City of Pacifica
Collection System Master Plan
Final Report

Prepared by:

RMC
Water and Environment

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List of Abbreviations

ACP	Asbestos Cement Pipe
ADWF	Average Dry Weather Flow
APN	Assessor Parcel Number
BWF	Base Wastewater Flow
CCTV	Closed-Circuit Television
CCWRP	Calera Creek Water Recycling Plant
CDO	Cease and Desist Order
CIP	Capital Improvement Program or Capital Improvement Plan
CIPP	Cured-in-Place Pipe
City	City of Pacifica
CMMS	Computerized Maintenance Management System
d/D	Ratio of flow depth to pipe diameter
DEM	Digital Elevation Model
DWF	Dry Weather Flow
EMS	Engineering Mapping Solutions
ENR CCI	Engineering News Record Construction Cost Index
fps	Feet per second
FY	Fiscal Year
GIS	Geographic Information System
gpd	Gallons per day
GWI	Groundwater Infiltration
HDPE	High Density Polyethylene (Pipe)
I/I	Infiltration and Inflow
LPR	Lining Point Repair
MFR	Multi-Family Residential
MG	Million Gallons
mgd	Million Gallons per Day
MH	Manhole
MPR	Major Point Repair
NASSCO	National Association of Sewer Service Companies
NAVD88	North American Vertical Datum 1988
NGVD29	National Geodetic Vertical Datum 1929

NPDES	National Pollutant Discharge Elimination System
OCE	Our Children's Earth Foundation
PACP	Pipeline Assessment and Certification Program
PDWF	Peak Dry Weather Flow
PR	Point Repair
PS	Pump Station
PVC	Polyvinyl Chloride (Pipe)
PWWF	Peak Wet Weather Flow
RDI/I	Rainfall Dependent Infiltration and Inflow
RMC	RMC Water and Environment
R/R	Rehabilitation/Replacement
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SECAP	System Evaluation and Capacity Assurance Plan
SFR	Single Family Residential
SQR	Structural Quick Rating
SSES	Sewer System Evaluation Survey
SSMP	Sewer System Management Plan
SWRCB	State Water Resources Control Board
V&A	V&A Consulting Engineers
VCP	Vitrified Clay Pipe
WWF	Wet Weather Flow
WWPF	Wet Weather Peaking Factor
WWTP	Wastewater Treatment Plant

Executive Summary

This report presents the results and recommendations of the Collection System Master Plan for the City of Pacifica (City). The report was prepared by RMC Water and Environment (RMC) under an agreement with the City dated October 27, 2009.

The original objective of this Master Plan was to update the City's last comprehensive assessment of its wastewater collection system, prepared in 1982, and to comply with the requirements of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, which require that every collection system agency in California prepare a Sewer System Management Plan (SSMP) which includes a System Evaluation and Capacity Assurance Plan (SECAP) and a plan for rehabilitation and replacement of sewers based on their condition.

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

Existing Sewer System and Service Area

The City's wastewater collection system serves a population of about 40,000 within the City of Pacifica city limits. The system includes approximately 96 miles of gravity sewer mains, 4 miles of pressure (force) mains, and 5 sewage pump stations. All wastewater is pumped via the three largest pump stations (Sharp Park, Linda Mar, and Rockaway) to the City's Calera Creek Water Recycling Plant (CCWRP). **Figure ES-1** shows the existing collection system.

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

The collection system also includes approximately 12,000 private sewer laterals. The City assumes responsibility for the maintenance and repair of the lower portion of the laterals (located within the public right-of-way) if they have cleanouts installed at the property line. Currently, an estimated 20 percent of private laterals have such cleanouts, but that number is expected to increase as more laterals undergo rehabilitation and replacement. There are some areas of the city, primarily in Linda Mar and Fairway Park, where the upper laterals (portion located on private property) are constructed of Orangeburg pipe, a fiberboard material that is known to disintegrate over time. These laterals are likely subject to considerable I/I, as well as increased likelihood of blockages and failures due to structural deterioration.

