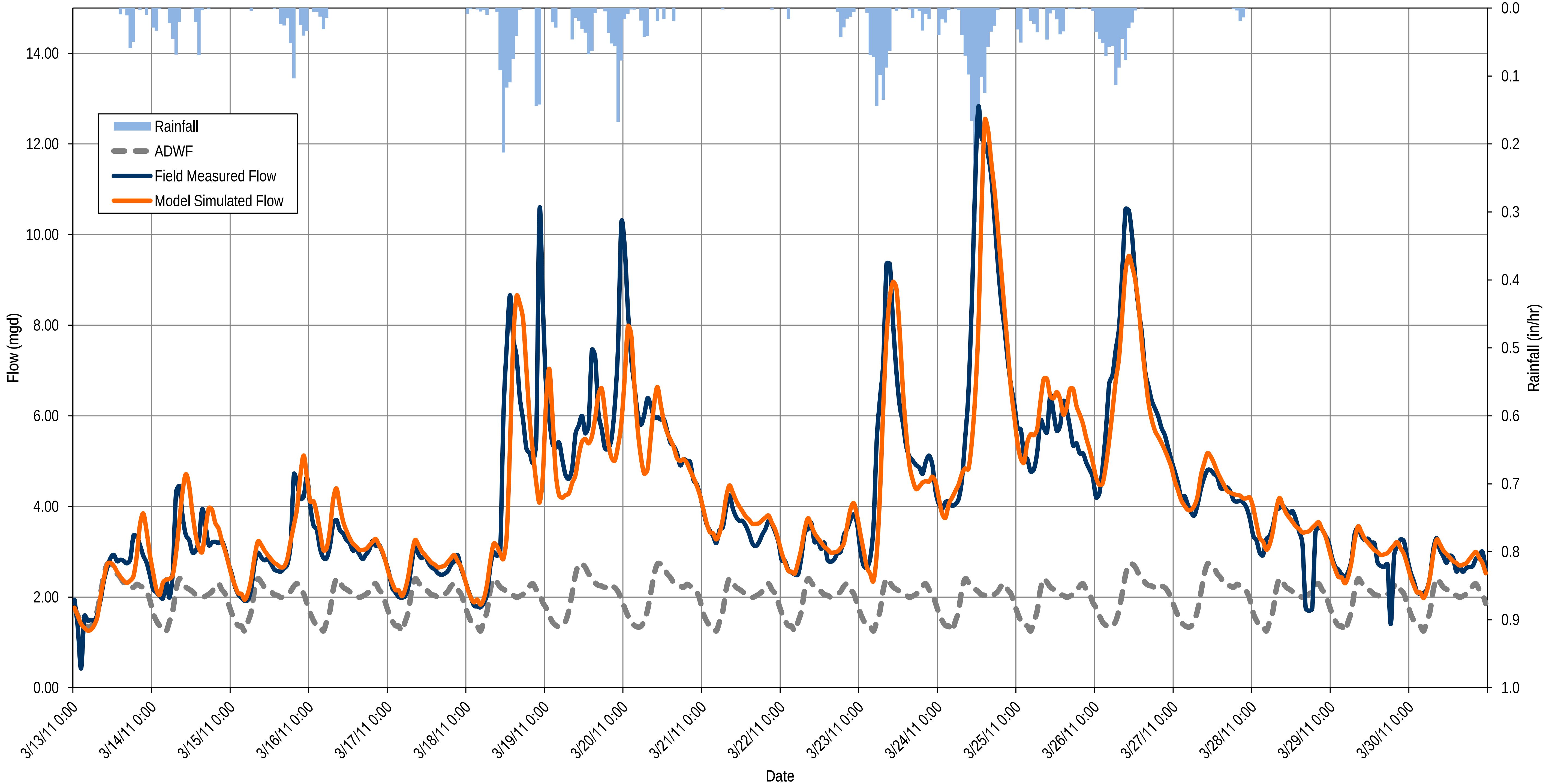
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83L-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

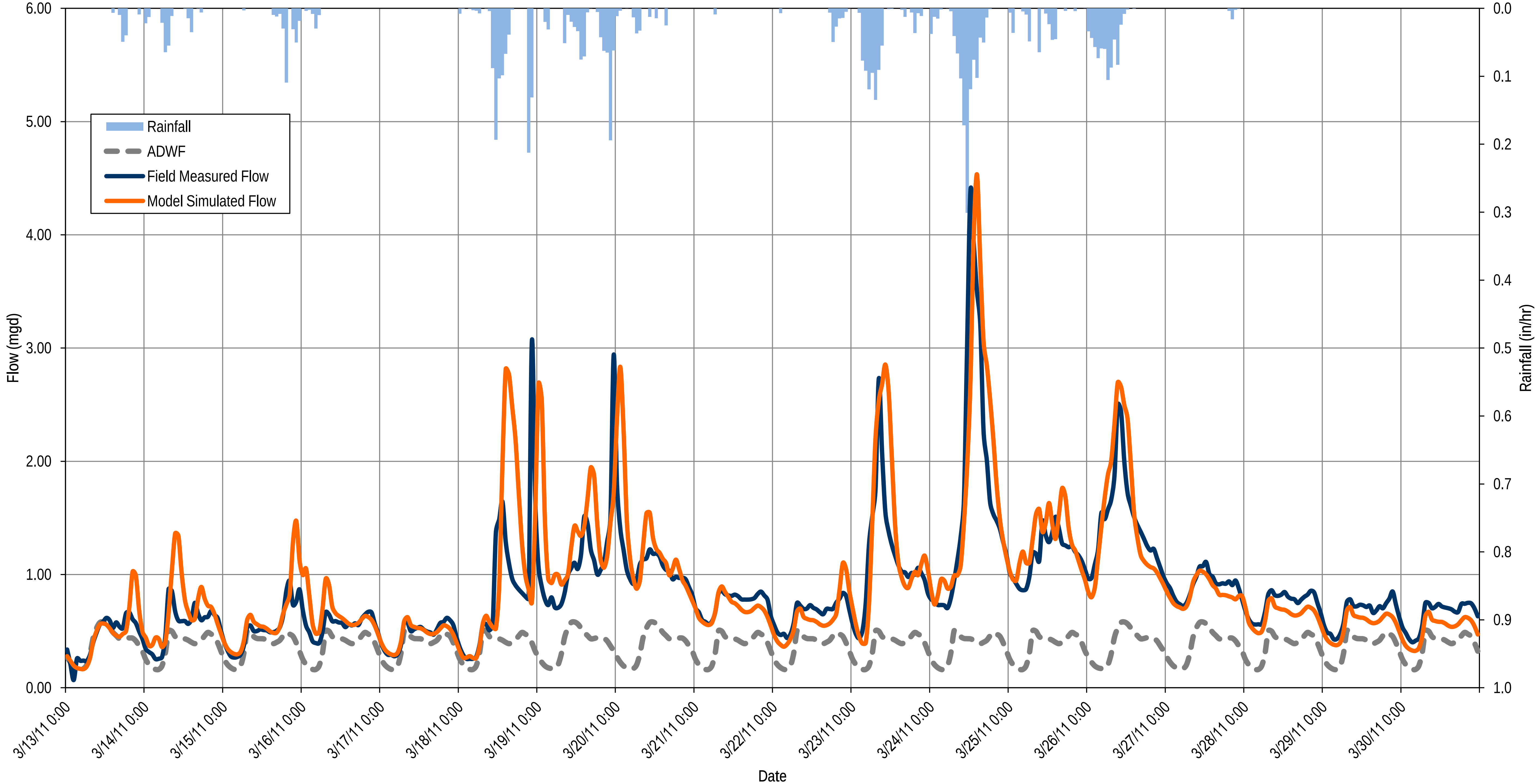
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83L-2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

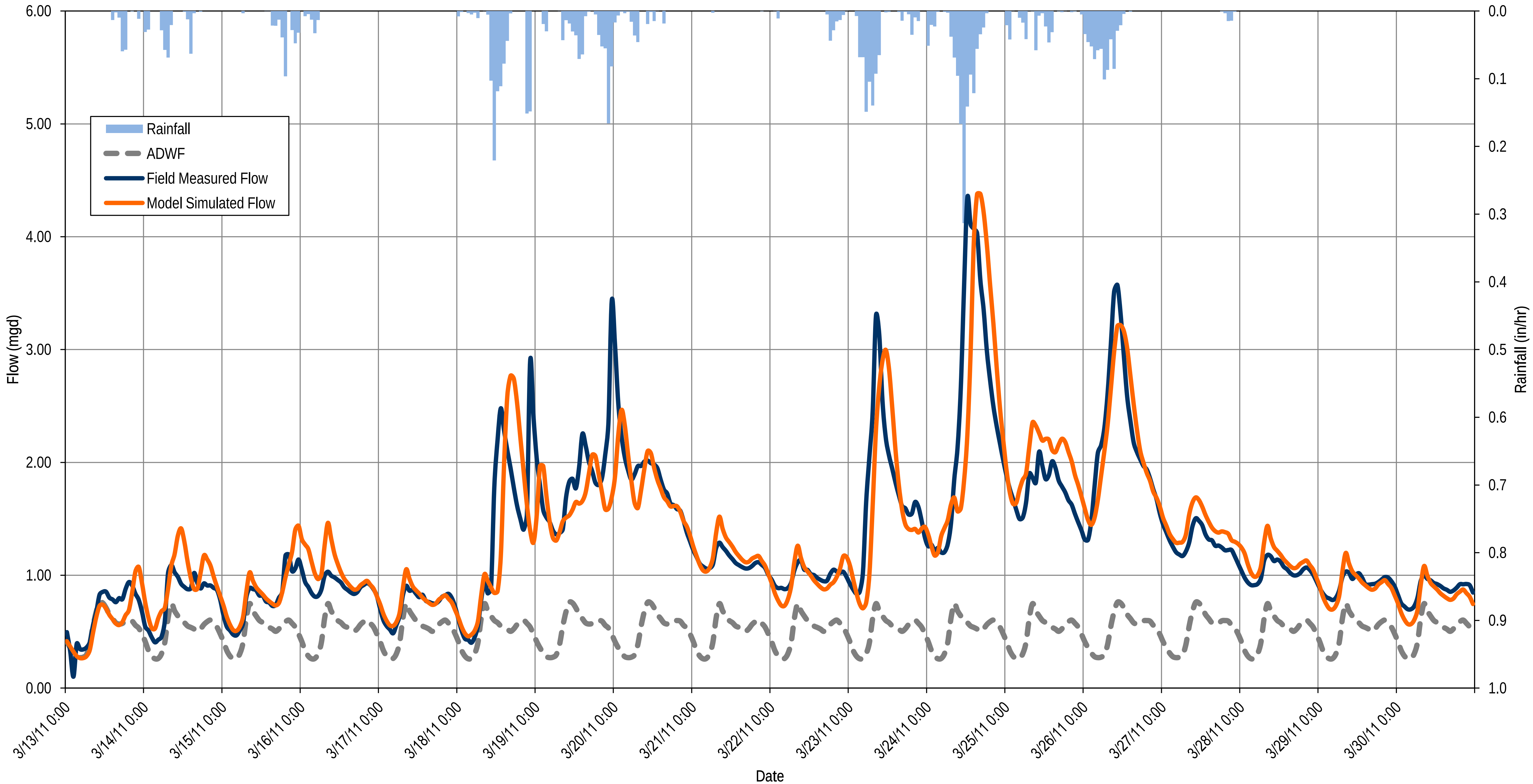
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

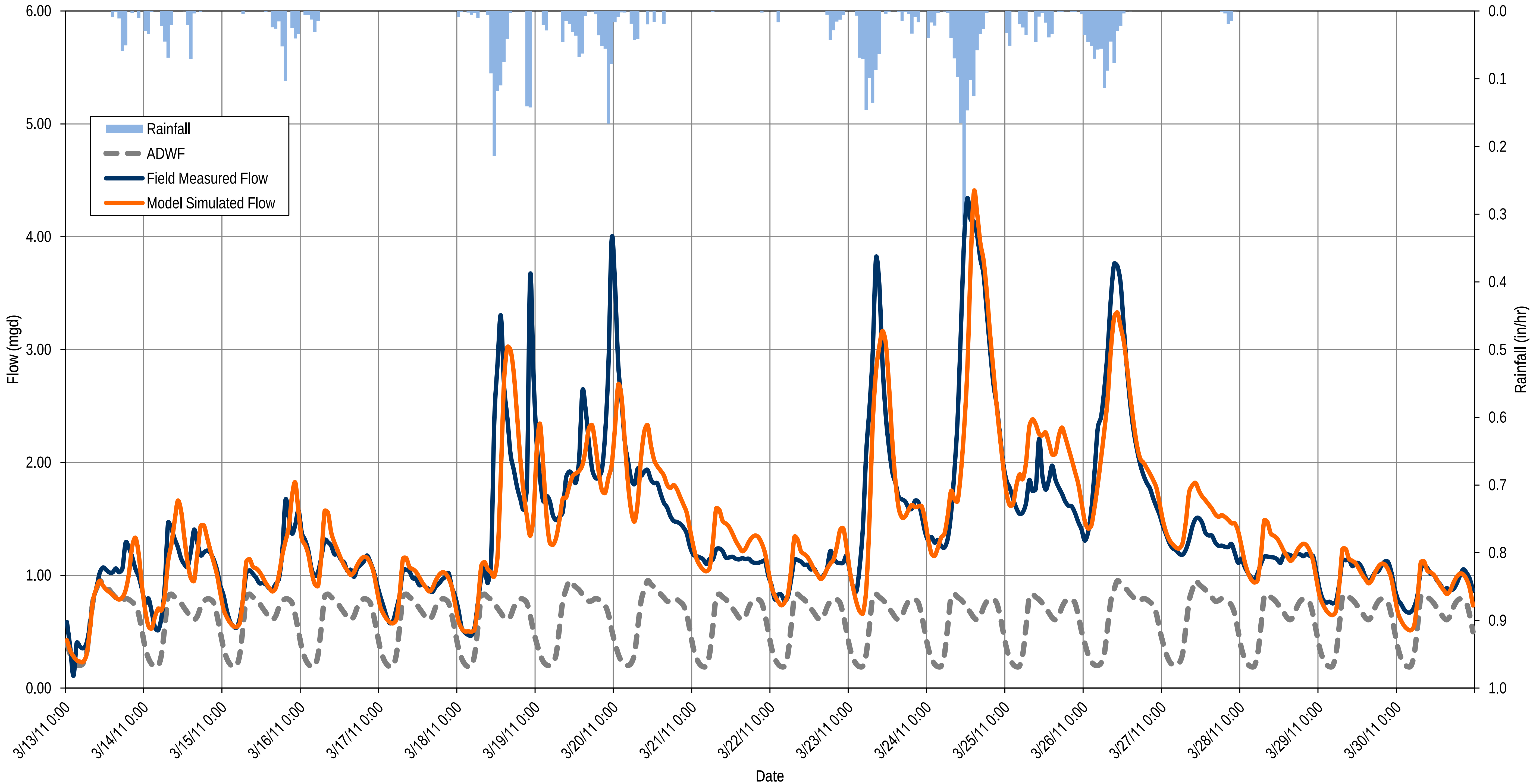
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-2 WET WEATHER CALIBRATION



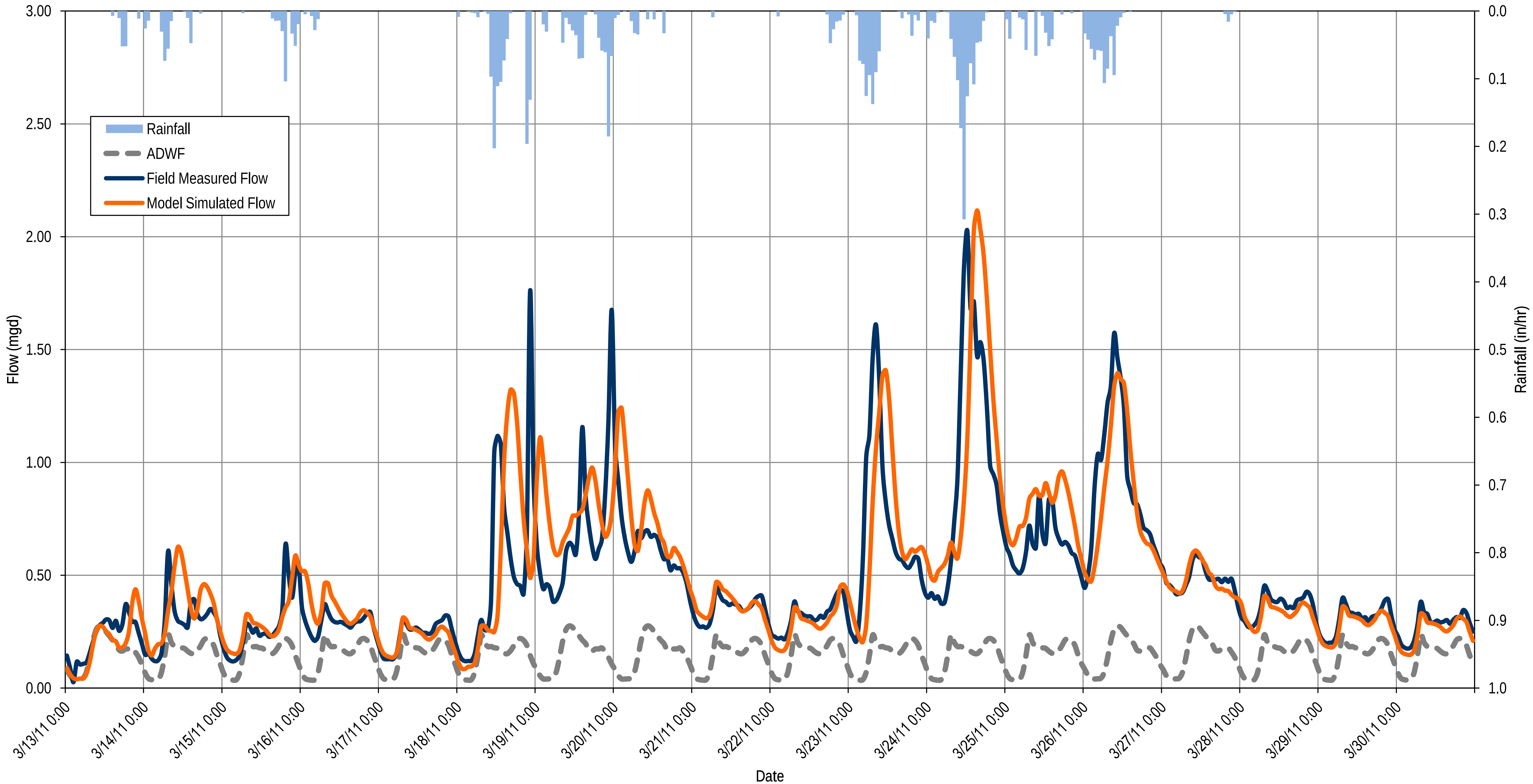
Wet Weather Flow Monitoring Comparison Chart

(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 83U-3 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

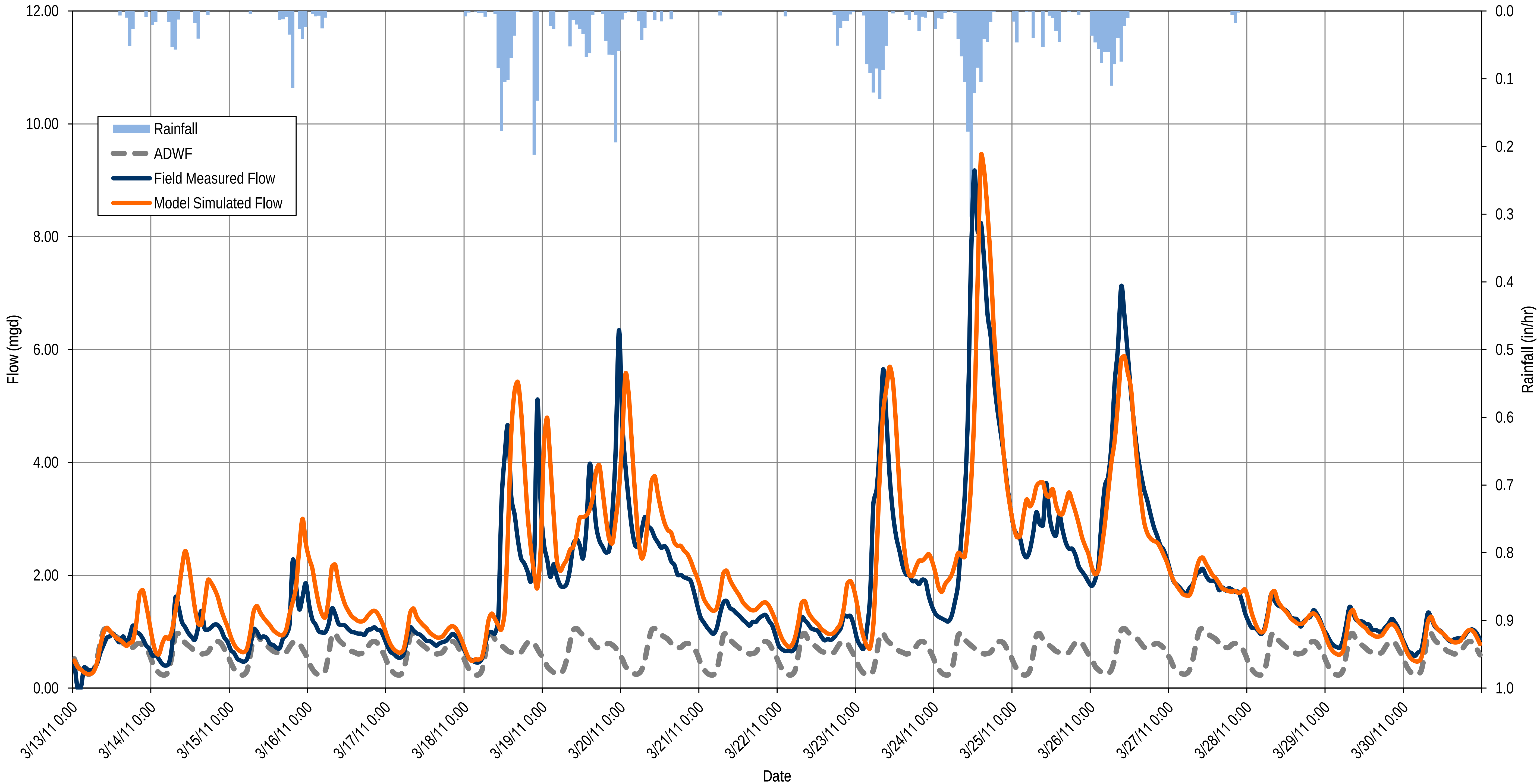
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-4 WET WEATHER CALIBRATION

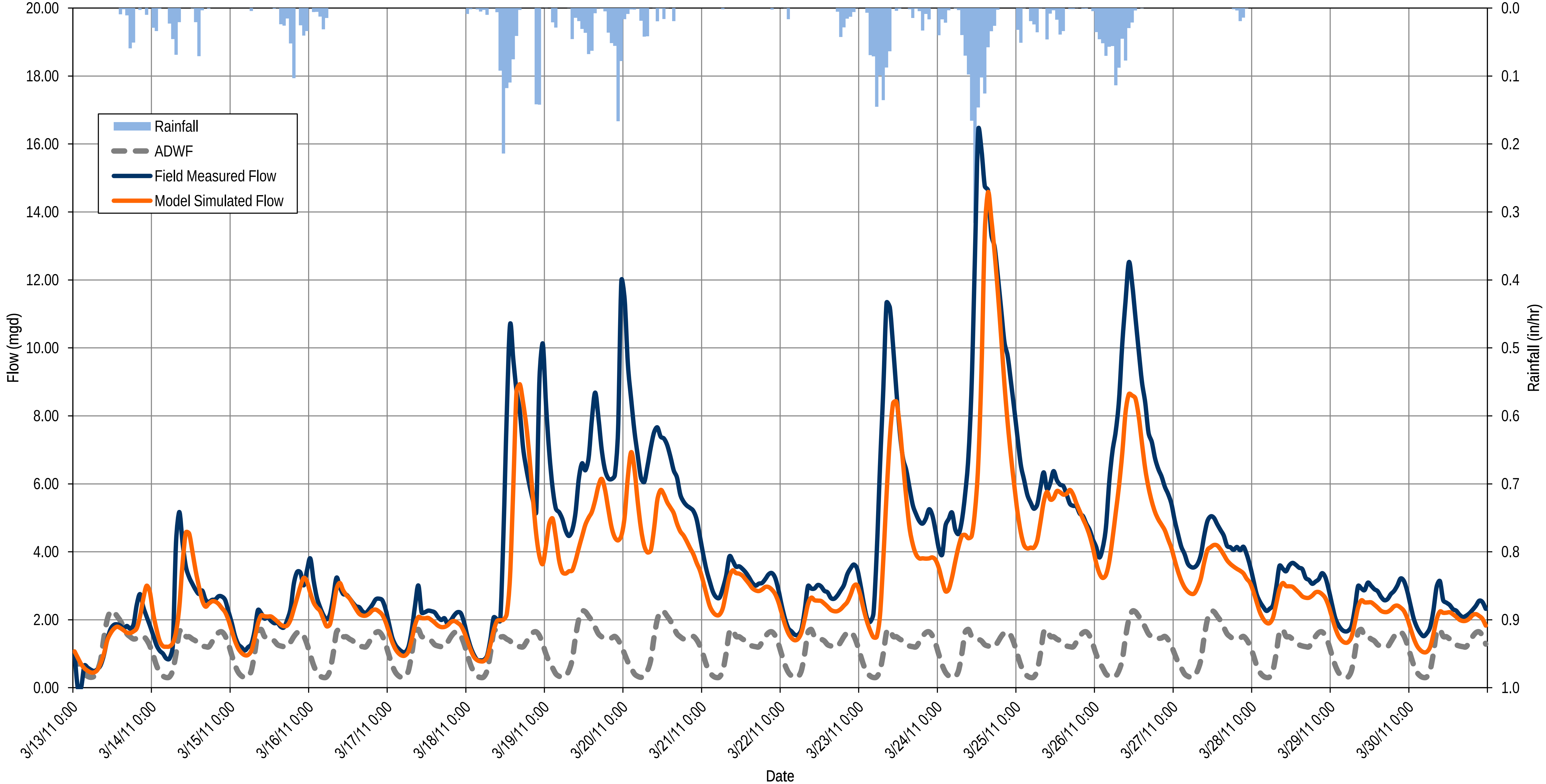


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 83U-F WET WEATHER CALIBRATION



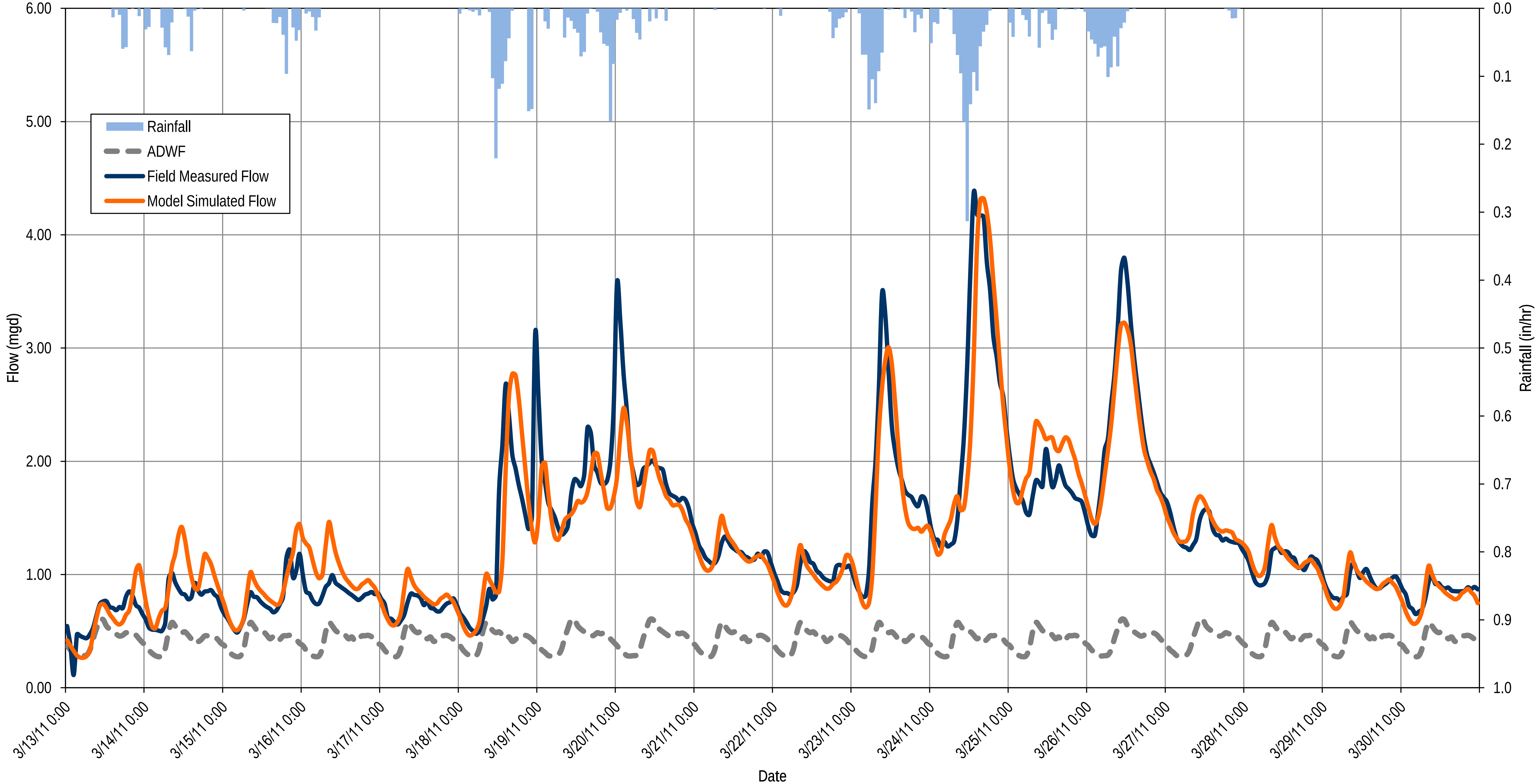
Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-1X WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

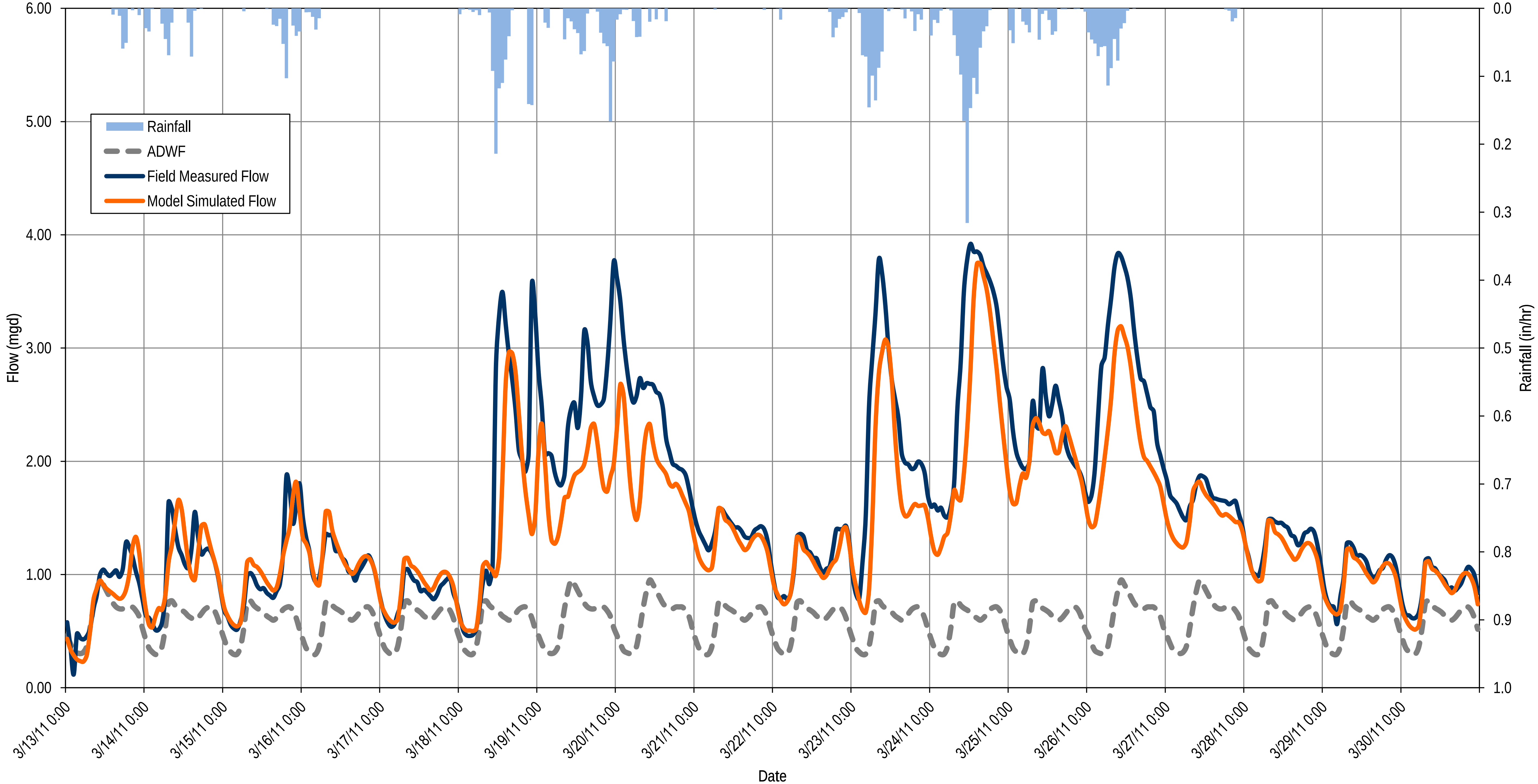
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-2X WET WEATHER CALIBRATION

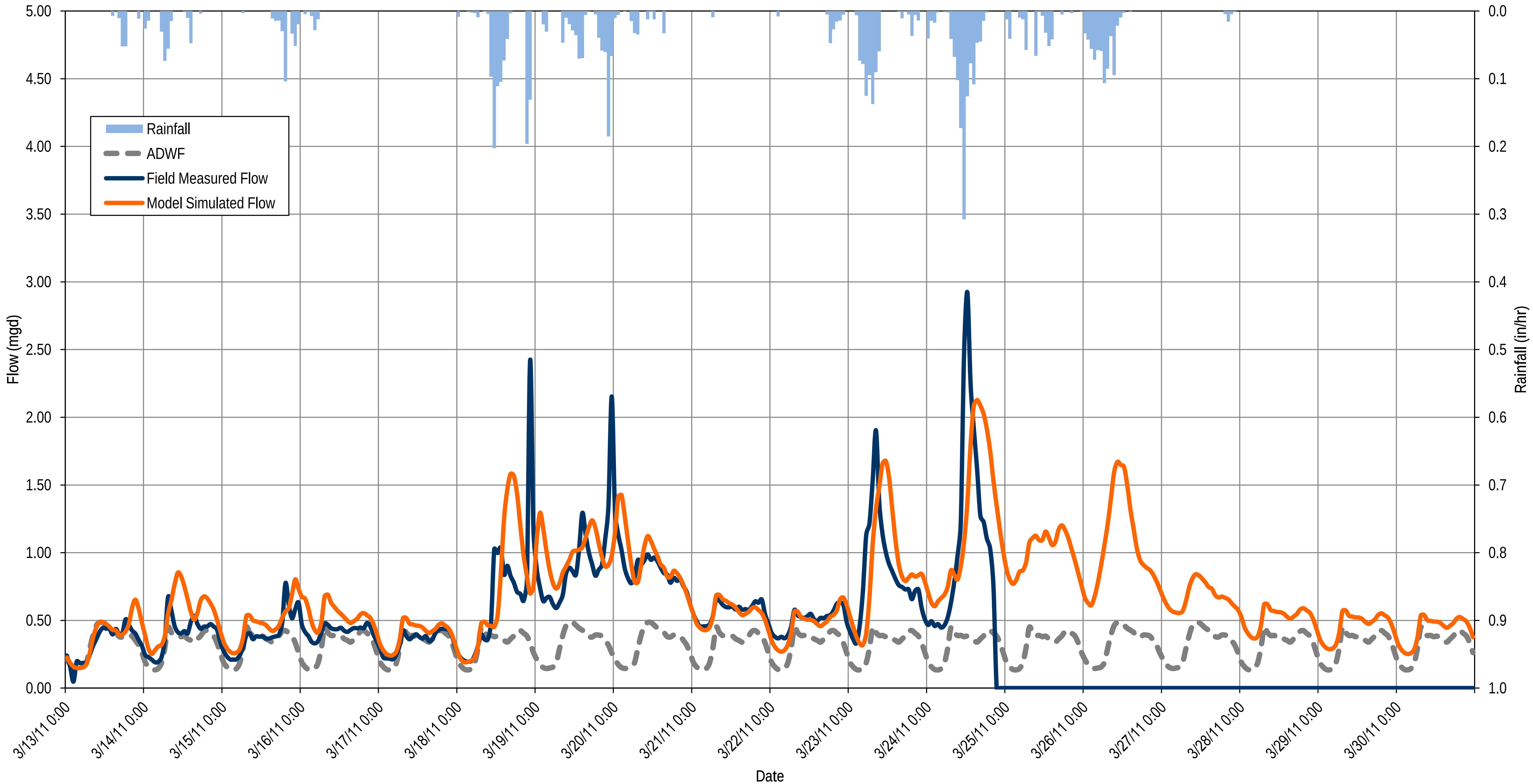


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 83U-3X WET WEATHER CALIBRATION

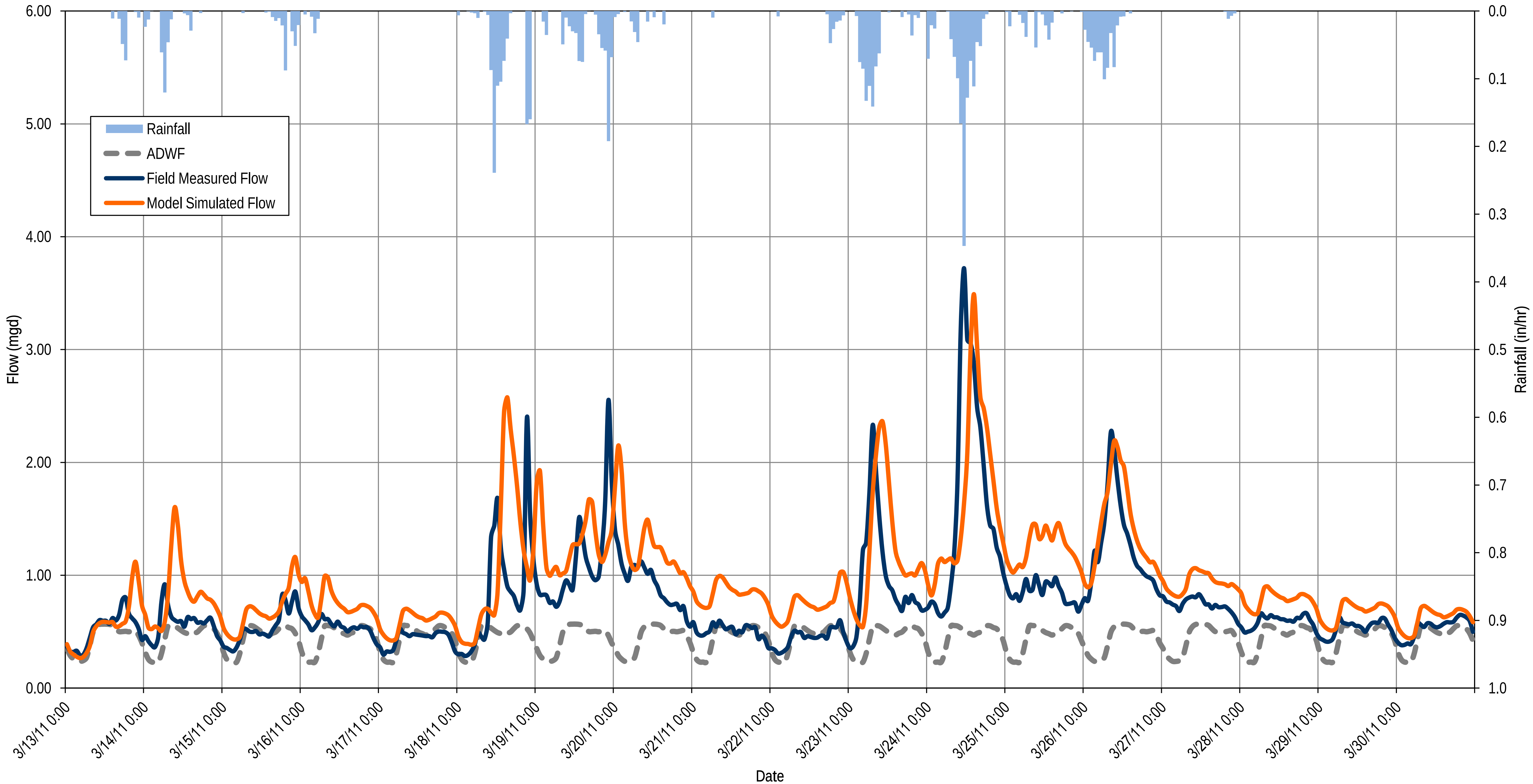


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_83.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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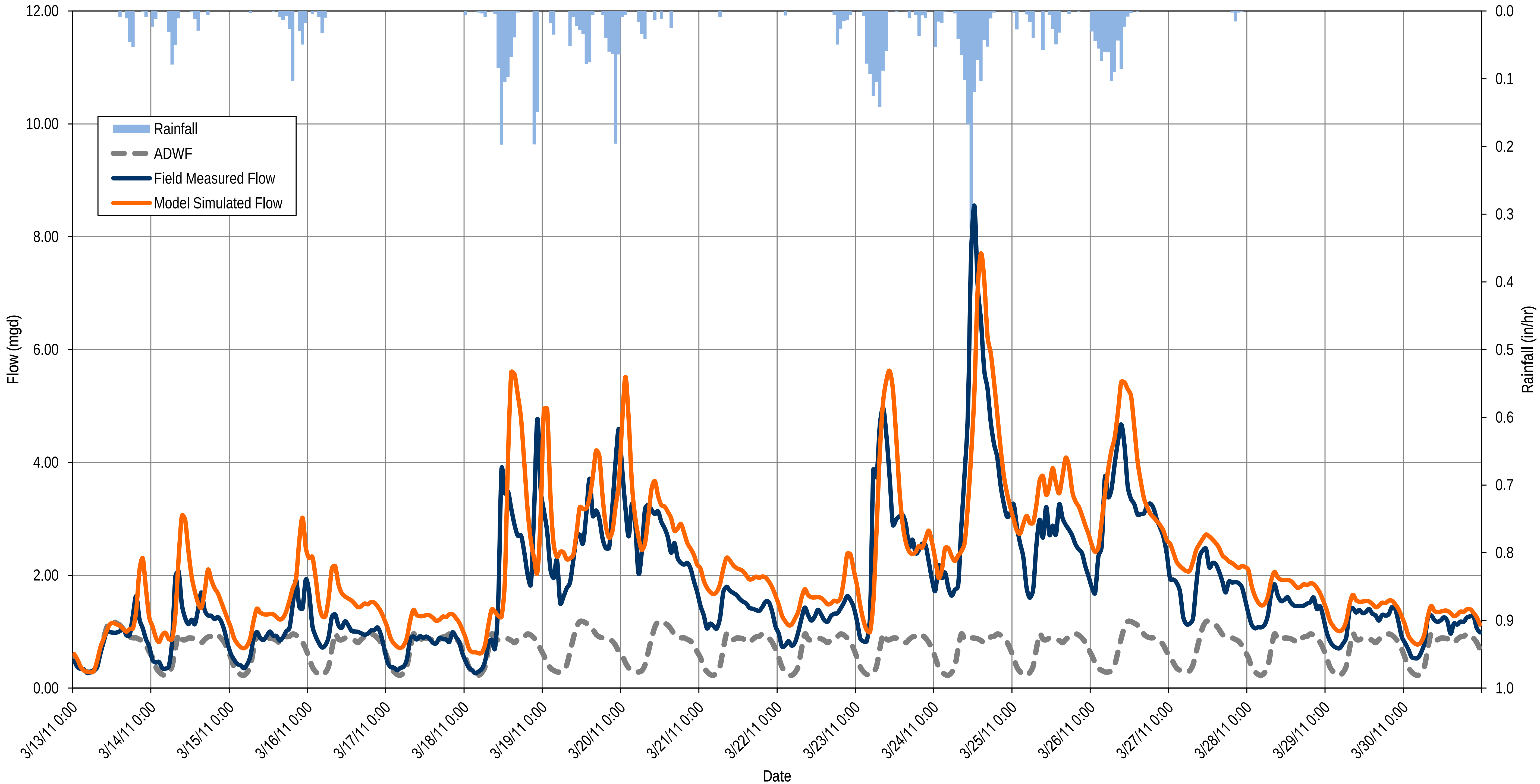
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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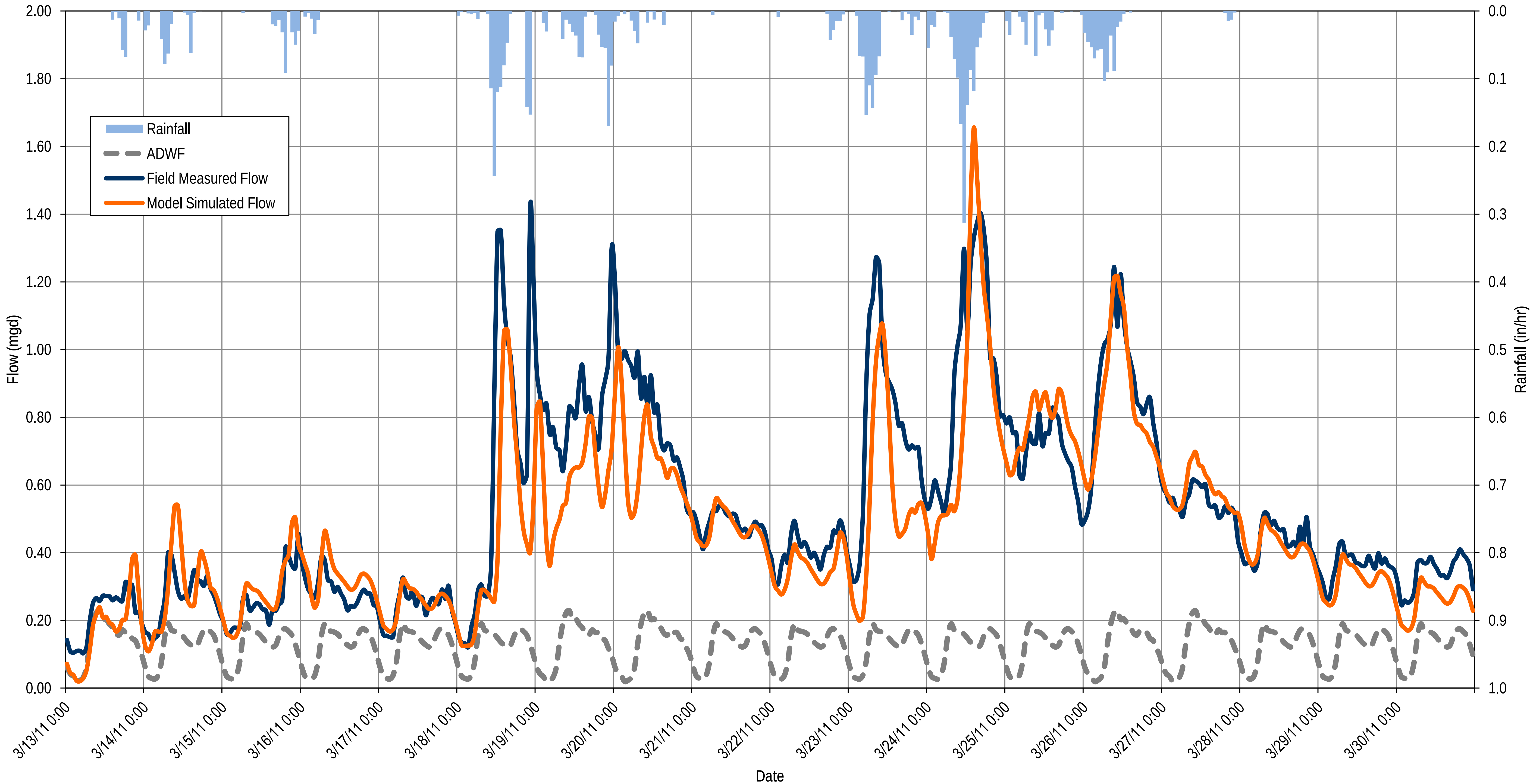
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84C WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

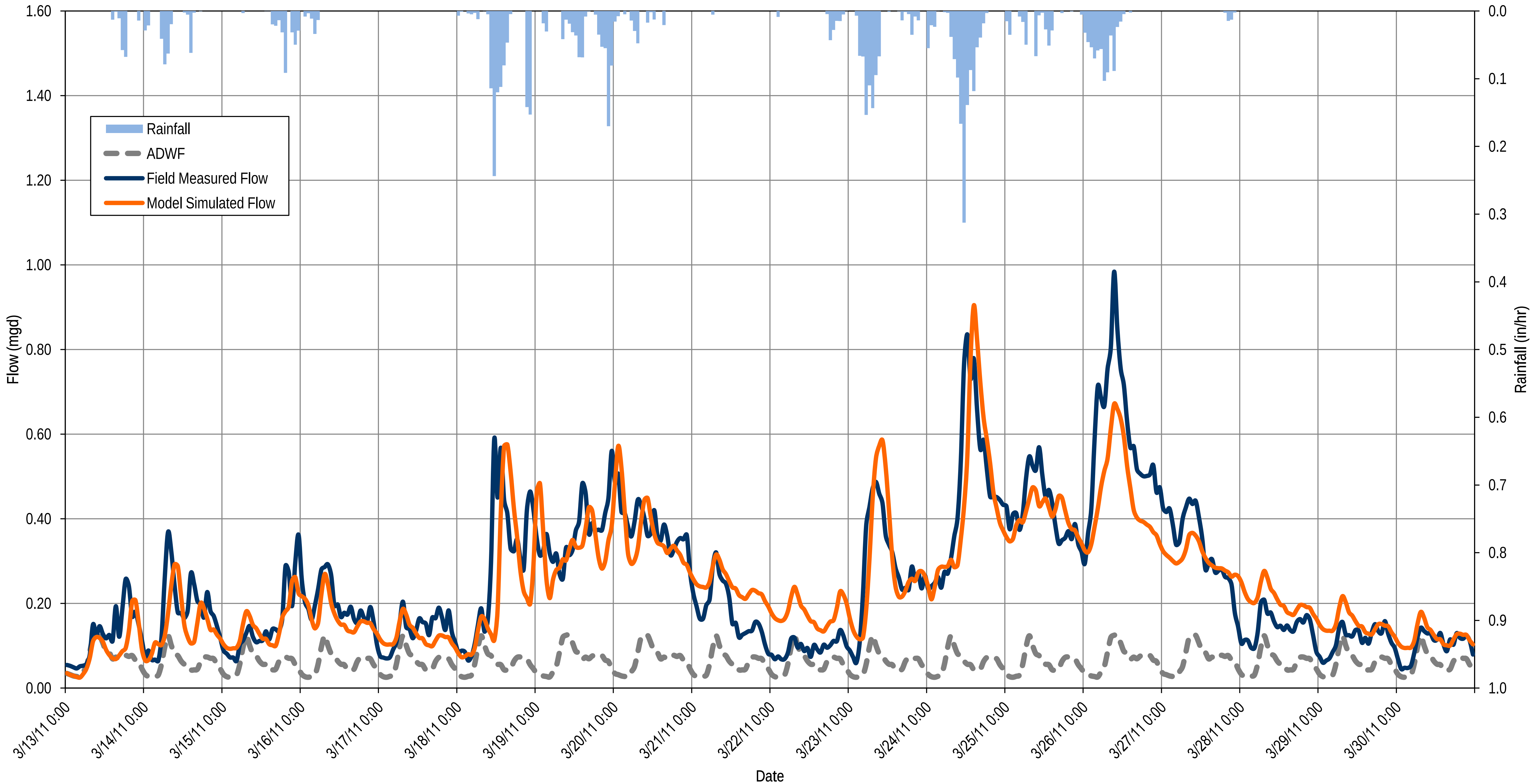
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_84.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84C.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