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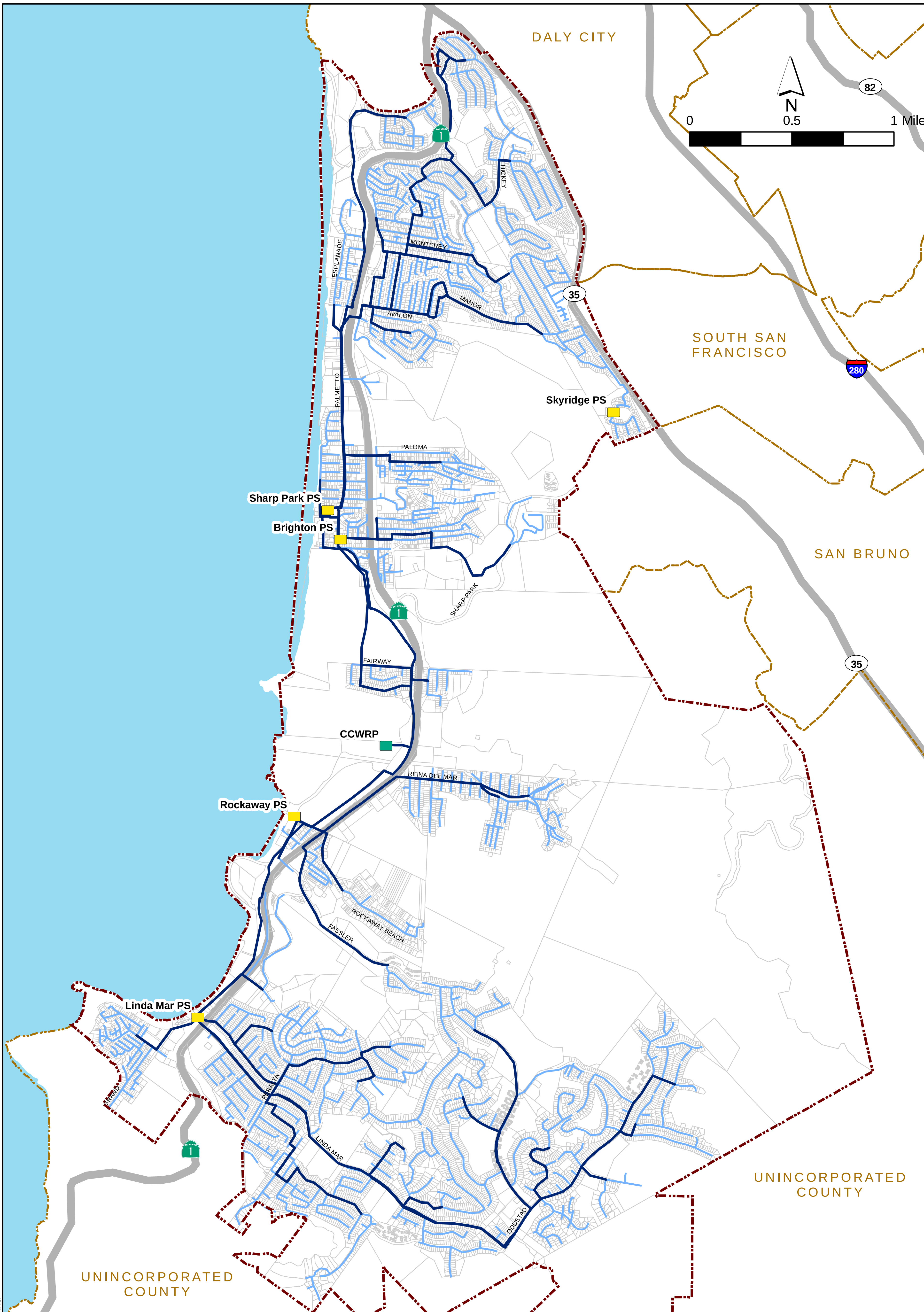


G:GIS\Modeled Sewer Network.mxd

- Modeled Sewers
- Unmodeled Sewers
- Pacifica City Limites
- Other City Boundaries

RMC Water and Environment

City of Pacifica
Collection System Master Plan

Existing Wastewater Collection System

Figure ES-1

Capacity Assessment

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

Flow loads to the model were developed from customer water use data (provided by the North Coast County Water District), estimates of additional flows from potential future development (fairly minimal for Pacifica, as the city is largely built out), and from a flow monitoring program conducted for this study. Winter water use data typically provides a very accurate estimate of base wastewater flow (BWF), as outside water use is minimal during that time of year. Flow monitoring was conducted at 17 sites in the collection system during the winter 2009/10, with rainfall data also collected by three temporary rain gauges. The purpose of the monitoring was to obtain data to confirm base wastewater flows and to quantify the I/I response of the system to rainfall. The flow monitoring data was used to estimate the amount of groundwater infiltration (GWI) and rainfall-dependent I/I (RDI/I) for various areas of the system and to confirm, through model calibration, that the hydraulic model reasonably simulates the actual performance of the system during both dry and wet weather conditions.