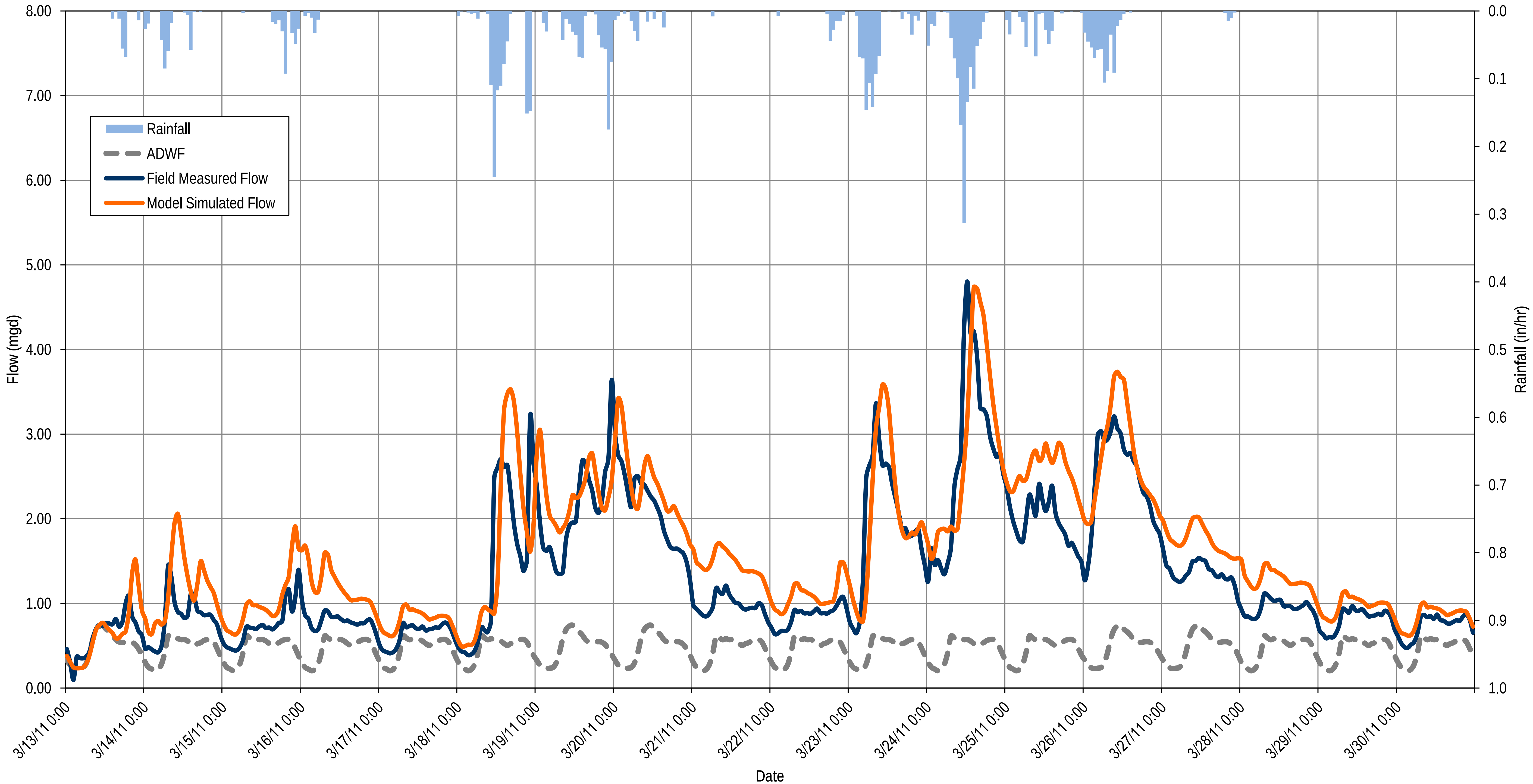
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_84.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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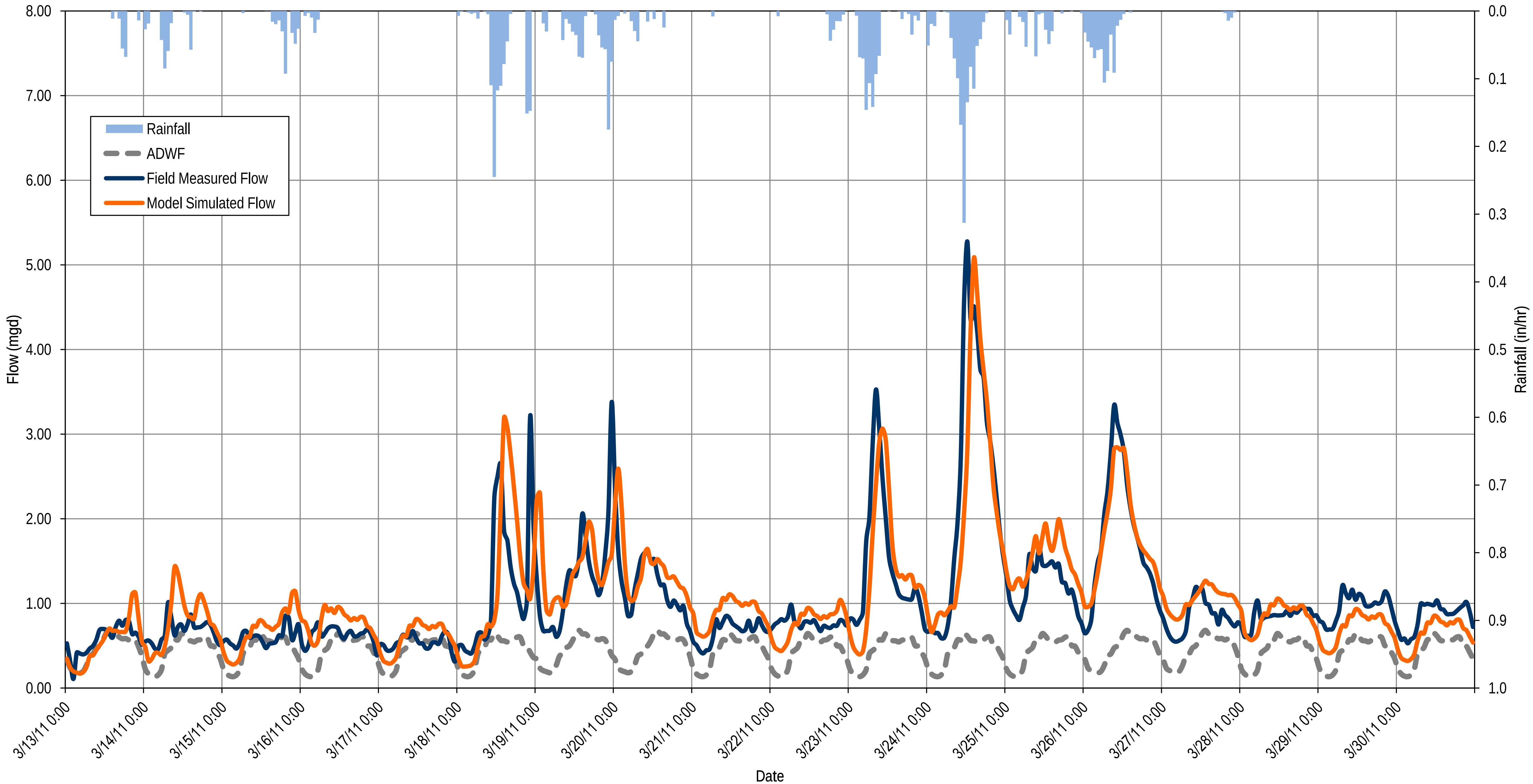
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

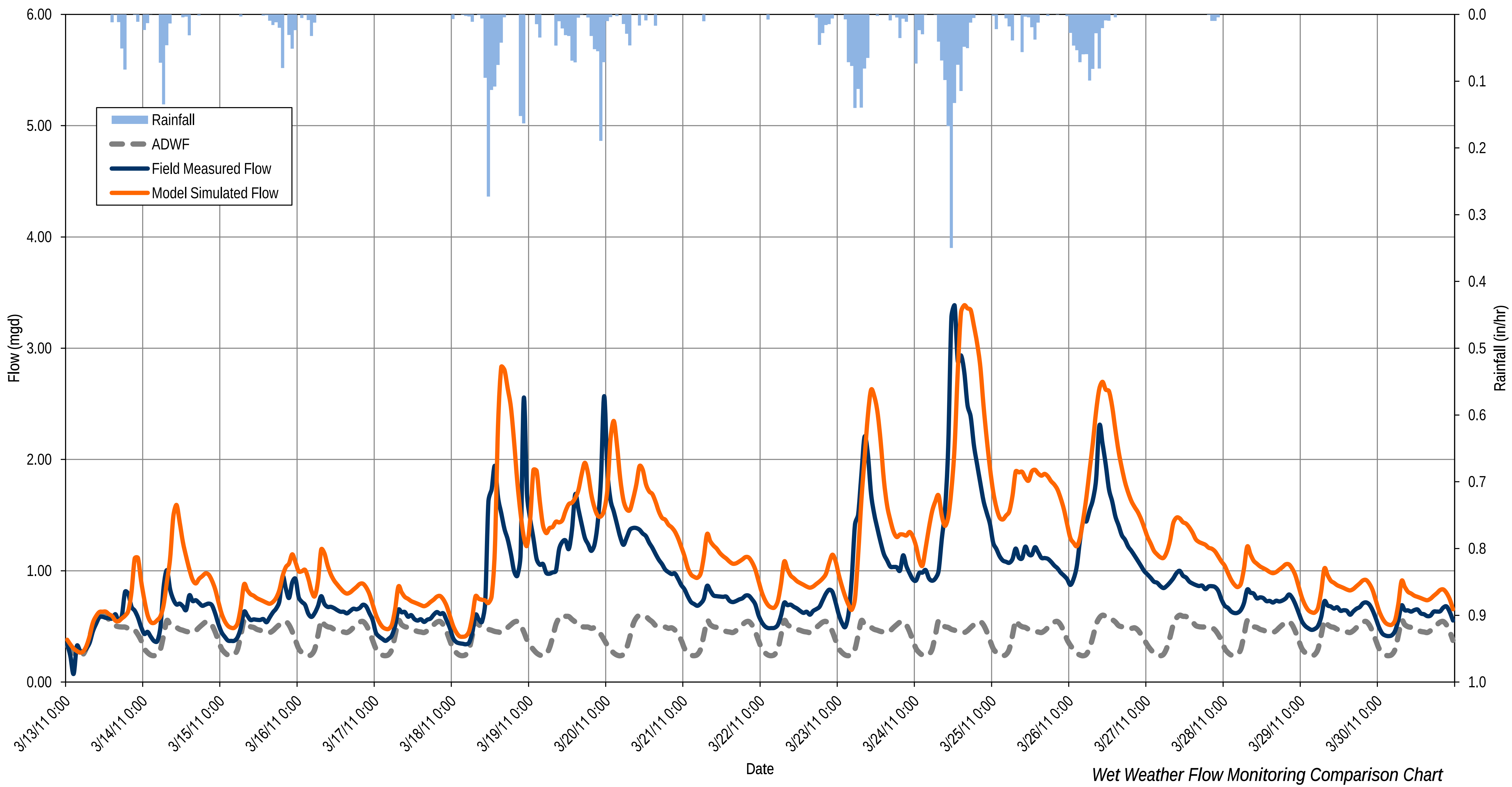
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_84.xlsx

City of Oakland

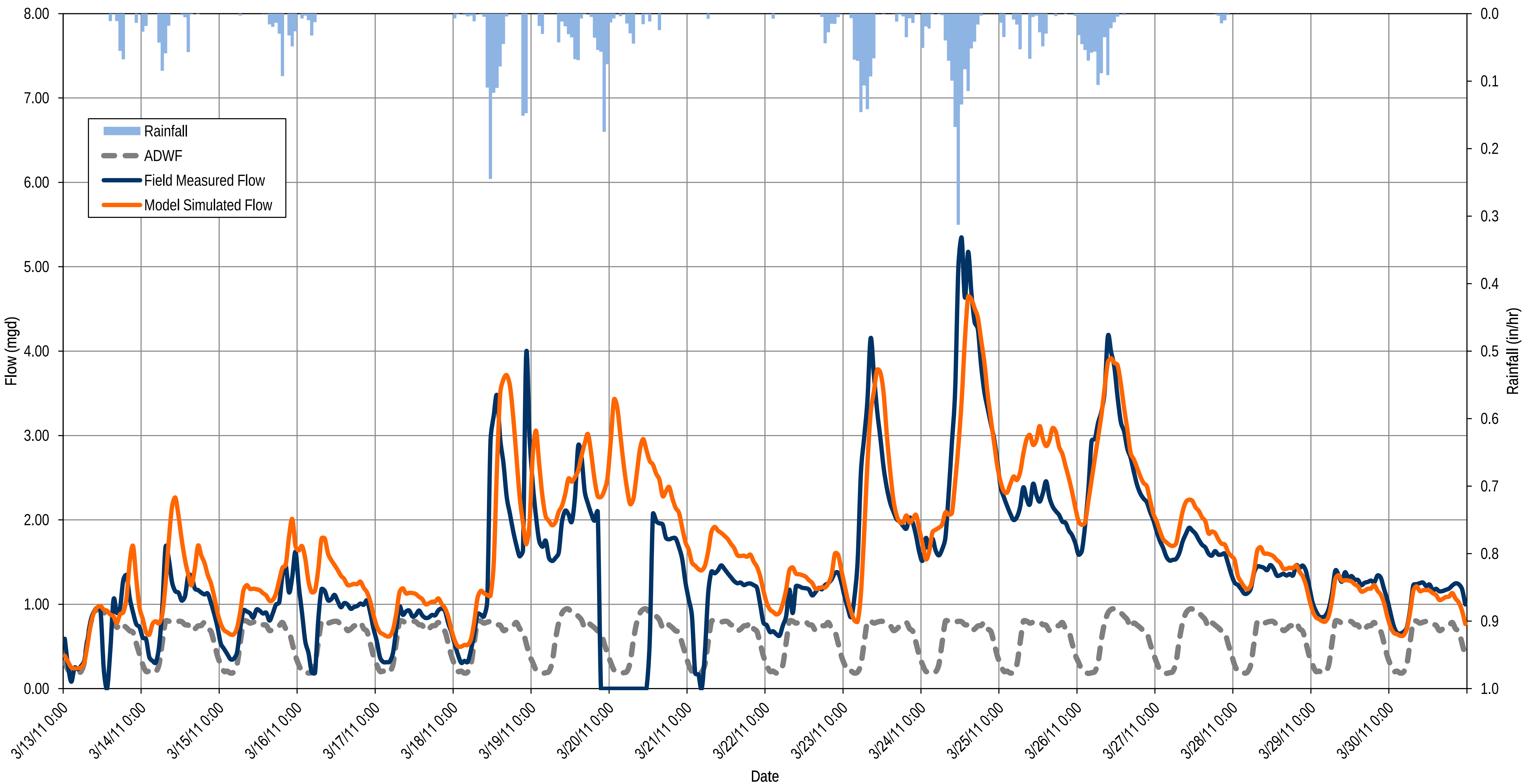
Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-3 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84U-1X WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/230/2011 Rainfall Event)