Design Storm

The capacity of the system was assessed with respect to a design rainfall event, defined as a 10-year recurrence frequency, 24-hour duration storm with a temporal rainfall distribution based on guidelines established in the U.S. Department of Agriculture Natural Resources Conservation Service publication Technical Release 55, "Urban Hydrology for Small Watersheds". This document defines a particular synthetic rainfall distribution, called an "SCS Type 1A" storm, which is applicable to areas in northwestern California. The SCS Type 1A rainfall distribution was applied to rainfall data specific to San Mateo County to develop a specific design storm for Pacifica. The storm has a total 24-hour rainfall of 3.74 inches with a peak intensity of 0.59 inches per hour. The design storm is comparable in size to notable large rainfall events that have occurred in the San Francisco Bay Area over the past several years, including the storms of December 31, 2005, and January 25, 2008.

Capacity Analysis Results

The hydraulic model was run with the 10-year design storm to identify areas of the collection system that would not have adequate capacity to convey the peak wet weather flows generated by that event. Capacity was considered inadequate whenever the model predicted that the peak flows would result in overflows from the system or surcharge (flow above the crown of sewer pipes) to within four feet of manhole rims. Pump station capacity was considered inadequate if the peak flows exceeded the station's firm capacity (capacity with the largest pump not in operation).

The modeling indicated gravity pipeline capacity deficiencies in 12 locations in the collection system, and inadequate firm pumping capacity at the Linda Mar Pump Station. Several of the deficiencies are locations of historical wet weather overflows, including locations along lower Linda Mar Boulevard and Palmetto Avenue.

Based on the model results, improvement projects to address the predicted capacity deficiencies were developed. The projects primarily involve replacing existing deficient sewers with larger diameter pipes, or diverting flows to other existing sewers with available capacity or to proposed new pipes. Proposed sewer improvements were tested in the model to confirm that they would eliminate the identified capacity deficiencies and to confirm that sewers and pump stations downstream of the upsized pipes could handle the higher peak flows.

The results of the modeling of proposed pipe capacity improvements indicated that peak flows reaching the Linda Mar Pump Station during the design storm event would be about 14.4 million gallons per day (mgd), exceeding both the firm and existing total capacity (with all pumps operating) of the pump station. Furthermore, the Linda Mar force main would not have capacity to convey those flows. Therefore, addressing the capacity issues at Linda Mar Pump Station would require addition of a fourth pump as well as constructing a two-mile long parallel force main near the Coast Highway from Linda Mar Boulevard to Reina del Mar. Under these conditions, influent peak wet weather flow to the CCWRP could reach 26 mgd, exceeding the 20 mgd hydraulic capacity of the treatment plant. Upgrading the CCWRP to handle these higher peak flows would be very expensive and difficult to implement, as the plant is located within the California coastal zone.

Accordingly, several "systemwide" alternatives were identified and evaluated to address this issue. In addition to the Capacity Enhancement Only alternative (implement sewer capacity improvement projects, increase Linda Mar Pump Station capacity and construct parallel force main, and upgrade CCWRP), two additional alternatives were evaluated: construction of a flow equalization facility at Linda Mar, and comprehensive sewer rehabilitation to reduce I/I to the level that would not require increasing Linda Mar pumping capacity or capacity of the CCWRP. The systemwide alternatives are discussed below.

Alternative 1: Capacity Enhancement Only

Under this alternative, all sewer capacity improvements would be implemented along with addition of a fourth pump at Linda Mar Pump Station and construction of a parallel force main. The CCWRP would be expanded by the addition of a sixth sequencing batch reactor and other improvements needed to handle the increased peak flows at the plant. The cost of such a plant expansion was estimated by City staff at $20 to $25 million. Furthermore, obtaining the required environmental, regulatory, and California Coastal Commission permits would likely be extremely difficult.

Alternative 2: Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar

Under this alternative, capacity improvements within the gravity collection system would be implemented, and a flow equalization facility would be constructed in the vicinity of the Linda Mar Pump Station. A fourth pump at Linda Mar Pump Station would also still be needed to provide firm pumping capacity; however, the equalization facility would reduce peak flows to the pump station to levels that could be handled by the existing force main and the CCWRP. The equalization facility would include a 2.1 million gallon (MG) underground concrete basin with pipes to divert flow to the basin during high wet weather conditions and a return pump station and piping to empty the basin after flows have receded and convey them back to the collection system. A preliminary site at the park-and-ride lot on the north side of Linda Mar Boulevard just east of the highway was assumed for the alternatives analysis; however, further siting studies, hydraulic analyses, geotechnical investigations, evaluation of environmental impacts and permitting requirements, and community outreach would be required before a final site could be selected. The estimated capital cost of the basin is $20 million.

Alternative 3: Collection System Capacity Improvements with Comprehensive Sewer Rehabilitation to Reduce I/I

Under this alternative, sewer capacity improvements and the fourth pump at Linda Mar Pump Station would be implemented, and comprehensive sewer rehabilitation would be conducted to reduce peak flows sufficiently to levels that could be handled by the existing force main and the CCWRP. Comprehensive rehabilitation involves rehabilitation or replacement of all sewer mains and associated laterals (both lower and upper portions) in an entire area of the system, with estimated I/I reductions of 70 to 80 percent overall. The targeted area for comprehensive rehabilitation would include approximately 20 miles of sewer mains and an estimated 2,700 laterals in the Pedro Point and lower Linda Mar areas, the areas of the system found to contribute the highest I/I flows. The estimated cost of comprehensive rehabilitation in these areas is $23 million (not including costs for upper lateral replacement). Since implementation of a comprehensive rehabilitation program would likely take 15 to 20 years or more, it was assumed that sewer capacity improvements would still be implemented to minimize the near-term risk of localized SSOs.

Recommended Capacity Assurance Plan

Table ES-1 provides a comparison of the three systemwide alternatives. Based on this comparison, it is recommended that the City proceed with implementation of Alternative 2, Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar. This alternative provides the best assurance of meeting regulatory and legal requirements to eliminate capacity-related SSOs in the near-term, and has the lowest estimated capital cost of the three alternatives. It is also recommended that the City initiate a long-term program of comprehensive sewer rehabilitation, which will further reduce the risk of dry weather blockages and overflows, as well as reduce the annual costs for operation and maintenance of the sewer system, pumping stations, and wastewater treatment plant. The rehabilitation program would be prioritized based on I/I as well as needs for structural sewer rehabilitation, discussed in the following subsection of this Executive Summary.

Table ES-1: Comparison of Systemwide Capacity Assurance Alternatives

Alternative		Advantages	Disadvantages	Est. Capital Cost
1	Capacity Enhancement Only	• Eliminates risk of wet weather SSOs due to Linda Mar PS capacity deficiency once parallel force main is constructed • Reduces risk of bypasses from CCWRP once plant expansion or equalization is constructed • Would allow portion of Linda Mar force main to be taken out of service for cleaning or inspection.	• Potential environmental and permitting impediments to construction of parallel force main • Significant environmental and permitting impediments to expansion of CCWRP • Continued risk of bypasses from CCWRP until plant expansion is completed	$34M[a]
2	Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar	• Eliminates risk of wet weather SSOs due to Linda Mar PS capacity deficiency once flow equalization facility is constructed • Reduces risk of bypasses from CCWRP • Would allow Linda Mar force main to be taken out of service for cleaning or inspection.	• Potential implementation impediments and community opposition to flow equalization facility	$24M
3	Collection System Capacity Improvements with Comprehensive Sewer Rehabilitation to Reduce I/I	• Reduced flow and associated O&M costs for pumping and treatment • Improved system condition and reduced costs for sewer maintenance and risk of blockages and dry weather SSOs in rehabilitated areas • Ultimately reduces risk of wet weather SSOs and bypasses due to Linda Mar PS capacity deficiency and CCWRP hydraulic limitations	• Continued risk of wet weather SSOs due to Linda Mar Pump Station capacity deficiency until significant amount of comprehensive rehabilitation is completed (could take 15 to 20 years) • Actual amount of I/I reduction achieved cannot be predicted with certainty. • Requires private lateral rehabilitation to achieve I/I reduction target.	$27M[b]

a. Includes estimated cost of $25M for capacity expansion of CCWRP.
b. Would require additional costs for private lateral rehabilitation.