DRAFT - October 4, 2012
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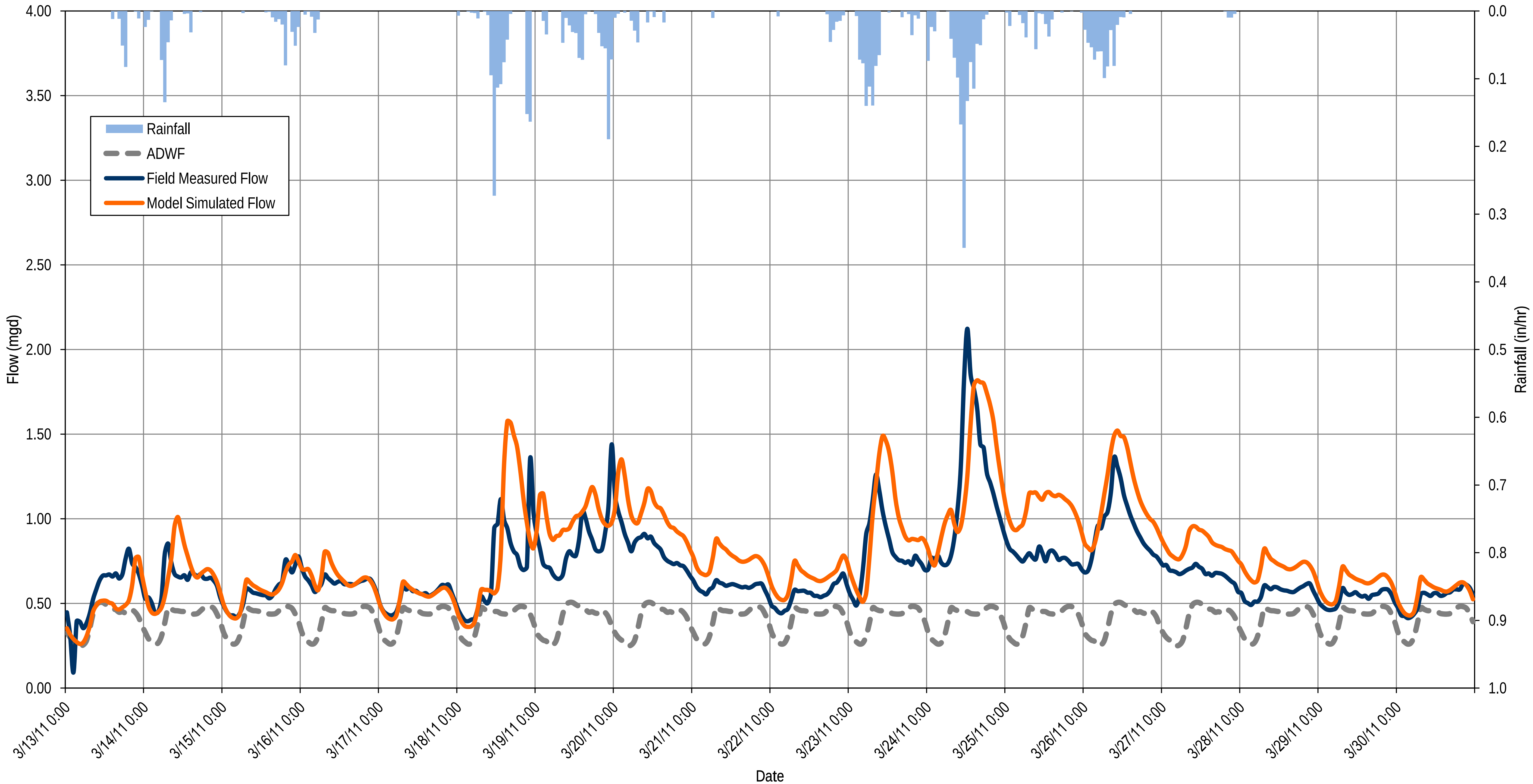
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-3X WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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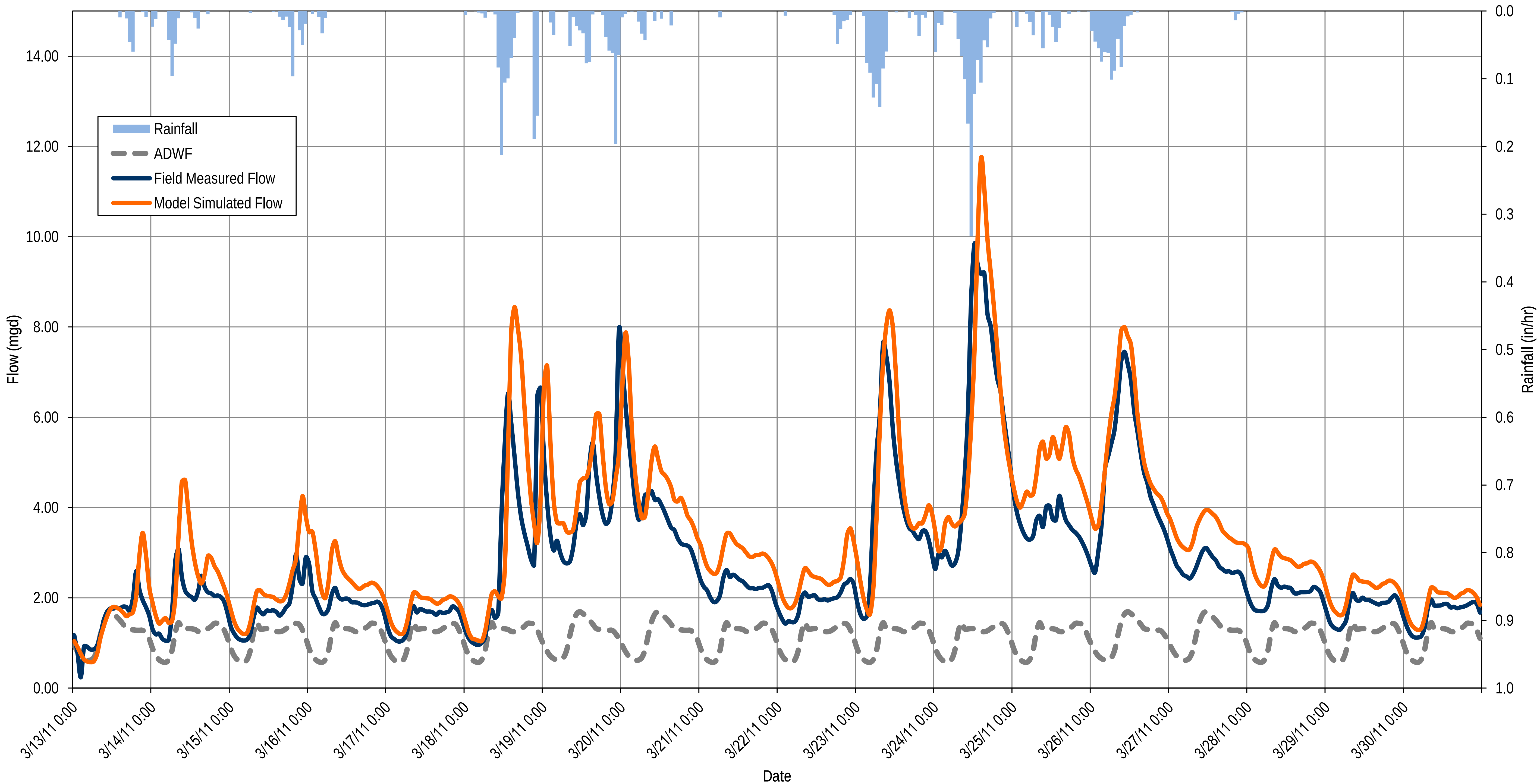
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84L-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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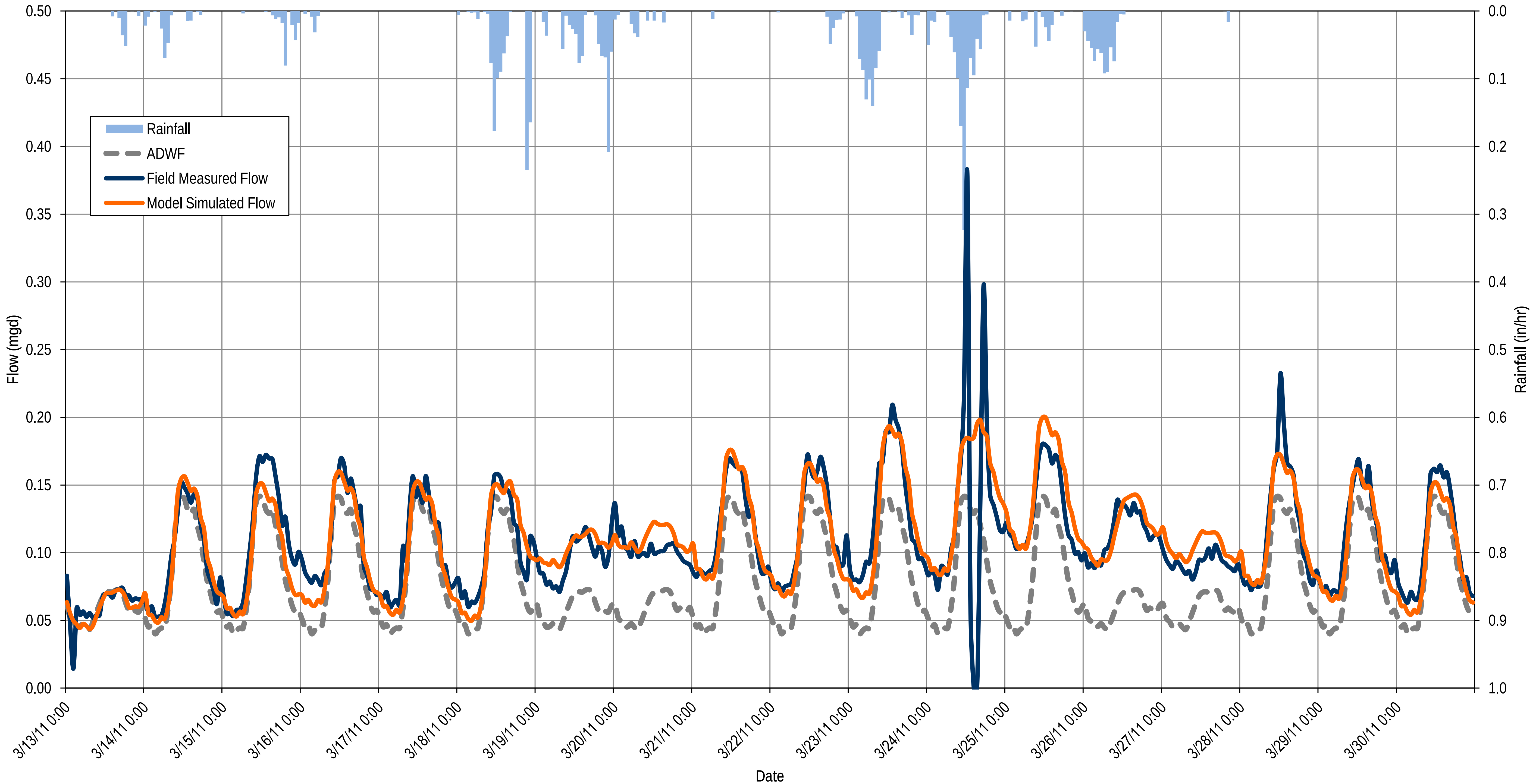
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 84L-2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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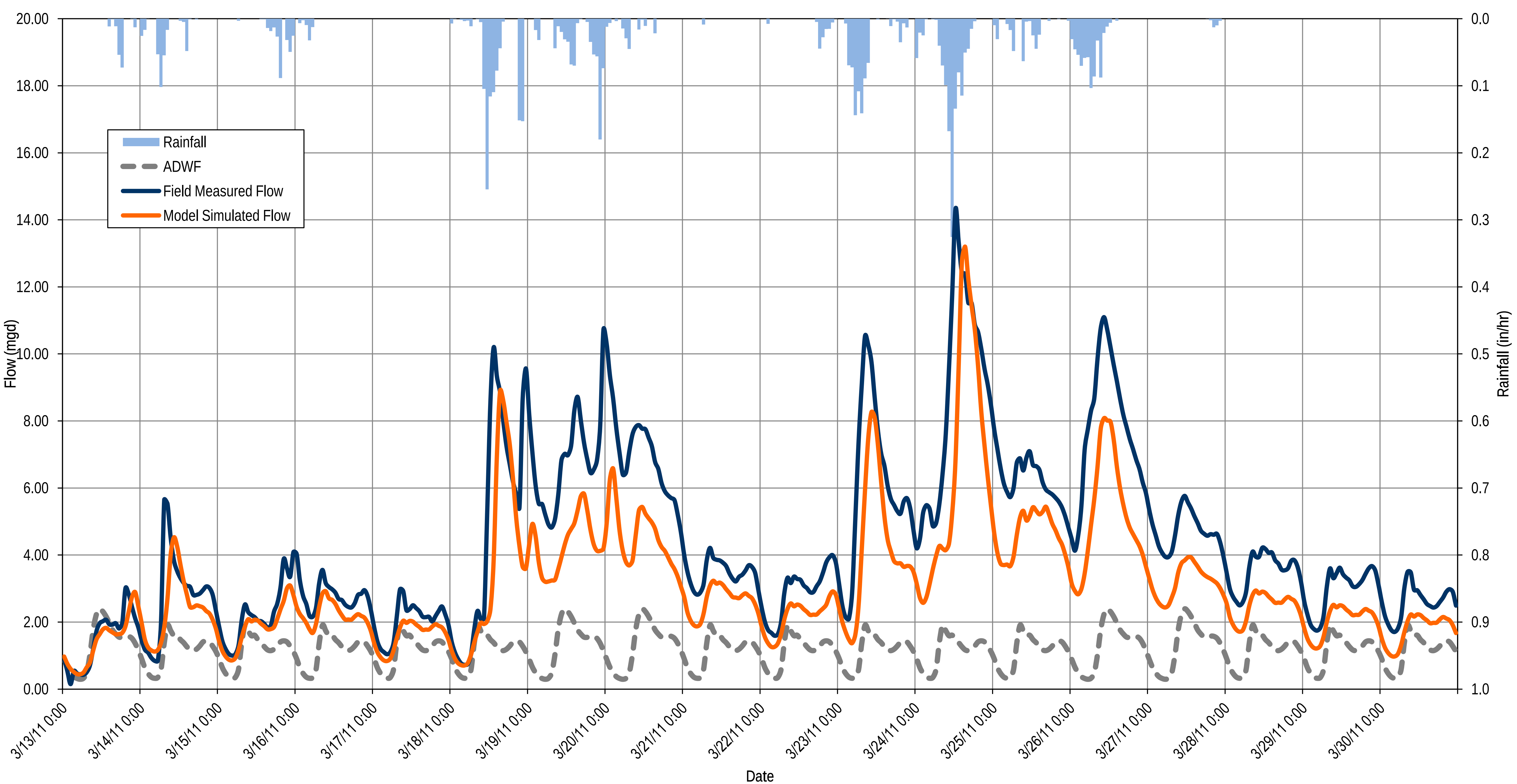
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 84U-F WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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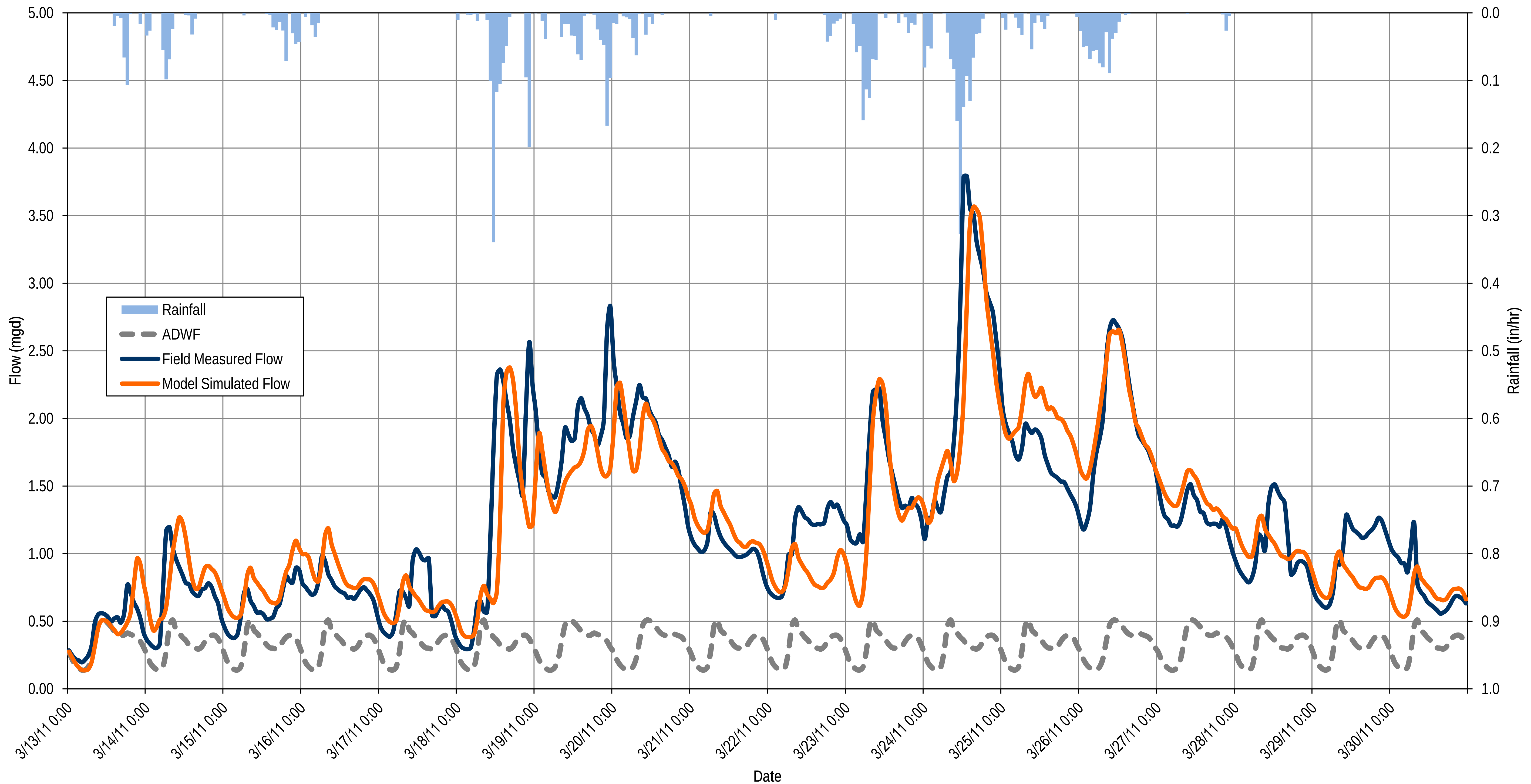
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85D WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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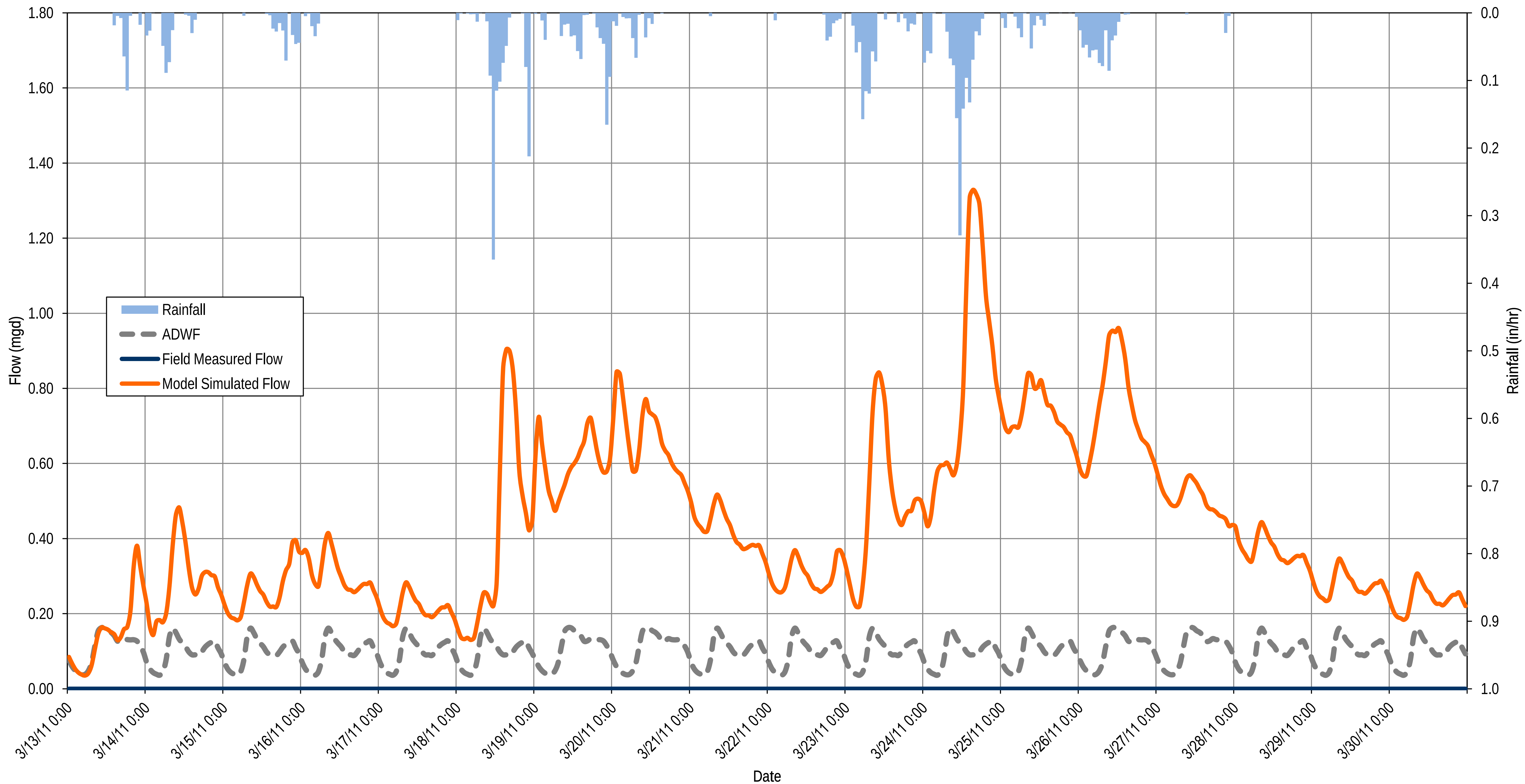
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85D.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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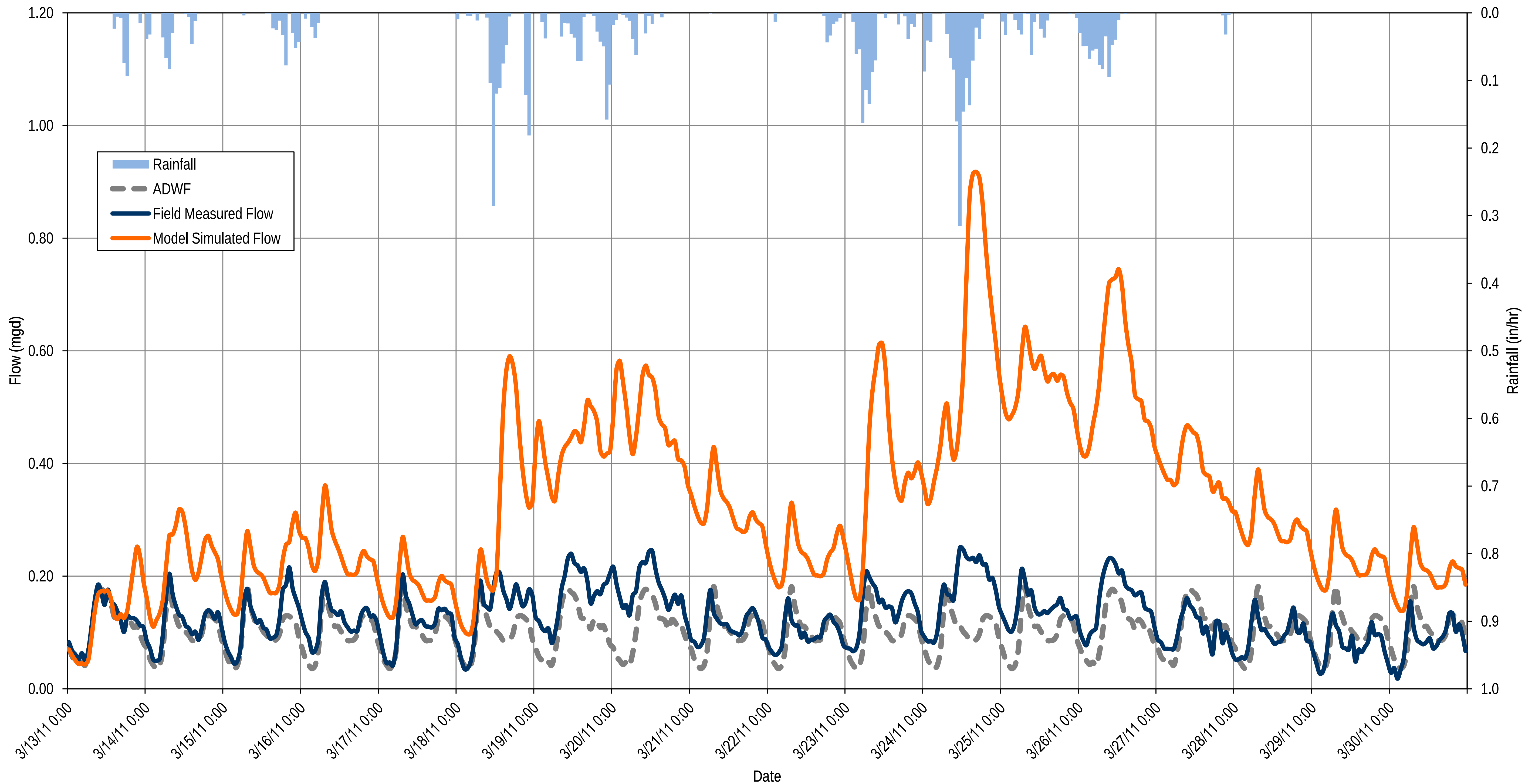
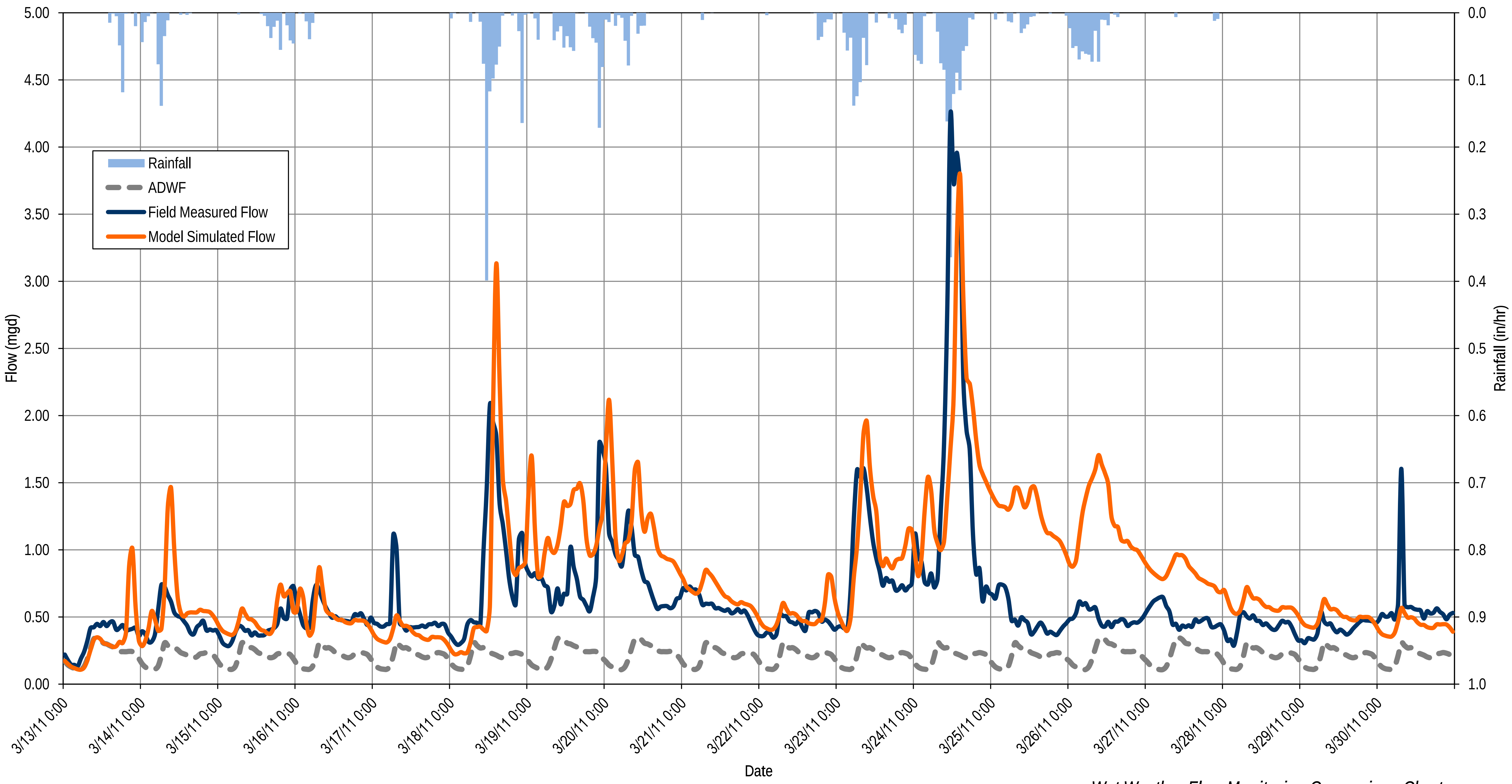
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85D.2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85E WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
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DRAFT - October 4, 2012
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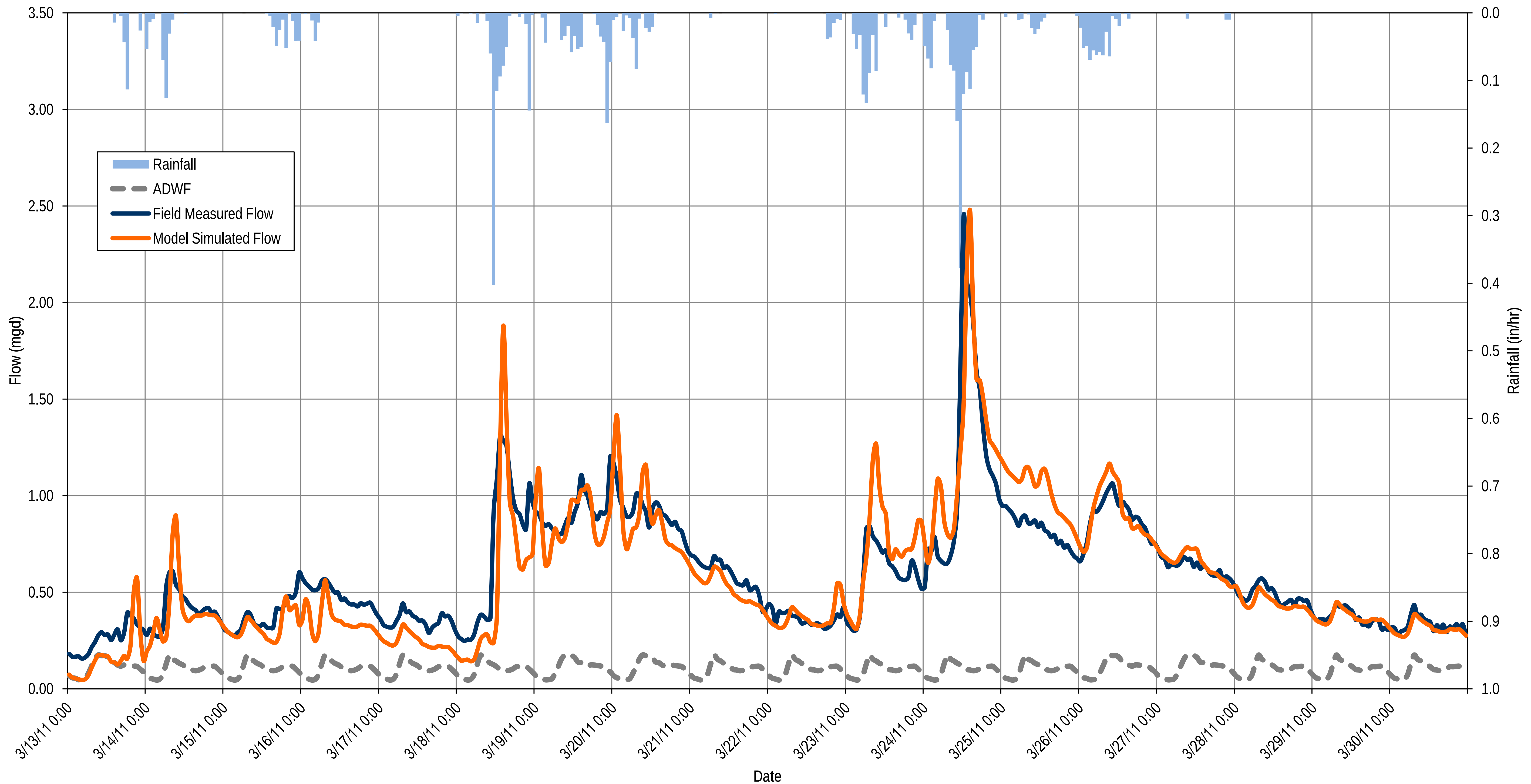
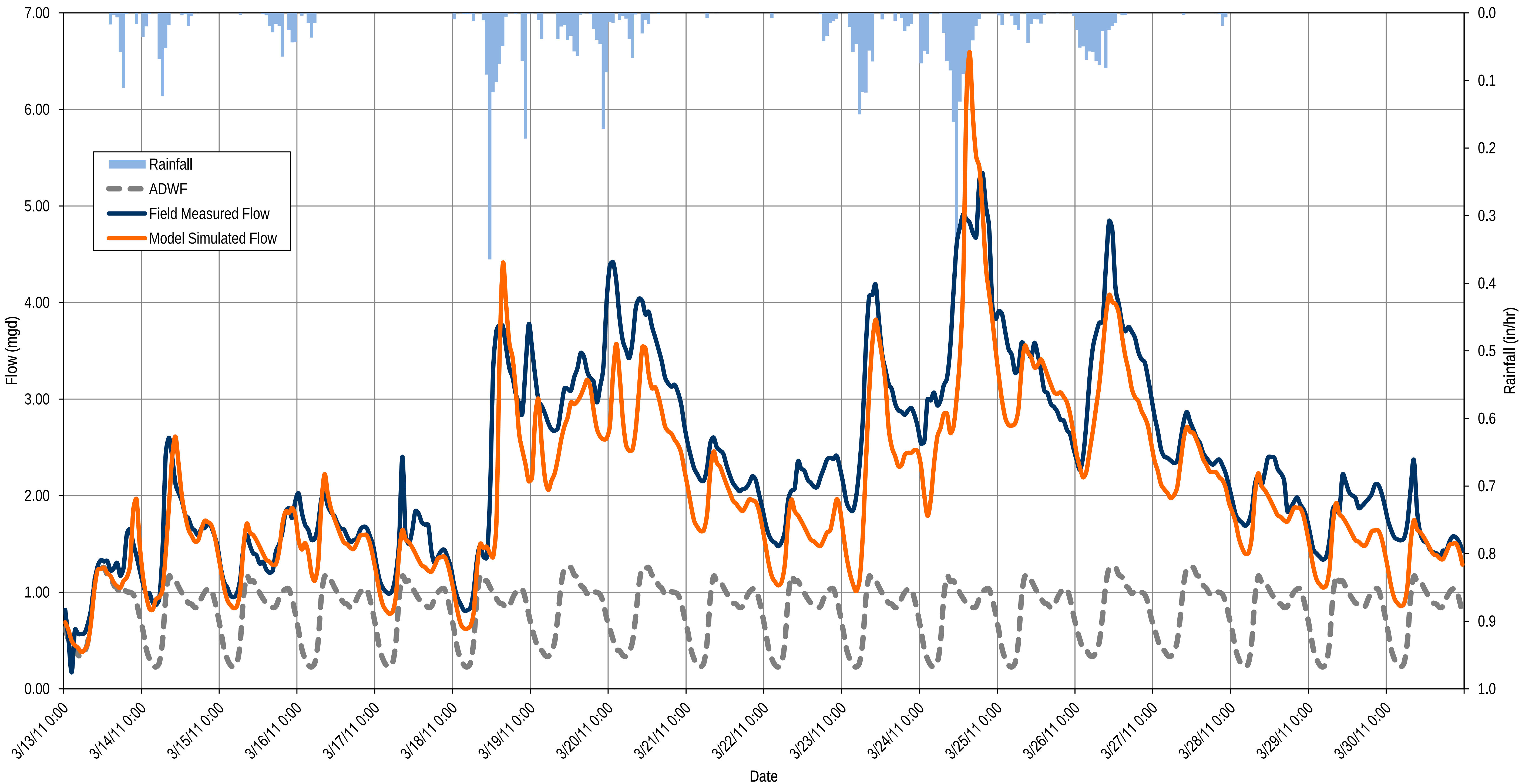
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85E.1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85U-1 WET WEATHER CALIBRATION

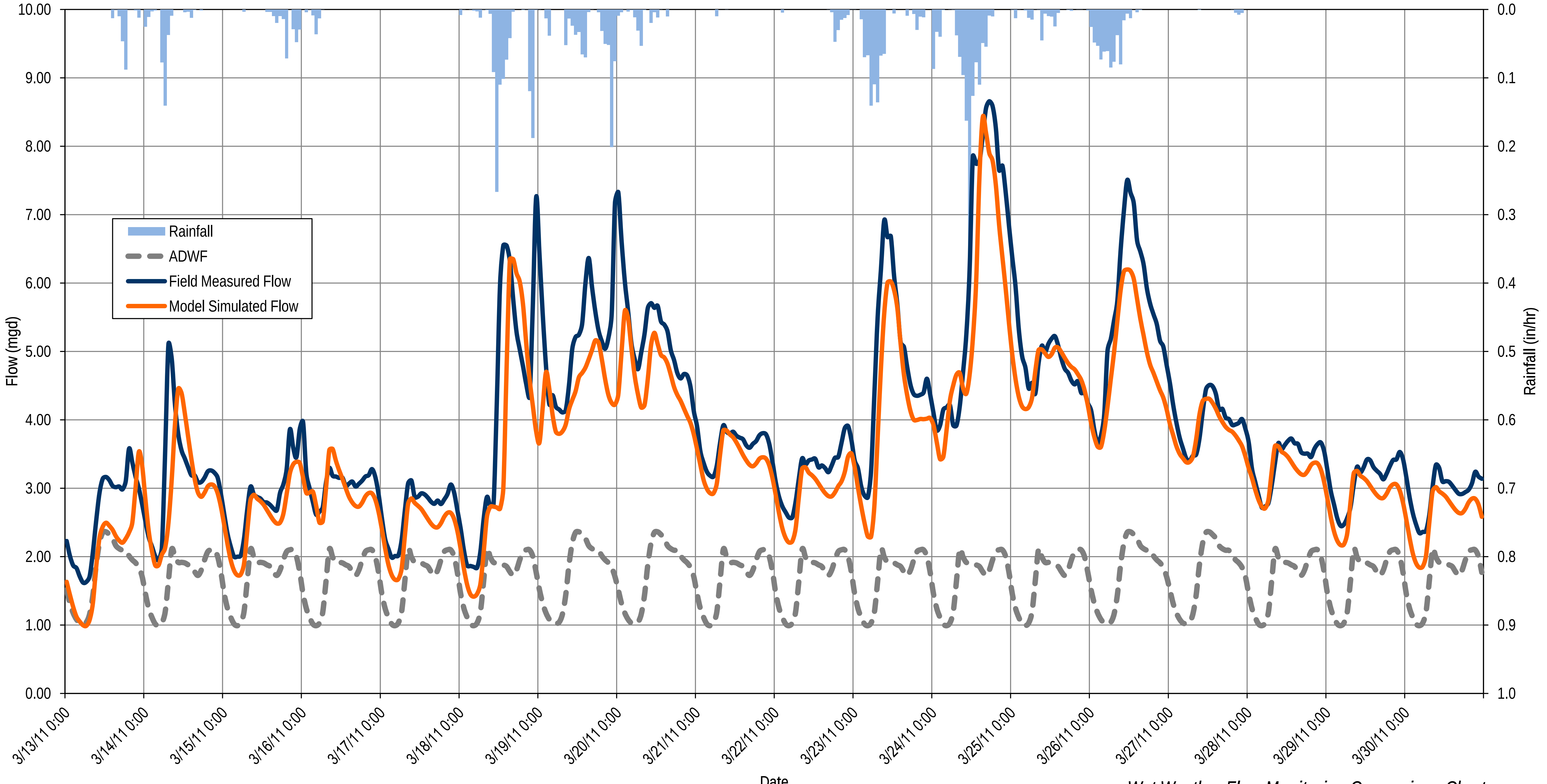


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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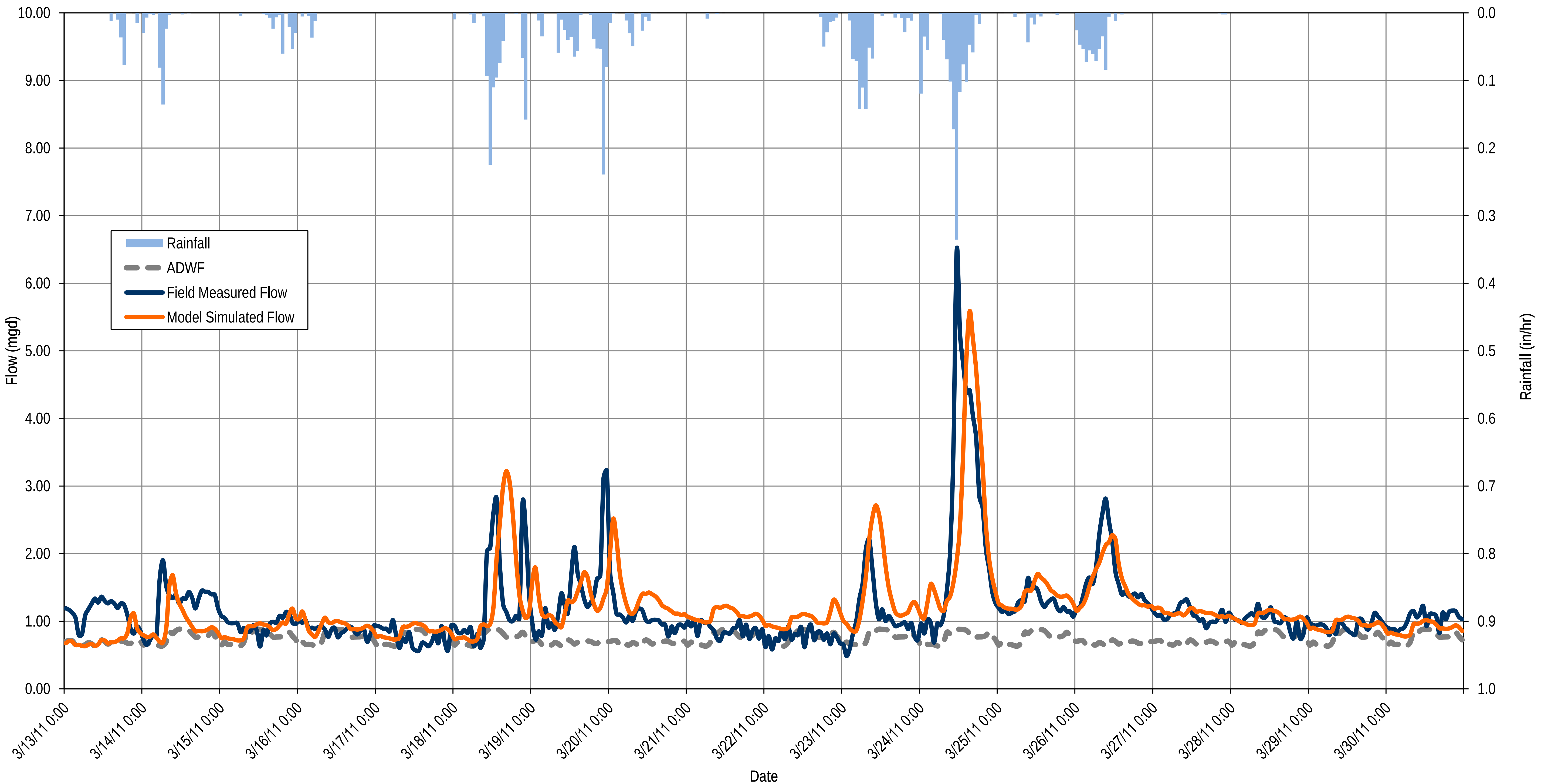
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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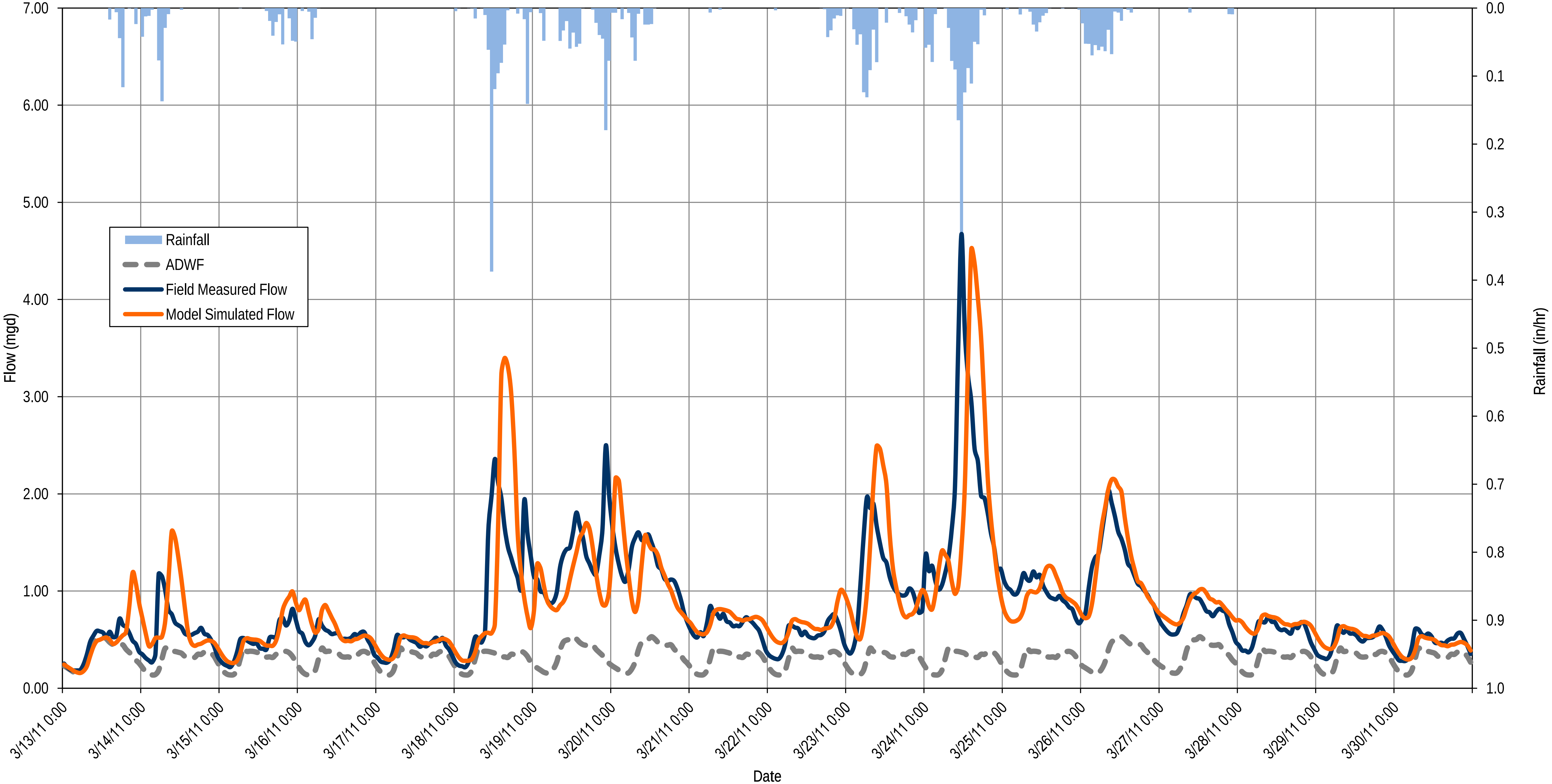
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85C WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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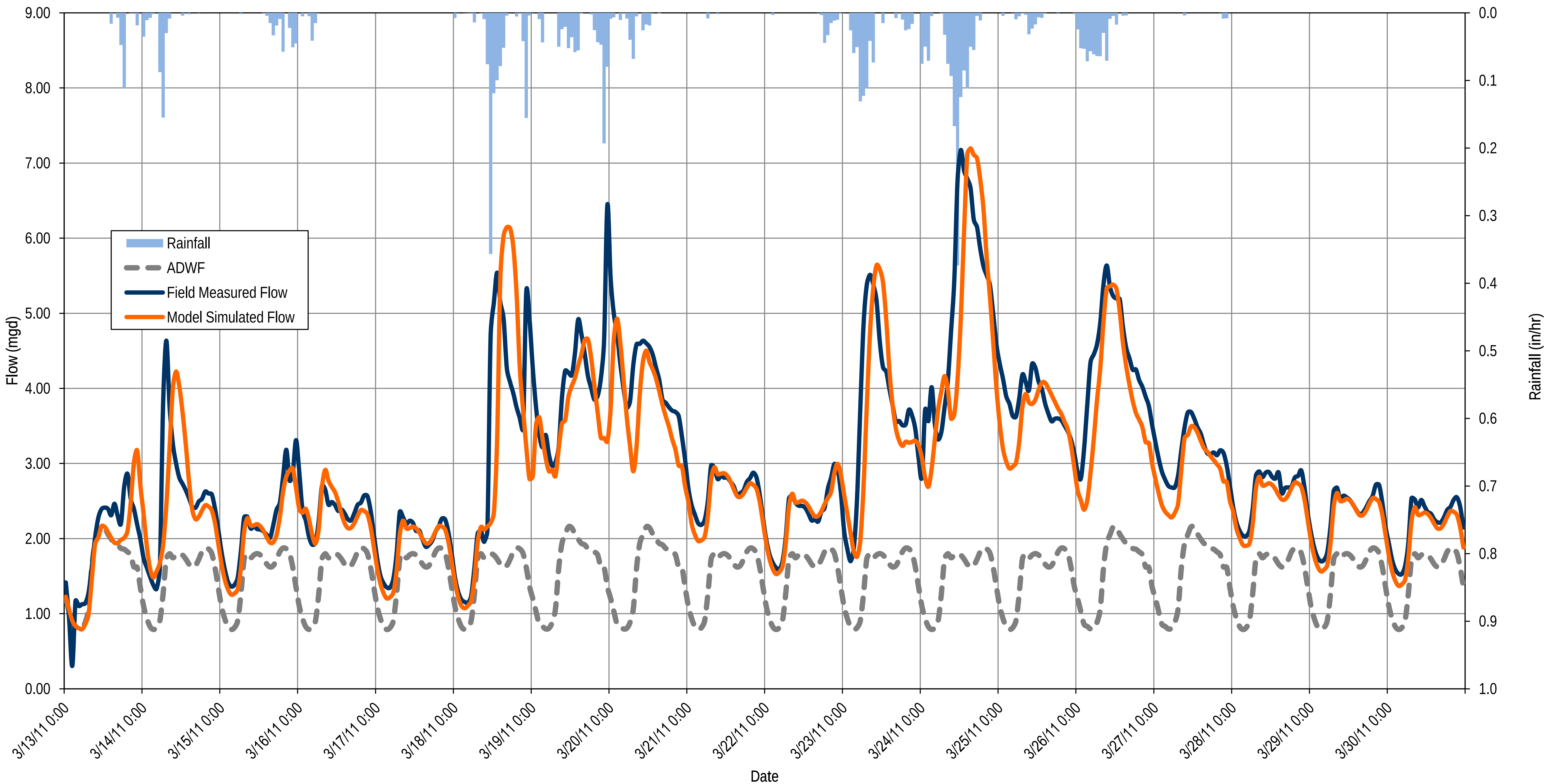
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85U-2 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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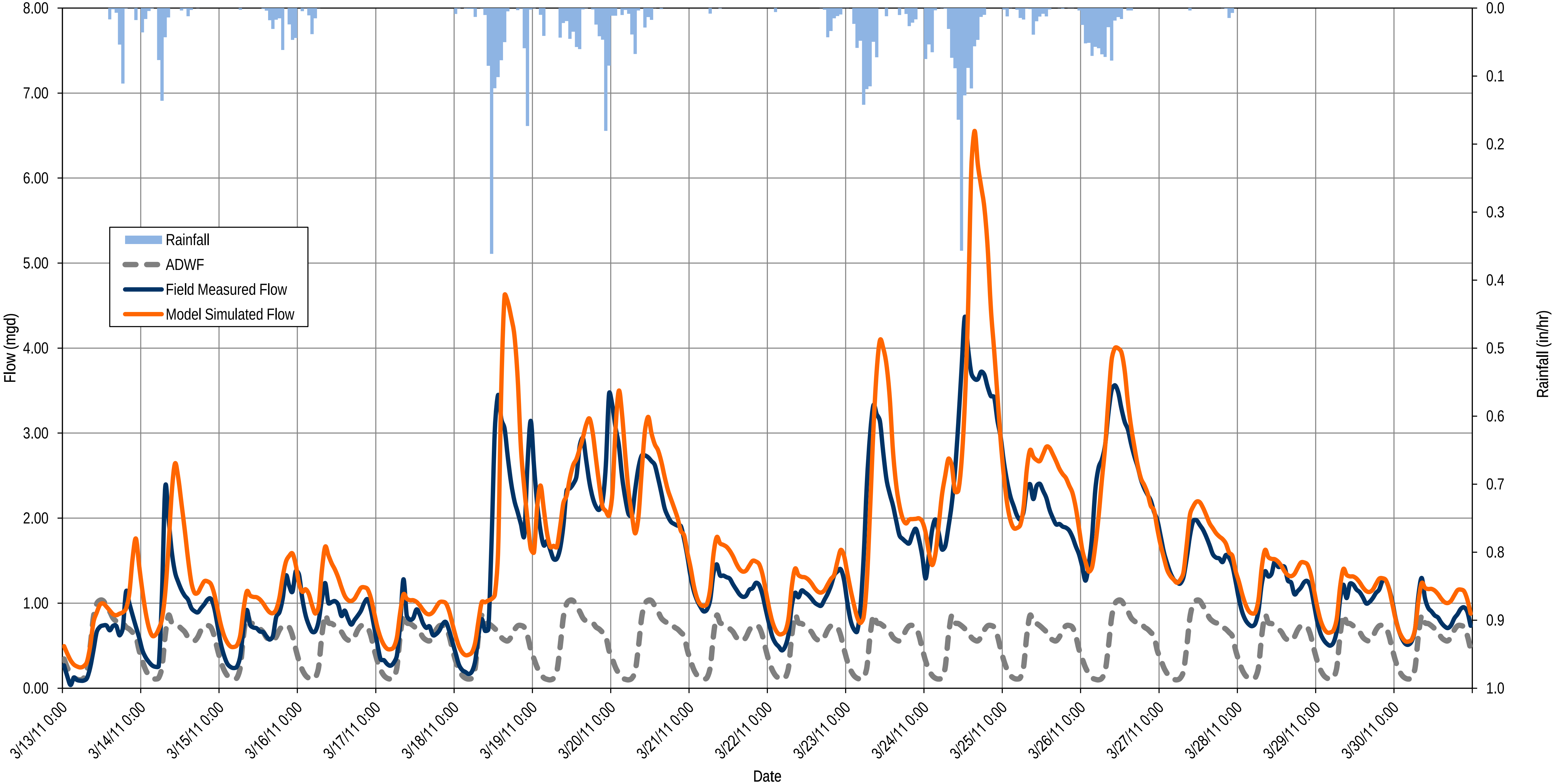
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-F WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

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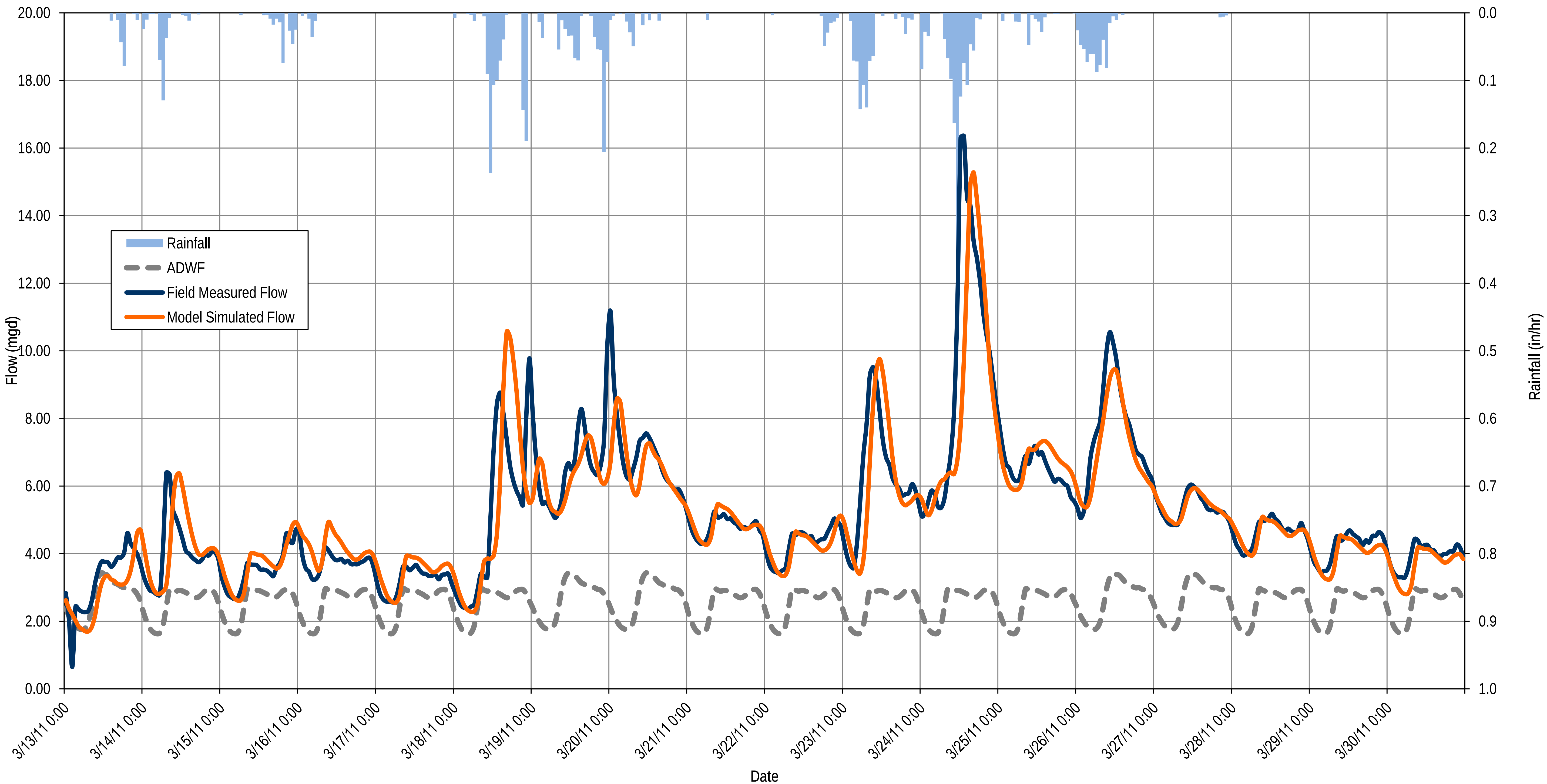
City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 85L-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
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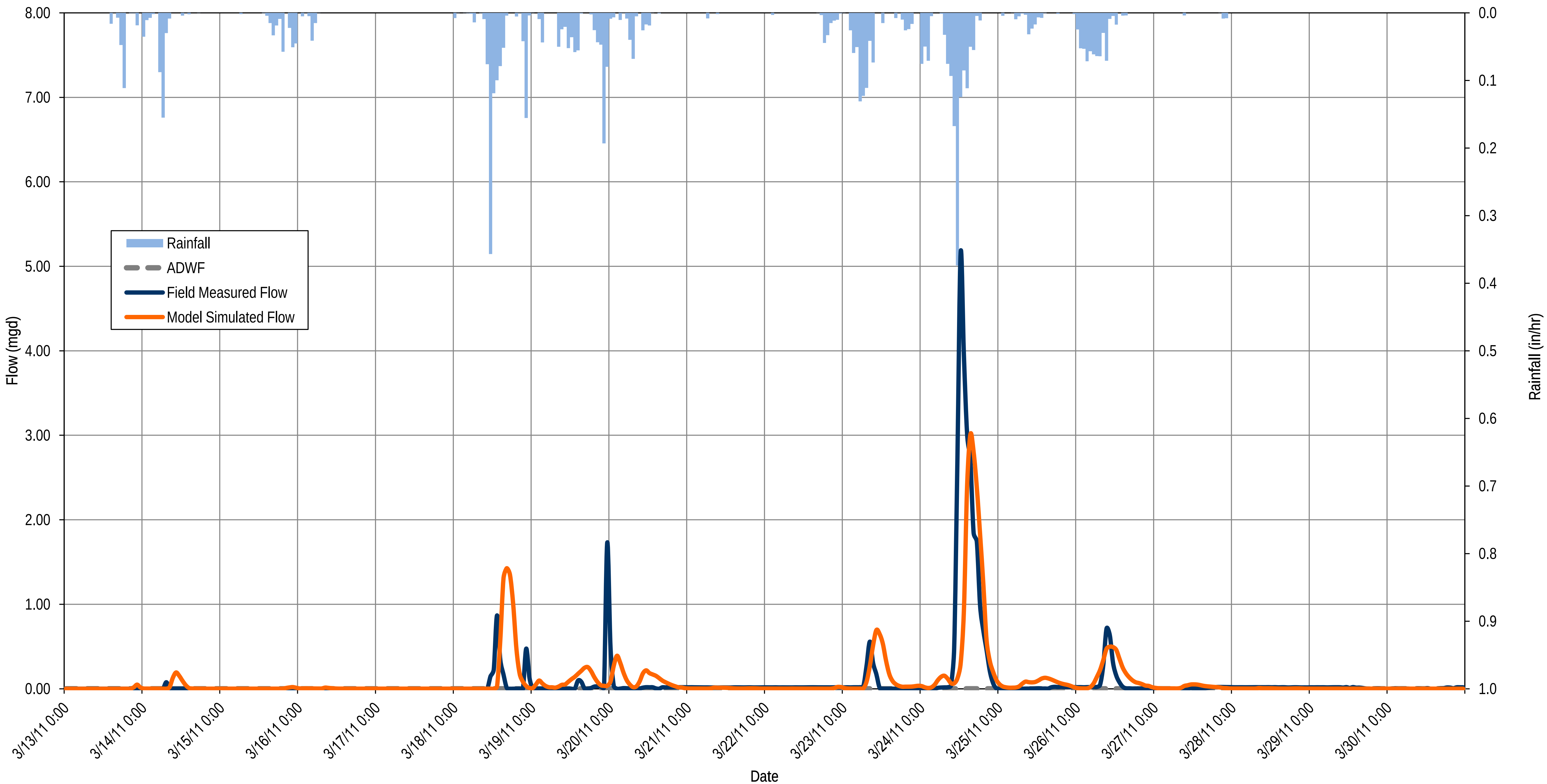
City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 85U-2BX WET WEATHER CALIBRATION

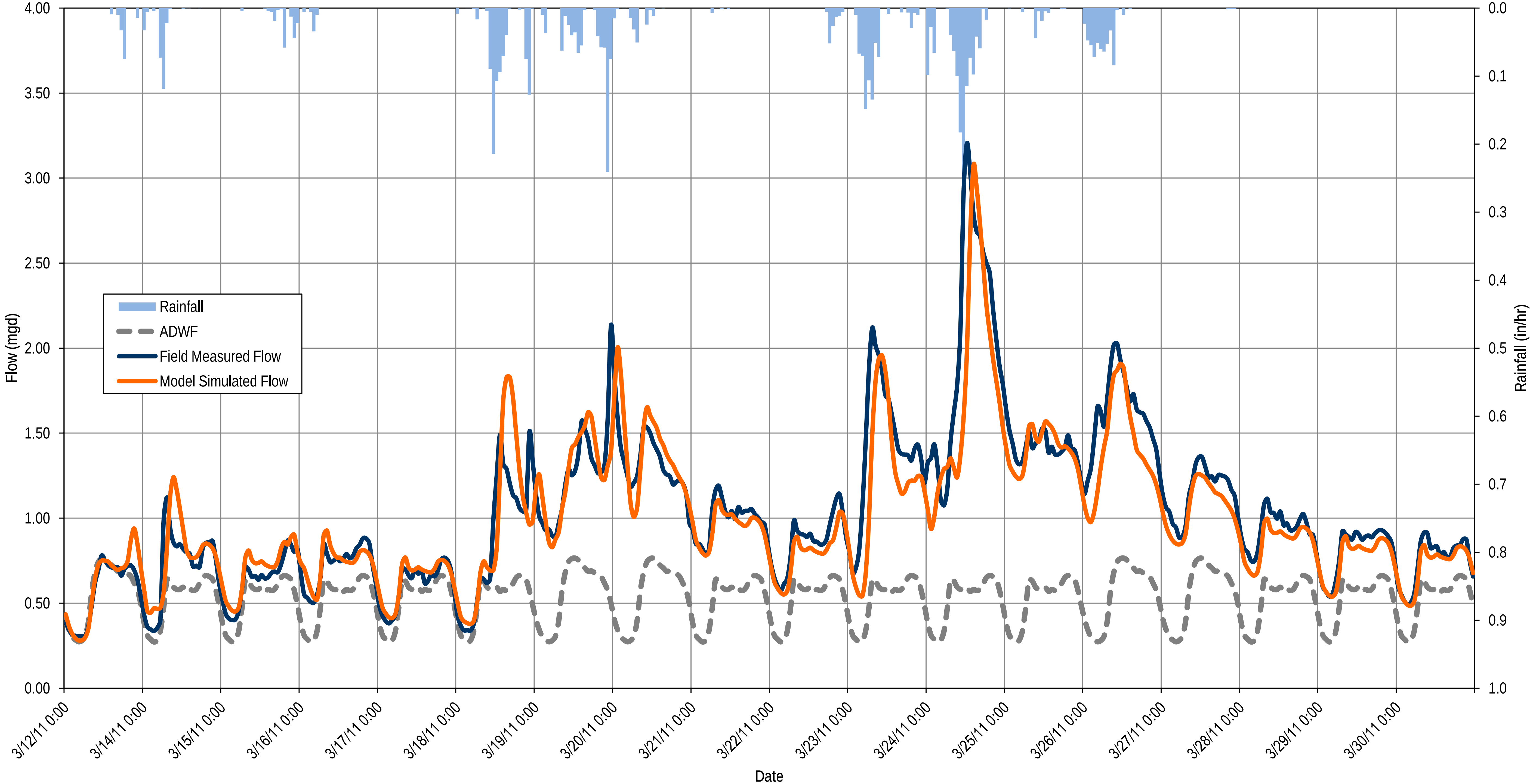


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_85.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 86A WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
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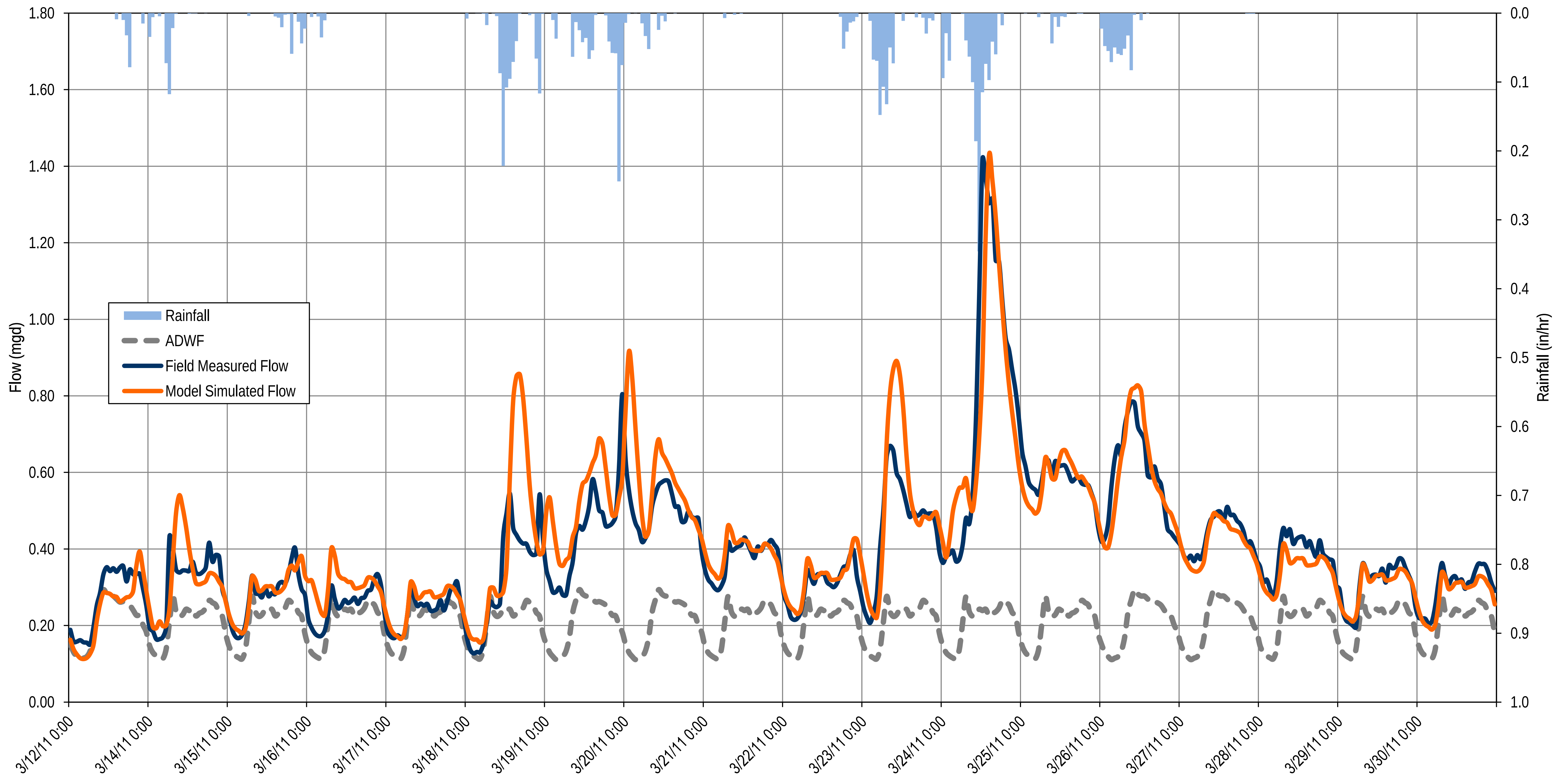
DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_86.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 86B WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

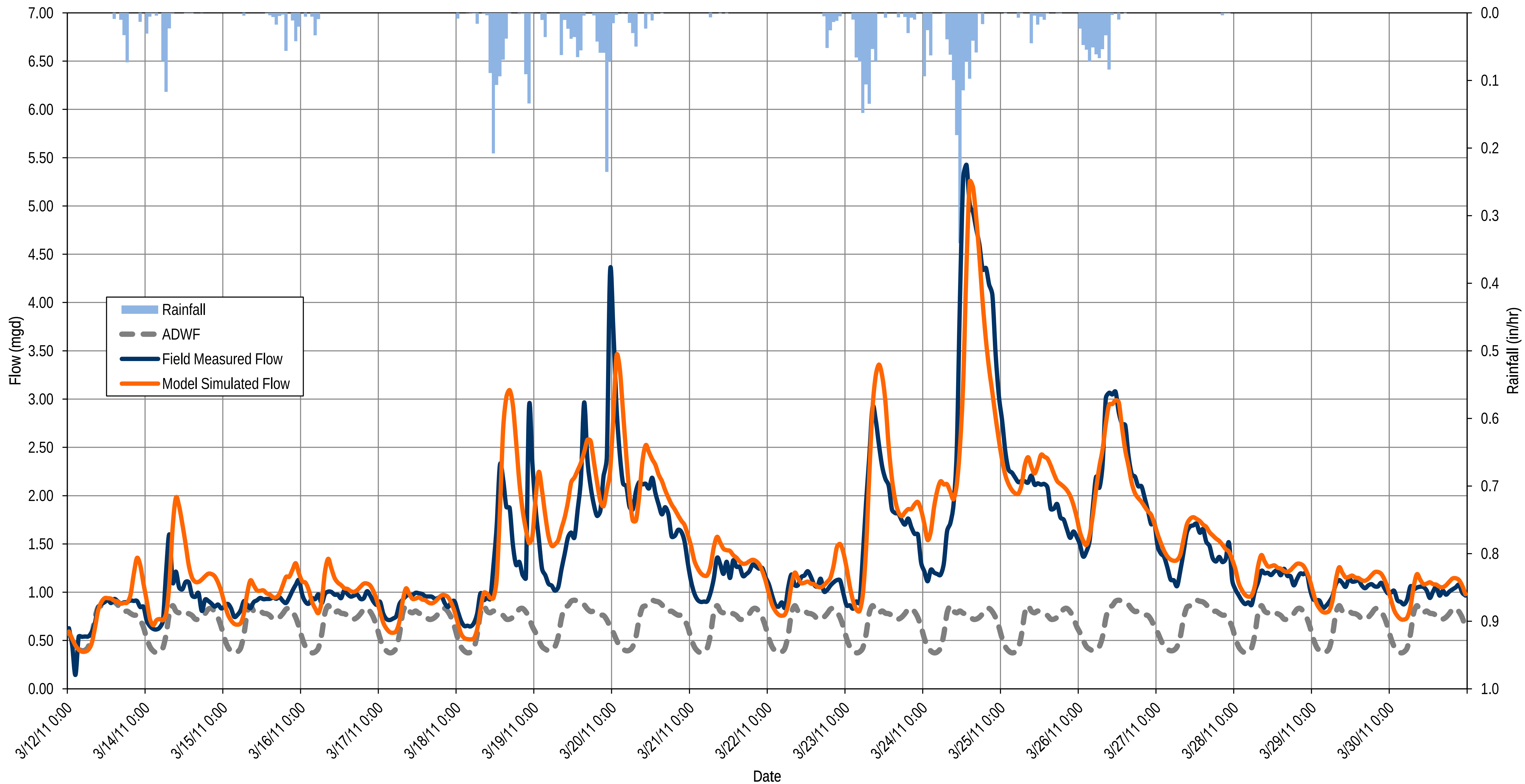
DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_86.xlsx

City of Oakland

Sewer System Hydraulic Model Calibration

FLOW MONITORING SITE 86-1 WET WEATHER CALIBRATION

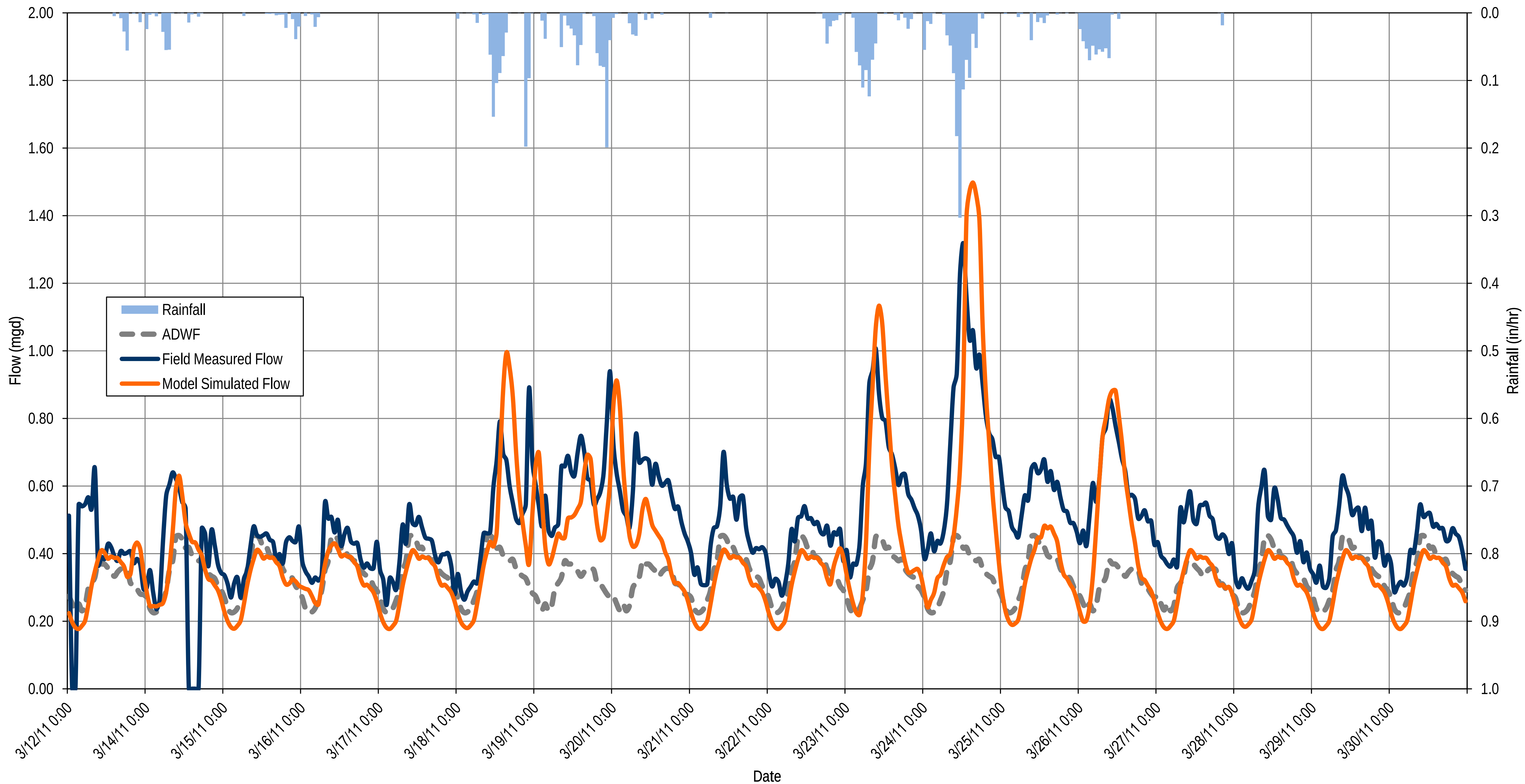


Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012

pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_86.xlsx

City of Oakland
Sewer System Hydraulic Model Calibration
FLOW MONITORING SITE 87-1 WET WEATHER CALIBRATION



Wet Weather Flow Monitoring Comparison Chart
(3/13/2011 - 3/30/2011 Rainfall Event)

DRAFT - October 4, 2012
pw://Carollo/Documents/Client/CA/Oakland/8574A00/Data/Calibration/CALIB_WET_87.xlsx

APPENDIX F - PSL ORDINANCE 13026

INTRODUCED BY COUNCILMEMBER ____________

APPROVED AS TO FORM AND LEGALITY

City Attorney

Revised at Request of PWAC 6/14/2011

OAKLAND CITY COUNCIL

ORDINANCE NO. 13080 C.M.S.

ORDINANCE REVISION AMENDING OAKLAND MUNICIPAL CODE TITLE 13, CHAPTER 13.08 TO ADD NEW REGULATIONS REQUIRING OAKLAND PROPERTY OWNERS TO INSPECT AND CERTIFY LOWER SEWER LATERALS IN THE PUBLIC RIGHT-OF-WAY AT THE TIME OF PROPERTY TRANSFER, MAJOR REMODELING AND CHANGE IN WATER SERVICE

WHEREAS, the United States Environmental Protection Agency (EPA) requires the City of Oakland, other East Bay municipalities and the East Bay Municipal Utility District (EBMUD) to develop and implement a regional program to reduce infiltration and inflow (I/I) into the cities' sewer systems and EBMUD's collection and treatment system; and

WHEREAS, EPA is requiring Oakland's property owners to have private building sewers (both upper building sewer laterals on private property and lower building sewer laterals in the public right-of-way) inspected and certified at the time of property transfer, major remodeling, or changes in water service to address infiltration and inflow (I/I) into building sewers; and

WHEREAS, in February 2010 EBMUD adopted regional regulations (EBMUD Regional Private Sewer Lateral Ordinance No. 311) to inspect and certify upper building sewer laterals; and

WHEREAS, the City of Oakland passed an ordinance amending Oakland Municipal Code Chapter 13.08 to adopt EBMUD's upper building sewer lateral regulation in Oakland (Ordinance No. 13026 C.M.S., passed July 2010); and

WHEREAS, EPA is requiring the City of Oakland to further regulate lower building sewer laterals in the same manner as upper building sewer laterals; and

WHEREAS, the City of Oakland desires to have EBMUD inspect and certify lower building sewer laterals at the same time it inspects and certifies upper building sewer laterals; and

WHEREAS, EBMUD has agreed to inspect and certify lower building laterals at the same time it addresses upper building sewer laterals; now, therefore,

THE COUNCIL OF THE CITY OF OAKLAND DOES ORDAIN AS FOLLOWS:

Section 1.

Add the following definitions to Section 13.08.020 - Definitions.

"Compliance Certificate" means a certificate issued by EBMUD indicating that a building sewer (upper building sewer lateral and lower building sewer lateral) complies with the requirements as set forth in the EBMUD Regional PSL Ordinance, Title VIII and this Chapter.

"EBMUD" means the East Bay Municipal Utility District, Special District No.l.

"EBMUD Regional PSL Ordinance" means the East Bay Municipal Utility District Ordinance 311, Title VIII, Regulation of ~~Private~~ Upper Sewer Laterals, its implementation and any future amendments or modifications thereto.

"Exemption Certificate"- A certificate issued by EBMUD to property owners who can demonstrate that work on the lateral has been completed in accordance with local ordinance requirements within 10 years of the period of time set forth in the EBMUD Regional PSL Ordinance.

Section 2.

Section 13.08.600 of Chapter 13 of the Oakland Municipal Code is added now to read:

13.08.600 - Building Sewer Inspection, Replacement, Compliance with EBMUD Regional PSL Ordinance, and Compliance Certificates.

The property owner shall be responsible for inspecting building sewers, obtaining all required permits, performing all necessary building sewer repair or replacement, scheduling inspections with EBMUD, passing a verification test witnessed by EBMUD, obtaining and filing with the City a Compliance Certificate from EBMUD as set forth in the EBMUD Regional PSL Ordinance for the entire building sewer (upper building sewer lateral and lower building sewer lateral) when one or more of the following events occurs:

A. Title Transfer. Prior to transferring title associated with the sale of any real property that contains any structure with a building sewer. Title transfer means the sale or transfer of an entire real property estate or the fee interest in that real property estate and does not include the sale or transfer of partial interest, including a leasehold. In addition, the following shall not be included: (1) transfer by a fiduciary in the course of the administration of a decedent's estate, guardianship, conservatorship, or trust, (2) transfers from one co-owner to one or more other co-owners, or from one or more co-owners into or from a revocable trust, if the trust is for the benefit of the grantor or grantors, (3) transfers made by a trustor to fund an inter vivios trust. (4) transfers made to a spouse, to a registered domestic partner as defined in Section 297 of the Family Code, or to a person or persons in the lineal line of consanguinity of one or more of the transferors. (5) transfers between spouses or registered domestic partners resulting from a decree of dissolution of marriage or domestic partnership, or a decree of legal separation or from a property settlement agreement incidental to a decree. (6) transfers from property owners to any financial institution as a result of a foreclosure or similar process.

B. Construction ~~and~~ or Remodeling. Whenever a property owner app~~h~~lies for any permit or other approval needed for construction, remodeling, modification or alteration of any structure with a building sewer where the cost of the work is estimated to exceed $100,000.

C. Change in Water Services. Whenever a property owner applies for any permit or other approval from the EBMUD for an increase or decrease in size of the owner's water meter.

D. An Individually-Owned Unit in a Multi-Unit Structure Served by a Common Private Sewer or Shared Laterals such as condominium or other common interest development. Within the period of time set forth in the EBMUD Regional Ordinance, the homeowners' association or a responsible party- for this type of multi-unit structure shall determine if the sewer lateral(s) is(are) in compliance with the EBMUD Regional PSL Ordinance and perform any necessary repair or replacement work to achieve compliance. Thereafter, re-certification of the sewer lateral shall occur at twenty (20) year intervals.

E. Property Developments Other Than Those Specified in (D) Above With Sanitary Sewers Totaling Greater Than 1000 Feet In Length. Within the period of time set forth in the EBMUD Regional PSL Ordinance, property owners or responsible parties for property developments with sanitary sewers totaling greater than 1000 feet in length, shall submit for EBMUD approval, a Condition Assessment Plan with a schedule to perform testing to assess the condition of all of the sewer laterals on the property to determine compliance with the EBMUD Regional PSL Ordinance. Within the period of time specified in the EBMUD Regional PSL Ordinance, property owners or responsible parties shall complete all condition assessment testing, and submit a ~~Final~~ Corrective Action Work Plan for EBMUD approval. ~~Thereafter,~~After the work is completed, re-certification of the sewer lateral shall occur at twenty (20) year intervals.

F. Exception. A property owner with an un-expired sewer lateral Compliance Certificate or similar documentation from another agency, or with a dated approved building/sewer permit from a permitting authority indicating that the sewer lateral was replaced in total within 10 years of the period of time set forth in the EBMUD Regional PSL Ordinance may submit the information to EBMUD along with a request for an Exemption Certificate. Upon review and approval, an Exemption Certificate will be issued by EBMUD. ~~A property owner of a structure with a building sewer that is less than 10 years old from the date of: (1) intended title transfer, (2) obtaining a permit for remodeling, or (3) obtaining an approval for the change in water service, and has appropriate evidence, such as a valid building permit showing that the sewer lateral was replaced in total and received a final inspection from the City, may request an Exemption Certificate from EBMUD and does not have to obtain a Compliance Certificate.~~

G. Dangerous and Insanitary Sewer Condition. Whenever a dangerous or insanitary sewer condition is found as set forth by this Chapter and a notice to abate is provided according to the procedure established by the Director of Public Works.

Section 3.

Section 13.08.610 of Chapter 13 of the Oakland Municipal Code is added now to read:

13.08.610 - Responsibility and Standards for Maintenance of Upper and Lower Building Sewer Laterals.

It shall be the responsibility of the property owner to perform all required maintenance, repairs and replacement of the upper and lower building sewer lateral in accordance with EBMUD's and the City of Oakland's ordinance requirements. Standards for maintenance of the upper and lower building sewer lateral are set forth below:

A. The upper and lower building sewer lateral shall be kept free from roots, grease deposits, and other solids, which may impede or obstruct the flow.
B. All joints shall be watertight and all pipes shall be sound.
C. The upper and lower building sewer lateral pipe shall be free of any structural defects such as fractures, cracks, breaks, openings, or missing portions.
D. All cleanouts shall be securely sealed with a proper cap or approved overflow device at all times.
E. There shall be no non-sanitary sewer connections to the upper or lower sewer lateral or to any plumbing that co~~mm~~nnects to the upper or lower sewer lateral.

Section 4.

Section 13.08.620 of Chapter 13 of the Oakland Municipal Code is added now to read:

13.08.620 - Adoption of the EBMUD Regional PSL Ordinance by Reference.

The East Bay Municipal Utility District Ordinance 311, Title VIII; Regulation of ~~Private~~ Upper Sewer Laterals is hereby adopted by reference. The City Council may adopt amendments or modifications to the ordinance thereto, as the ordinance may be amended or modified by EBMUD.

IN COUNCIL, OAKLAND, CALIFORNIA, JUL 19 2011

PASSED BY THE FOLLOWING VOTE:

AYES- BROOKS, BRUNNER, DE LA FUENTE, KAPLAN, KERNIGHAN, NADEL, SCHAAF, and PRESIDENT REID – 8

NOES- 0

ABSENT- 0

ABSTENTION- 0

ATTEST: LaTonda Simmons
LaTonda Simmons
City Clerk and Clerk of the Council
of the City of Oakland, California

Introduction Date JUL 5 2011

DATE OF ATTESTATION: July 21, 2011

APPENDIX G – PSL STATEMENT OF ROLES AND RESPONSIBILITIES

STATEMENT OF ROLES AND RESPONSIBILITIES
BETWEEN THE CITY OF OAKLAND (OAKLAND)
AND THE EAST BAY MUNICIPAL UTILITY DISTRICT (DISTRICT)
FOR IMPLEMENTATION OF
EAST BAY REGIONAL PRIVATE SEWER LATERAL PROGRAM

DEFINITIONS

1. Compliance Certificate: A certificate issued by the DISTRICT indicating that the private sewer lateral complies with the DISTRICT's verification test requirements.

2. Enforcement: Punitive measures taken by DISTRICT to achieve compliance by those failing to satisfy the Regional Private Sewer Lateral (PSL) Ordinance requirements.

3. Outreach Materials: Information prepared by DISTRICT, and mutually agreed to by OAKLAND and DISTRICT, about the Regional PSL Program describing procedures, processes, and fees for distribution to property owners, real estate and escrow professionals, contractors and other interested parties.

4. Regional Private Sewer Lateral (PSL) Ordinance: East Bay Municipal Utility District Ordinance No. 311 Section VIII titled "Regulation of Upper Sewer Laterals" that sets forth requirements for upper laterals to be inspected and if necessary repaired or replaced when certain triggers are met by a property owner.

5. OAKLAND'S Municipal Code: City of Oakland's local municipal ordinances and regulations.

6. Regional Private Sewer Lateral (PSL) Program: The comprehensive management effort to implement the requirements of both the Regional PSL Ordinance and related portions of OAKLAND'S Municipal Code. The Regional PSL Program requires the testing of privately owned sewer laterals and where needed, repair or replacement of defective laterals by property owners who are:
    - selling their homes;
    - performing building remodel projects in excess of $100,000; or
    - changing their water meter size.

7. Verification Test: A test consisting of a low pressure air or water exfiltration test conducted on a private sewer lateral to ensure that the lateral is free of leaks.

8. Waiver Process: OAKLAND'S process to enable a property owner to receive a waiver for performing work on the lower lateral under certain approved conditions.

9. Exemption Certificate: A certificate issued by the DISTRICT when the property owner provides appropriate evidence, such as a valid building permit, showing that the sewer lateral was replaced in total less than 10 years ago. When an Exemption Certificate is issued the property owner does not have to obtain a Compliance Certificate.

OUTREACH

1. DISTRICT agrees to produce and provide to OAKLAND (with replenishments as needed) outreach materials for the Regional PSL Program. DISTRICT agrees to maintain
   a. A website for the Regional PSL Program with appropriate referrals to OAKLAND'S web pages; and
   b. A Phone number and contact person where the public can get answers to questions about the program.

2. OAKLAND agrees to make available outreach materials, prepared by the DISTRICT for the Regional PSL Program at City Hall, Oakland's Permit Center and other locations as needed.

3. OAKLAND and DISTRICT shall assist each other in outreach activities, as needed.

PERMITTING AND INSPECTION

1. OAKLAND continues to be the permitting agency for all sewer lateral work in accordance with OAKLAND'S Municipal Code.

2. OAKLAND agrees to expeditiously issue sewer and encroachment permits for sewer lateral work that must be performed for the Regional PSL Program.

3. DISTRICT agrees to expeditiously schedule sewer lateral verification tests and issue Compliance Certificates when a sewer lateral passes such tests.

4. OAKLAND shall continue to perform construction and materials inspection for all sewer lateral work.

5. DISTRICT shall witness the verification test for the entire sewer lateral, consisting of the upper lateral and lower lateral and document compliance or non-compliance.

CERTIFICATES AND WAIVERS

1. DISTRICT shall issue a single Compliance Certificate valid for an entire sewer lateral that passes the verification test. The DISTRICT will not issue a Compliance Certificate in the event either an upper lateral or a lower lateral does not pass a verification test on a property, unless the upper lateral passes and a waiver from OAKLAND for the lower lateral work is granted.

   If OAKLAND wishes to issue a waiver, OAKLAND shall:
   a) fill out the DISTRICT provided waiver form (Attachment A),
   b) return the waiver form to the property owner, and
   c) direct the property owner to return the waiver form to the DISTRICT.

2. OAKLAND shall not complete a final inspection to finalize a project for remodeling projects in excess of $100,000 until the property owner produces a Compliance Certificate or Exemption Certificate for sewer lateral work required by the Regional PSL Program.

3. OAKLAND shall make available information to property owners about the benefits of obtaining a Regional PSL Program Compliance Certificate even where compliance is not mandated by the Regional PSL Program.

DATA SHARING and ANNUAL REPORTING

1. DISTRICT will prepare annual report as required by the regulatory agencies.

2. DISTRICT will develop and maintain a regional database of records for the Regional PSL Program and will share data, as reasonably requested, in a timely fashion.

3. As required by its Stipulated Order, beginning July 1, 2012, OAKLAND shall "submit to EBMUD [i.e., DISTRICT], in either electronic or hard copy format as the City [i.e., OAKLAND] chooses, a monthly log of all remodel permits for jobs greater than $100,000 where a final inspection has been completed to finalize the project;" the monthly log shall include the parcel number and address of each job where the final inspection was completed the prior month.

4. OAKLAND shall provide to DISTRICT a copy of its GIS based maps showing sub-basins in which sewers have been rehabilitated from calendar year 2000 to 2010. If property owners seeking Exemption Certificates ask OAKLAND for copies of historic sewer permits, OAKLAND shall utilize its best efforts to expeditiously provide copies of such permits, if available.

5. DISTRICT and OAKLAND agree to identify key staff contacts involved with the Regional PSL Program.

ENFORCEMENT

1. Enforcement actions for work to be performed on upper private sewer laterals under the Regional PSL Ordinance shall be the sole responsibility of the DISTRICT.

2. Enforcement actions for work not completed in accordance with OAKLAND'S Municipal Code shall be the sole responsibility of OAKLAND.

MODIFICATIONS

DISTRICT and OAKLAND may modify this Statement by written agreement at any time. Each party agrees to meet and confer in good faith upon request of the other party for a modification.

INSURANCE

The Parties to this Statement shall maintain during the life of the Statement Workers' Compensation, Commercial General and Automobile Liability Insurance or comparable self insurance.

TERM

This Statement may not be terminated prior to June 30, 2014, unless either (1) OAKLAND obtains EPA approval of a no-less-stringent application for an OAKLAND PSL ordinance or (2) the parties mutually agree to terminate. Thereafter, this Statement may be terminated by either (1) mutual agreement of the parties or (2) six months' written notice from the terminating party to the other party.

ADVICE OF COUNSEL:

Each of the signators to this Statement affirms and acknowledges that it has read and fully appreciates and understands the words, terms, conditions and provisions of this Statement applicable to such signator, is fully and entirely satisfied with the same, has had the opportunity to be represented by legal counsel of its choice in the negotiation, preparation and execution of this Statement, has had the opportunity to confer with its counsel prior to the execution of this Statement, and has executed this Statement voluntarily and of its own free will and act.

The signators specifically agree that any rule of construction, to the effect that ambiguities are to be resolved against the drafting party, shall not apply to the interpretation of this Statement.

ENTIRE STATEMENT

This Statement represents the entire understanding of DISTRICT and OAKLAND as to those matters contained herein. No prior oral or written understanding shall be of any force or effect with respect to those matters covered hereunder. This Statement may only be modified by amendment in writing signed by each party.

SEVERABILITY

Should any part, term, or provision of this Statement be decided or declared by the Courts to be, or otherwise found to be, illegal or in conflict with any laws of the State of California or the United States, or otherwise be rendered unenforceable, or ineffectual, the validity of the remaining parts, terms, portions or provisions shall be deemed severable and shall not be affected thereby, providing such remaining parts, terms, portions or provisions can be construed in substance to constitute the Statement that the Parties to this Statement intended to enter into in the first instance.

AUTHORITY TO EXECUTE STATEMENT

Each of the signators to this Statement warrant to each of the other signators that it has obtained the necessary consent and authority to execute this Statement and to make this Statement binding upon itself.

COUNTERPARTS

This Statement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

IN WITNESS WHEREOF, the parties hereto each herewith subscribe to the same in duplicate.

EAST BAY MUNICIPAL UTILITY DISTRICT

By: ____________________ Date: 07/14/11

General Manager

CITY OF OAKLAND

By: ____________________ Date: 7/11/11

City Administrator

Regional Private Sewer Lateral Program

PRIVATE SEWER LATERAL WORK WAIVER

Parcel Address:

____

Street Address City

Parcel Number: __ __ __ - __ __ __ __ - __ __ __ - __

Expiration: ______________________________________

Special Instructions:

Submit a copy of this document to EBMUD as evidence that requirements to comply with the Regional Private Sewer Lateral Program have been waived. Retain a copy of this waiver for your records for any future parcel sale, re-model greater than $100,000, or change of water meter size.

Waiver Number: ____________________________

Issue Date: ____________________________

Reason for Waiver (check one):

__ Paving Moratorium

__ Other – describe: ______________________________

Issued by:

____

City, Department, Employee Name and Title

Signature: ______________________________________

APPENDIX H – CITY OF PIEDMONT FLOWS TECHNICAL MEMORANDUM

City of Oakland: Sanitary Sewer Flows to and from Piedmont

Client:	City of Oakland
Project Name:	Administrative Order Sewer Services
City Project No:	C329119
Prepared by:	Kevin Krajewski, P.E.
Review by:	Glenn Willson, P.E.,
Subject:	Piedmont Flows
Date:	June 14, 2012

DRAFT

INTRODUCTION

This memorandum summarizes the average and peak sanitary sewer flows originating from the City of Oakland and entering the City of Piedmont, and the sanitary sewer flows originating from the City of Piedmont and entering the City of Oakland within Oakland Basin 54. Basin 54 discharges into the East Bay Municipal Utility District (EBMUD) South Interceptor. Flow data analyzed in this technical memorandum was taken from the flow monitoring conducted by EBMUD from December 1, 2010 to March 31, 2011. Figure 1 below shows a schematic diagram of the Oakland-to-Piedmont-to-Oakland-to-EBMUD sanitary sewer boundary conditions. Figure 2 shows satellite imagery of the flow monitoring locations at the Piedmont boundary. Figure 3 shows a sewer map of Basin 54.

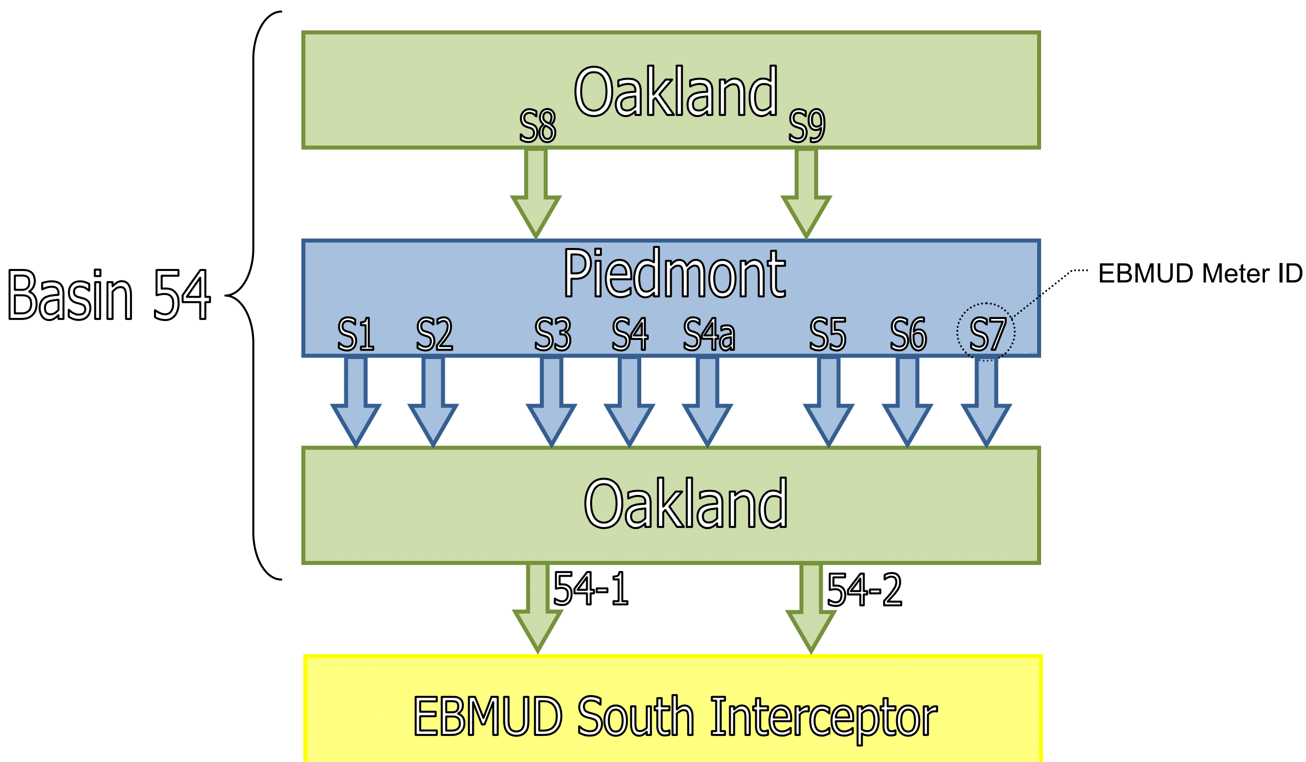


Figure 1. Flow Schematic: Oakland/Piedmont/EBMUD Sanitary Sewer Crossings

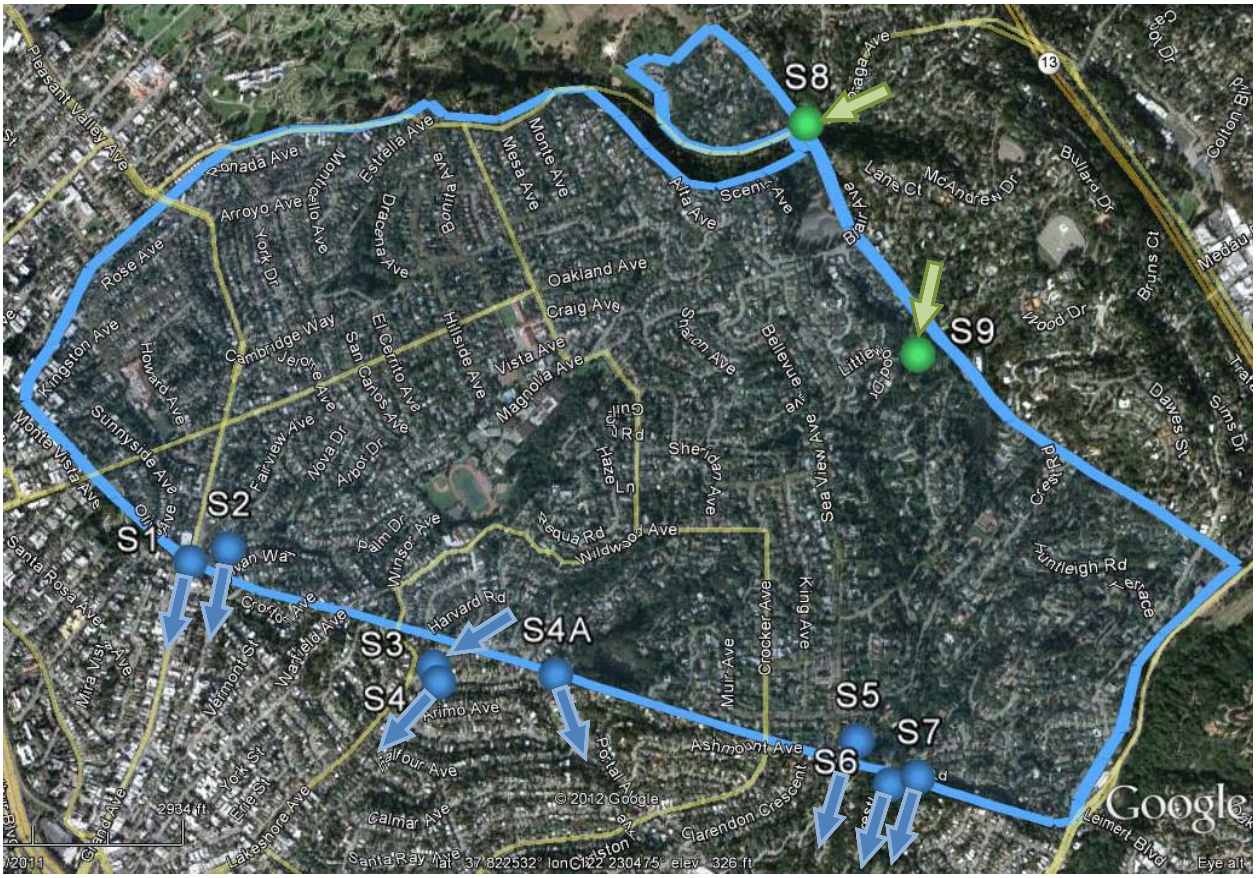


Figure 2. Satellite Photo: Oakland/Piedmont Sanitary Sewer Crossings

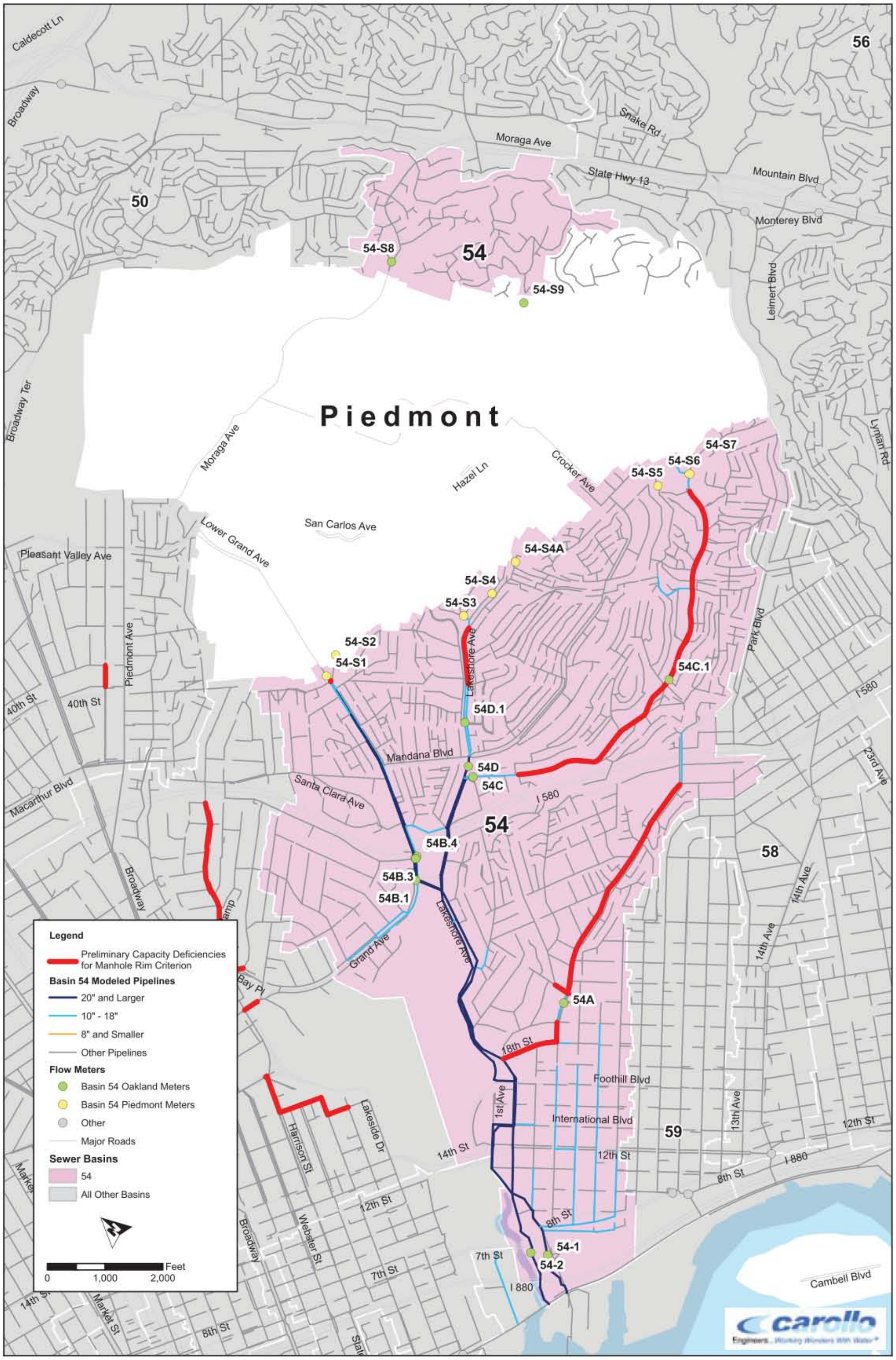


Figure 3. Basin 54

AVERAGE DRY WEATHER FLOWS

The average dry weather flows into and out of Piedmont, and from Oakland into the EBMUD South Interceptor (December 1, 2010 through March 31, 2011) are summarized in Figure 4[1]. Values shown are flow rates given in million gallons per day (mgd).

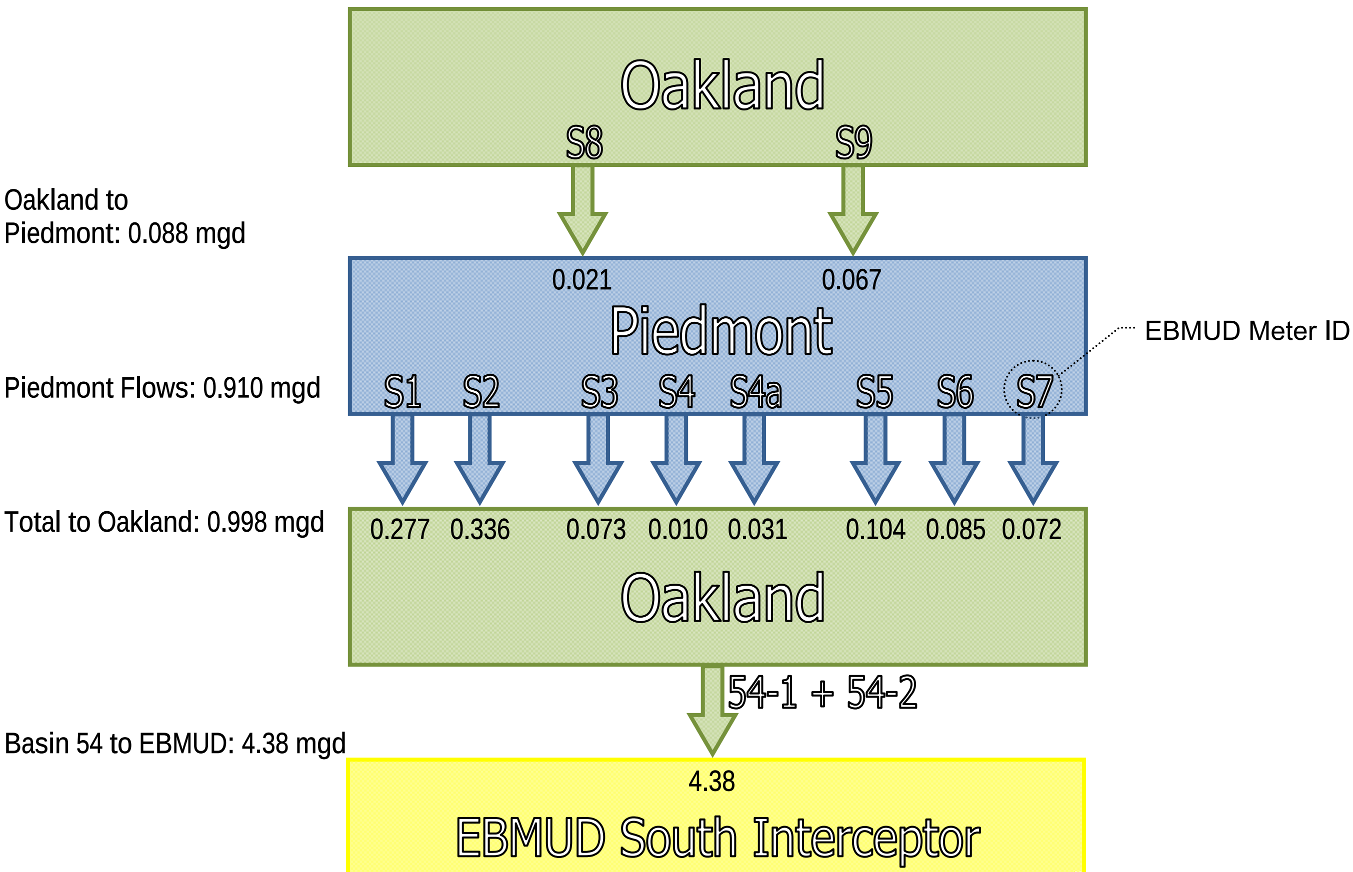


Figure 4. Flow Schematic: Average Dry Weather Flows

[1] Site 54-2 is an overflow relief line for Site 54-1. During dry weather flow conditions, there is no measurable flow through this site.

PEAK WET WEATHER FLOWS

The highest flows of the monitoring period system-wide occurred between 11:30 AM and 12:30 PM on March 24, 2011. The peak wet weather flows on March 24, 2011 are summarized in Figure 5, and plotted as real-time hydrographs in Figure 6.

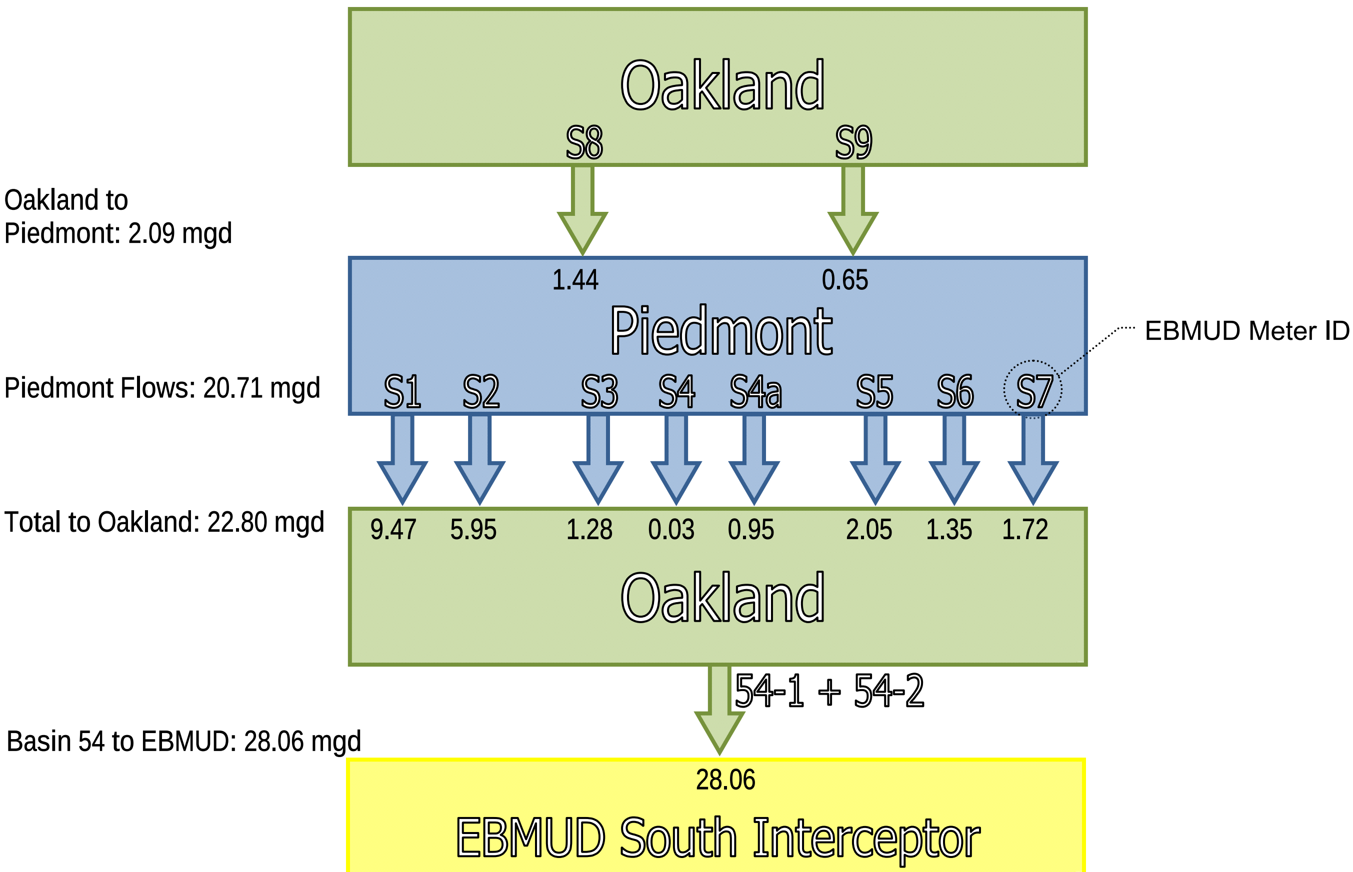


Figure 5. Flow Schematic: Peak Measured Wet Weather Flows (March 24, 2011)

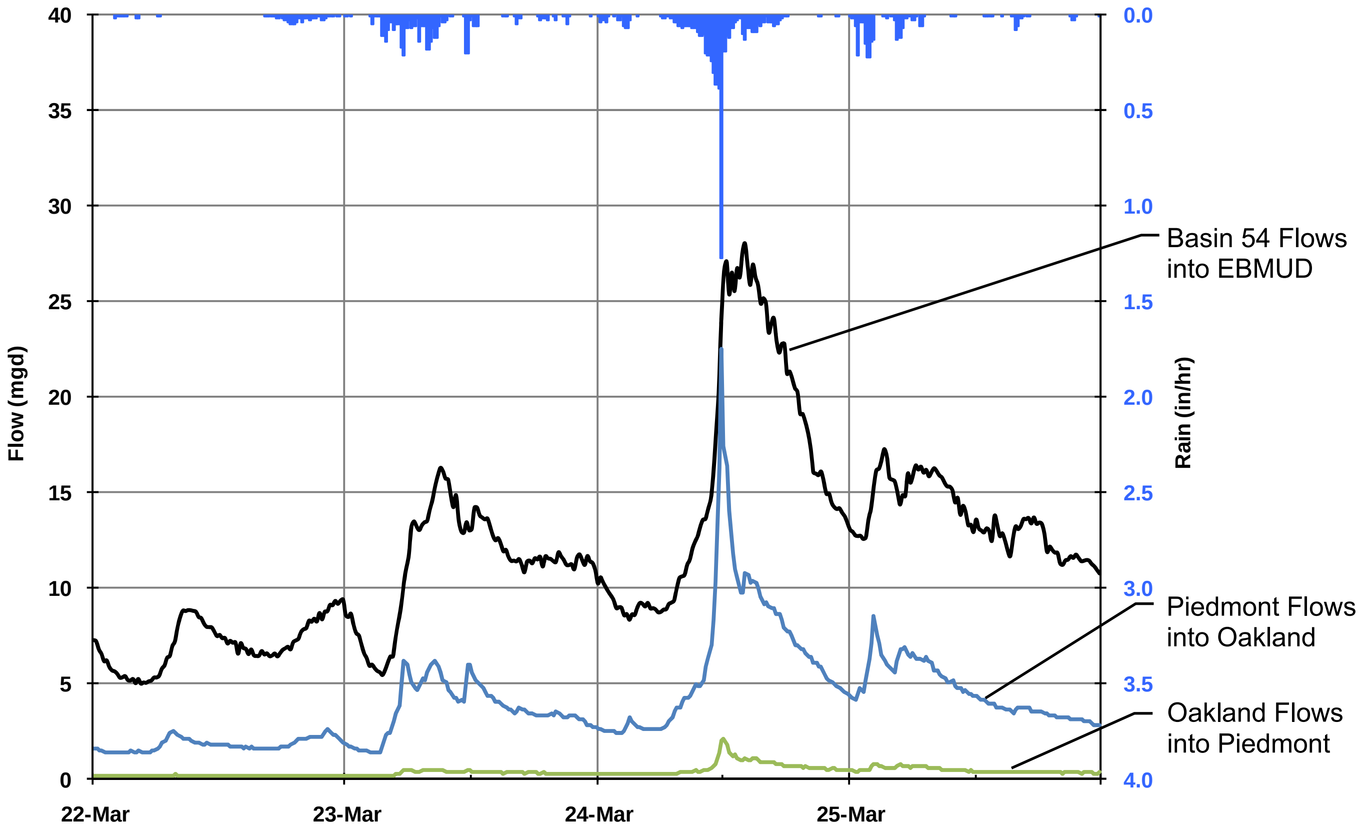


Figure 6. Hydrographs: Oakland, Piedmont and EBMUD Flows (March 22 - 26, 2011)

PEAKING FACTORS

<u>Peaking factor</u> is defined as the peak measured flow divided by the average dry weather flow (ADWF). The peaking factor ratio is often utilized as an indicator of **inflow** into a collection system. Inflow is storm water discharged into the sewer system through direct connections such as downspouts, area drains, cross-connections to catch basins, etc. These sources transport rain water directly into the sewer system and the corresponding flow rates are tied closely to the intensity of the storm. Inflow often causes 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.

Based on the EBMUD flow data from 2010/2011, Figure 7 summarizes the peaking factors.

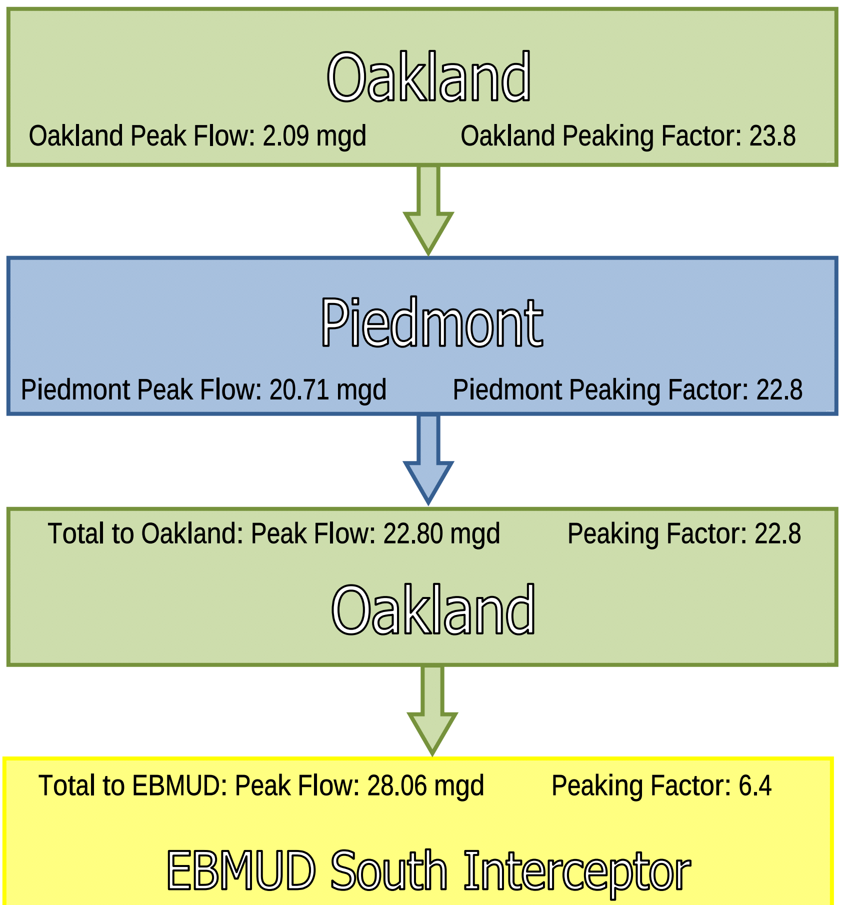


Figure 7. Flow Schematic: Summary of Peak Flows and Peaking Factors

It is noted that peak flow rates will be subject to attenuation. Due to attenuation, the peak flows, and correspondingly the peaking factors, from Oakland into Piedmont, will be reduced as the Oakland flows are conveyed through Piedmont. Similarly, the peak flows (and peaking factors), from Piedmont are reduced as the Piedmont flows are conveyed through Oakland. Attenuation is further explained in *Appendix A*.

DISCUSSION

The sharp upward spike that is evident in the Oakland-to-Piedmont flows and the Piedmont-to-Oakland flows does not occur in the Oakland-to-EBMUD flow data (Figure 8). The peak has been "shaved" and smoothed. This may be occurring due to either (1) flows being throttled and stored within the Basin 54 collection system, or (2) peak flows are not staying contained within the collection system. There is evidence that suggests the latter when examining the flows through the Trestle Glen trunk sewer.

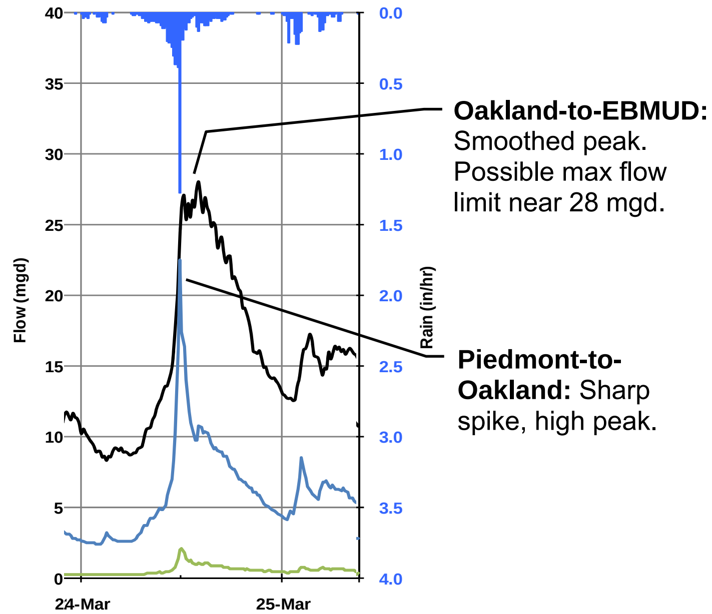


Figure 8. Peak Flows Snapshot

Trestle Glen Trunk Sewer

The Trestle Glen Trunk Sewer within Basin 54 has a history of capacity issues. Figure 9 shows a detail of the Trestle Glen Trunk Sewer.

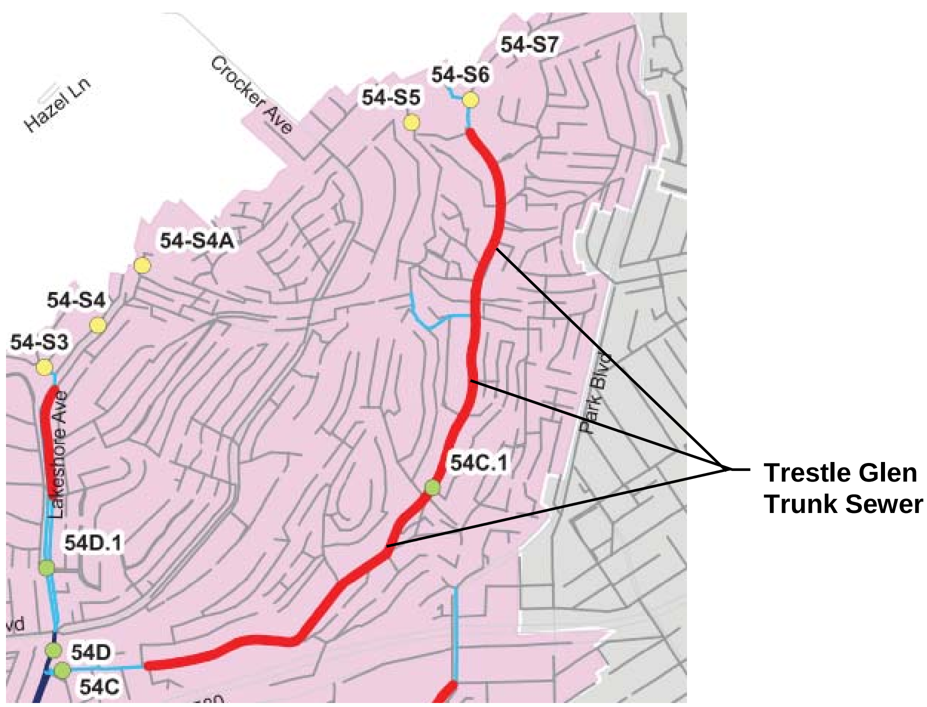


Figure 9. Trestle Glen Trunk Sewer

Site 54C.1 is located at approximately the midpoint of the Trestle Glen Trunk Sewer, as it traverses from the Piedmont border to Lakeshore Avenue. Site 54C is located at the most downstream location on the Trestle Glen Line near the intersection of Lakeshore Avenue.

Examining the flows on March 24, 2011 through Sites 54C.1 and 54C, the peak flows of nearly 7.5 mgd through 54C.1 were not conveyed through to Site 54C (Figure 10a). It is estimated that the capacity of the Trestle Glen Trunk Sewer measures approximately 5.5 mgd under peak storm event conditions.

Figure 10b overlays the Piedmont contributing flows (Sites S5, S6 and S7) with Site 54C.1. The peak flows from Piedmont measure 4.88 mgd, compared to 7.62 mgd total through Site 54C.1; approximately 64% of the peak flows through 54C.1 were generated within the City of Piedmont.

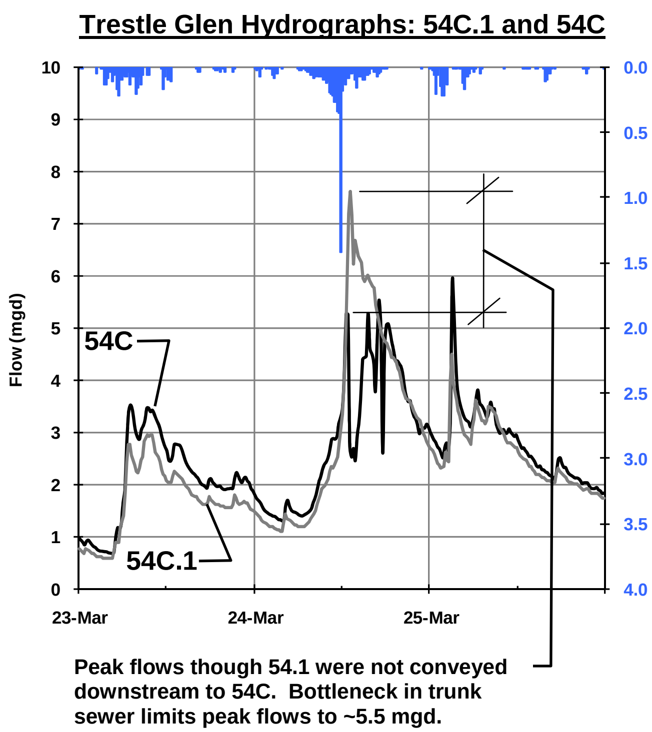


Figure 10a. Trestle Glen: 54C.1 and 54C.

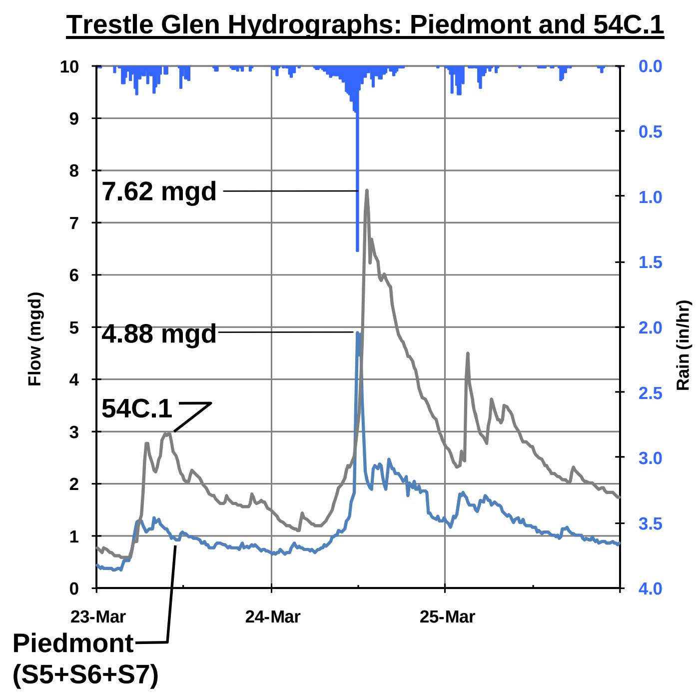


Figure 10b. Trestle Glen: Piedmont and 54C.1

The purpose of this discussion is to demonstrate that inflow contribution can be measured and assigned proportionally. This may help in determining funding allocations between the mutually interested shareholders for a capital improvement project.

SUMMARY

The sanitary sewer flows originating from the City of Oakland and entering the City of Piedmont, and the sanitary sewer flows originating from the City of Piedmont and entering the City of Oakland within Oakland Basin 54 were evaluated. The flows from Basin 54 discharging into the EBMUD South Interceptor were also analyzed. Peak flows and peaking factors were of specific interest, and the Trestle Glen Trunk sewer flows within Basin 54 were analyzed. Table 1 summarizes key items of this technical memorandum.

Table 1.
Capacity Analysis Summary

Item	Result
Peak rainfall event analyzed:	March 24, 2011. This storm event had the largest flow response within the City of Oakland for the 2011/2012 wet weather season.
Peak flow rates from Oakland into Piedmont (March 24, 2011):	Peak flow Rate: 2.09 mgd Peaking Factor: 23.8
Peak flow rates from Piedmont into Oakland (March 24, 2011):	Peak flow Rate: 22.80 mgd Peaking Factor: 22.8
Peak flow rates from Oakland into EBMUD (March 24, 2011):	Peak flow Rate: 28.06 mgd Peaking Factor: 6.4
Comments regarding flows from Oakland to EBMUD:	For the March 24, 2011 rainfall event, the peak flows at the discharge location into the EBMUD South Interceptor are less than expected. Either the peak flows are (1) throttled and stored within the Basin 54 collection system, or (2) not staying contained within the collection system.
Comments regarding Trestle Glen Trunk Sewer Flows:	There is evidence that suggests that peak flows measured at the approximate midpoint of the Trestle Glen trunk sewer were not conveyed downstream to the connection point with the Lakeshore trunk sewer.
Trestle Glen Capacity:	Trestle Glen trunk sewer peak flows are limited to approximately 5.5 mgd during peak storm event conditions due to capacity limitation.
Piedmont Contribution to Trestle Glen Trunk Sewer:	Piedmont generated peak flows measured 4.88 mgd during the March 24, 2011 rainfall event.
Peak flows through Trestle Glenn Trunk Sewer at midpoint, prior to capacity limitations:	Site 54.1 peak flows measured 7.62 mgd during the March 24, 2011 rainfall event.
Piedmont percentage of Peak Flow Contribution to Trestle Glen Trunk Sewer:	64%

APPENDIX A. ATTENUATION

Flow attenuation in a sewer collection system is the natural process of the reduction of the peak flow rate through redistribution of the same volume of flow 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 11.

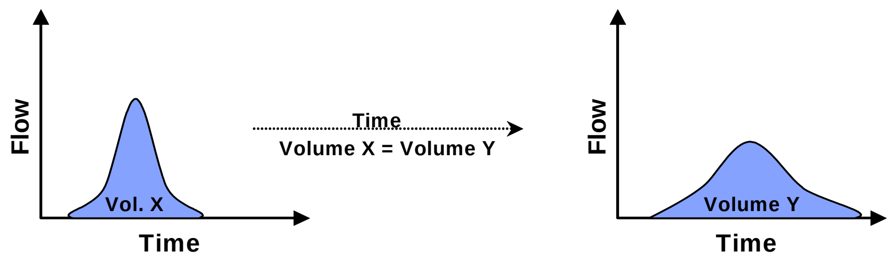


Figure 11. Attenuation Illustration

Within a sanitary sewer collection system, each individual basin will have a specific flow profile. As the flows from the basins combine within the trunk sewer lines, the peaks from each basin will (a) not necessarily coincide at the same time, and (b) due to the length and time of travel through the trunk sewers, peak flows will attenuate prior to reaching the treatment facility. 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.

APPENDIX I – CAPACITY RELATED IMPROVEMENT PROJECT DETAIL MAPS

CAPACITY IMPROVEMENT PROJECT 1
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

CITY OF OAKLAND

carollo
Engineers...Working Wonders With Water®

November 15, 2012
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CAPACITY IMPROVEMENT PROJECT 2

SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

CITY OF OAKLAND

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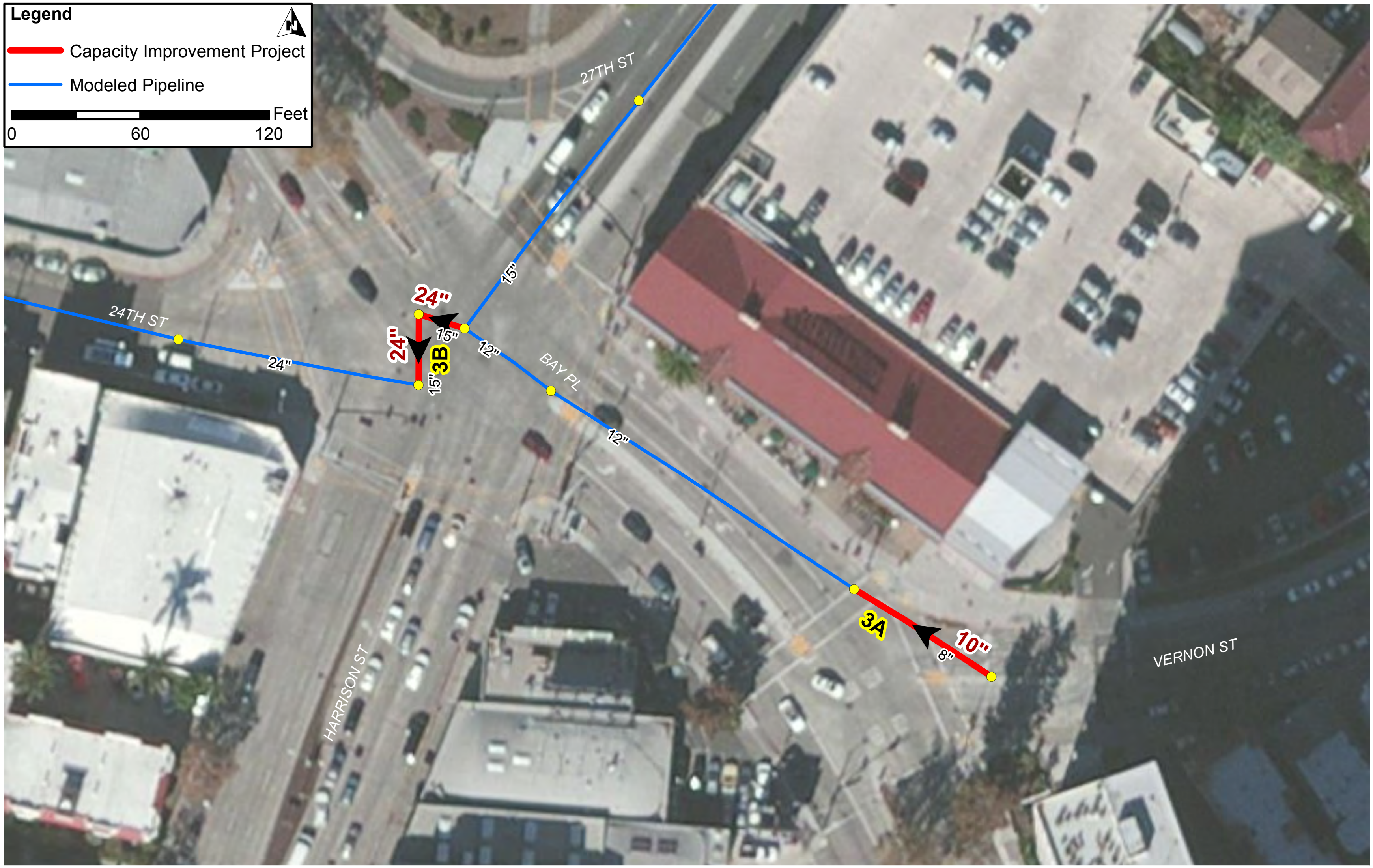

CAPACITY IMPROVEMENT PROJECT 3
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

CITY OF OAKLAND

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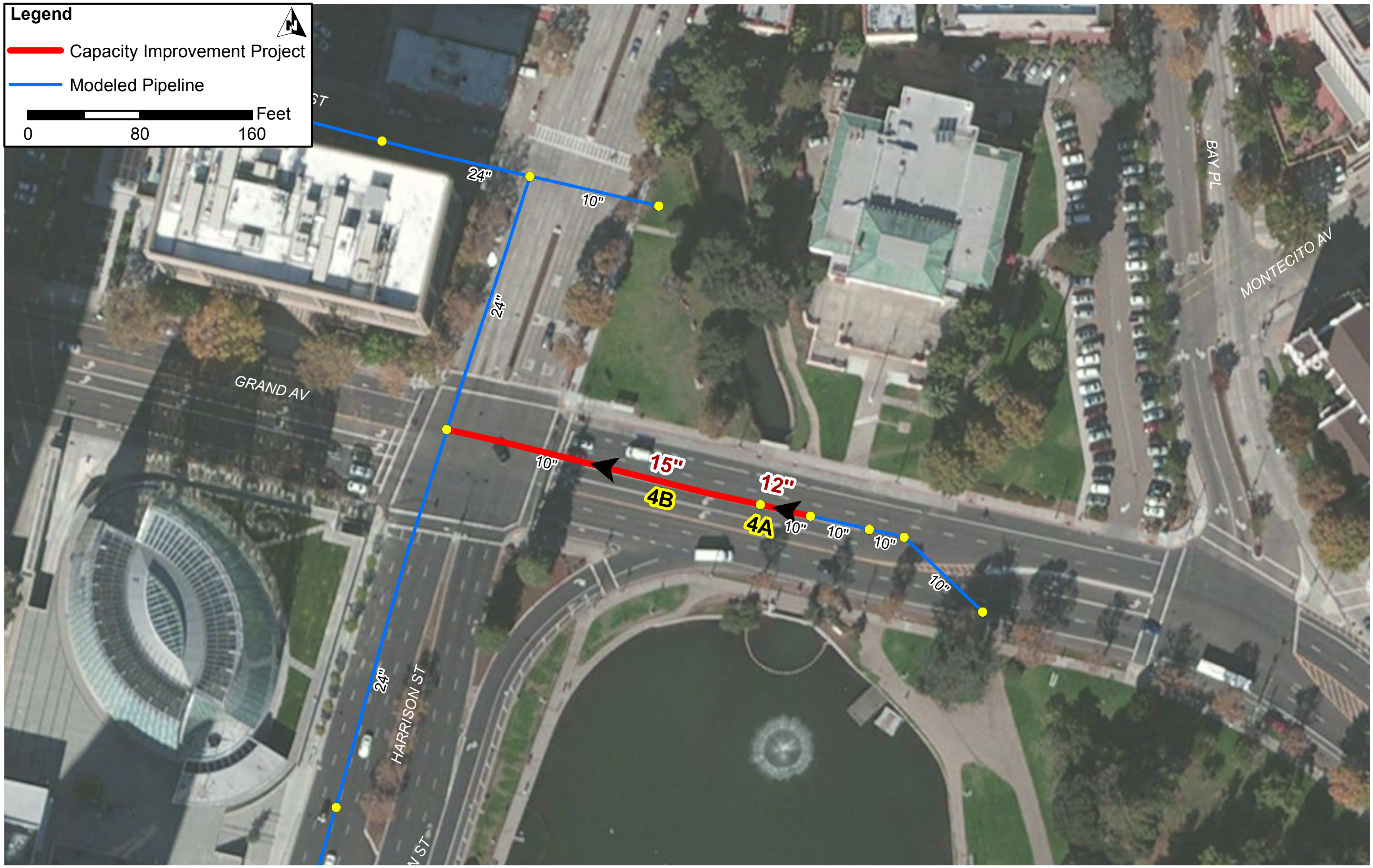

CAPACITY IMPROVEMENT PROJECT 4
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

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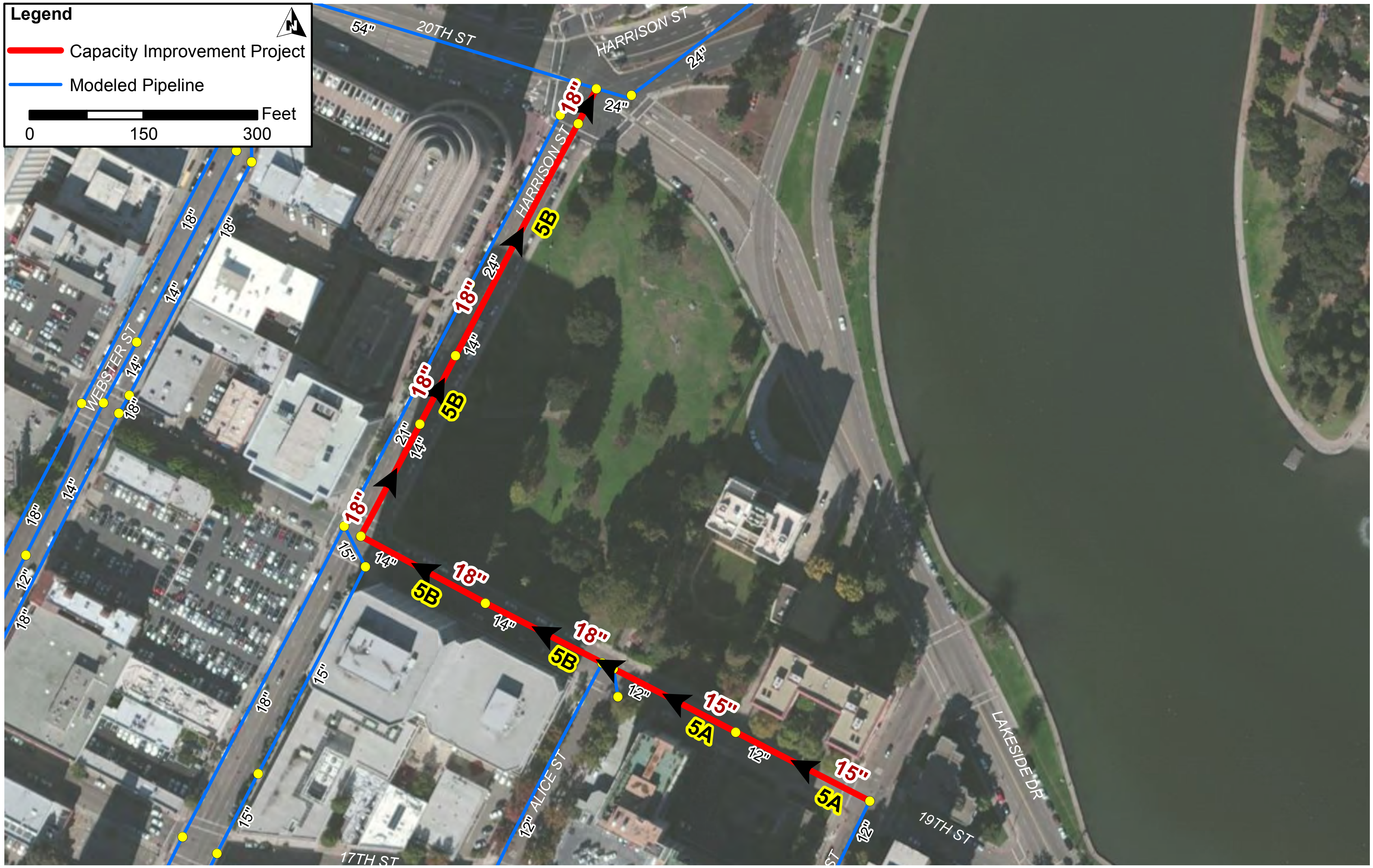

CAPACITY IMPROVEMENT PROJECT 5

SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
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CAPACITY IMPROVEMENT PROJECT 6

SEWER SYSTEM HYDRAULIC MODELING
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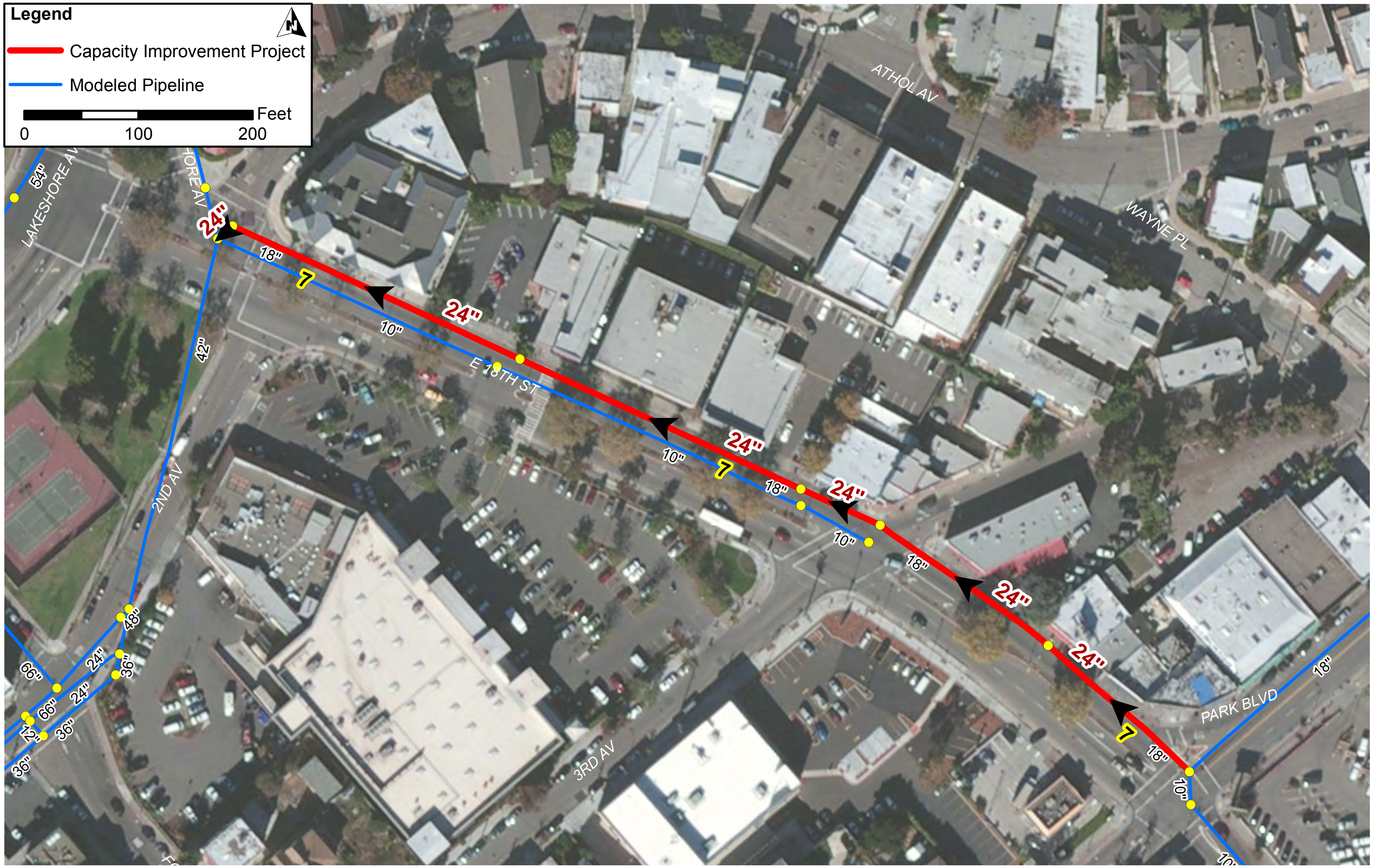

CAPACITY IMPROVEMENT PROJECT 7
SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

CITY OF OAKLAND

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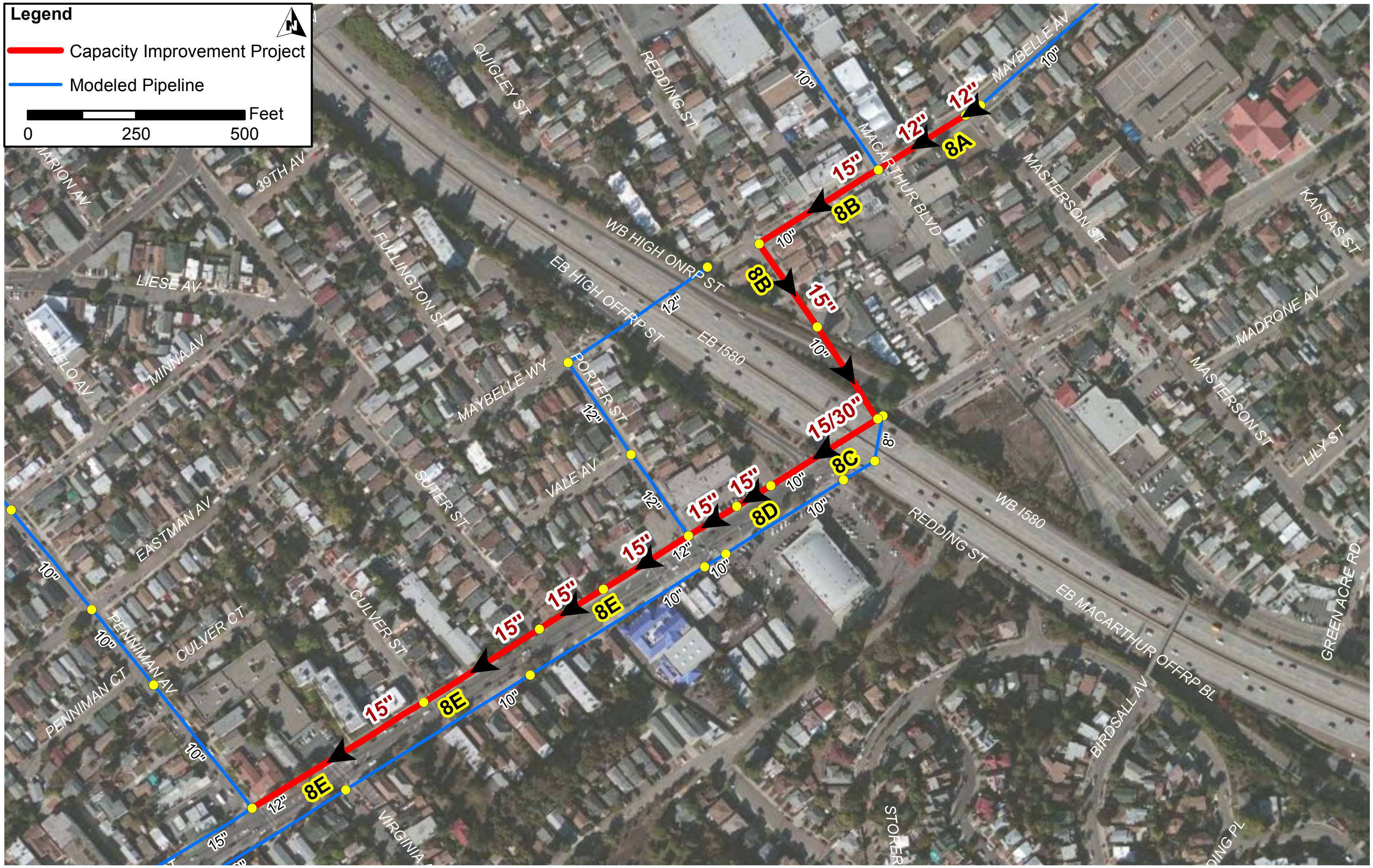

CAPACITY IMPROVEMENT PROJECT 8

SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

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CAPACITY IMPROVEMENT PROJECT 9

SEWER SYSTEM HYDRAULIC MODELING
AND CAPACITY ANALYSIS REPORT
CITY OF OAKLAND

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