Condition Assessment and Rehabilitation/Replacement Program

The condition of the gravity collection system was evaluated through review of closed-circuit television (CCTV) inspection data collected by the City over the past five years. As of June 2011, the City has inspected approximately 40 percent of the sewers in the system, and plans to complete inspection of the remainder of the sewers by 2013. For recording CCTV data, the City uses the Pipeline Assessment and Certification Program (PACP) guidelines developed by the National Association of Sewer Service Companies (NASSCO), which are considered the current standard of the industry.

Condition ratings were developed for the inspected sewers using the PACP system, which assigns grades to all observed defects based on their type and severity. Grades are assigned to both structural defects (e.g., cracks, broken pipe, offset pipe joints) and maintenance-related defects (e.g., grease, debris, root intrusion). To utilize the condition rating and defect information, RMC, in conjunction with City staff, developed a decision process to determine the appropriate sewer renewal method for sewers with defects warranting near-term repair. The focus of the analysis was on pipes with major defects that could result in structural failures; large offset joints, which can impede inspection and cleaning equipment; and significant root intrusion, which can cause blockages resulting in SSOs. Each inspected pipe was analyzed to identify the apparent most cost-effective method of renewal (e.g., localized point repair, lining, or replacement) to address these issues; or if renewal not considered necessary at this time, the pipe was identified for continued maintenance at an appropriate cleaning frequency.

The results from the rehabilitation decision analysis of the inspected sewers were extrapolated to the remainder of the system based on the age and size of those pipes. This enabled estimates of sewer renewal quantities to be developed for the entire system. **Table ES-2** summarizes these quantities, and **Table ES-3** presents the estimated cost of this work. For the as-yet-uninspected portion of the system, however, the specific pipes requiring rehabilitation or replacement will be determined based on subsequent CCTV inspection results.

Table ES-2: Projected Sewer Renewal Requirements

Sewer Renewal Reason and Decision	Length of Pipe Segments (ft.)	Percentage of Total Pipe Length	Number of Localized Repairs
Major Structural Defects	**113,431**	**22.3%**	**325**
Replace	*47,721*	*9.4%*	*0*
Line	*6,669*	*1.3%*	*19*
Localized Repair	*59,041*	*11.6%*	*306*
Large Offset Joints	**33,668**	**6.6%**	**143**
Replace	*3,945*	*0.8%*	*0*
Localized Repair	*29,723*	*5.8%*	*143*
Significant Root Intrusion	**23,887**	**4.7%**	**7**
Replace	*22,203*	*4.4%*	*0*
Line	*1,684*	*0.3%*	*7*
Renewal Subtotal	**170,986**	**33.6%**	**475**
Maintain/Re-inspect in Future	**338,273**	**66.4%**	**0**
TOTAL	**509,259**	**100%**	**475**

Table ES-3: Estimated Near-Term Costs for Sewer Rehabilitation and Replacement

Reason for Renewal	Estimated Construction Cost[a]	Estimated Capital Cost[b]
Major Structural Defects	$10,141,000	$12,676,000
Large Offset Joints	$1,812,000	$2,265,000
Significant Root Intrusion	$3,129,000	$3,911,000
Total	**$15,082,000**	**$18,852,000**

a. Includes 30% allowance for contingencies.
b. Includes 25% allowance for engineering, administration, and legal costs.

Long-Range Capital Improvement Program

The recommended CIP includes 14 capacity improvement projects, including construction of the proposed Linda Mar flow equalization facility. The recommended capacity projects are listed in **Table ES-4** and shown in **Figure ES-2.** The projects have been assigned relative priorities based on the extent of predicted capacity deficiencies and the potential impacts of wet weather SSOs on the community or the environment should they occur as a result of these deficiencies. In addition to the flow equalization facility, three of the collection system capacity projects are considered high priority, including the replacement of the existing 12-inch parallel sewer in Palmetto Avenue north of Paloma Avenue with an 18-inch pipe; upsizing of the main trunk sewer serving the Pedro Point area; and upsizing the existing 12- and 15-inch parallel trunk sewer in lower Linda Mar Boulevard. Other capacity projects have been assigned lower priorities because there have not been documented overflows at these locations and the potential impact of overflows is lower.

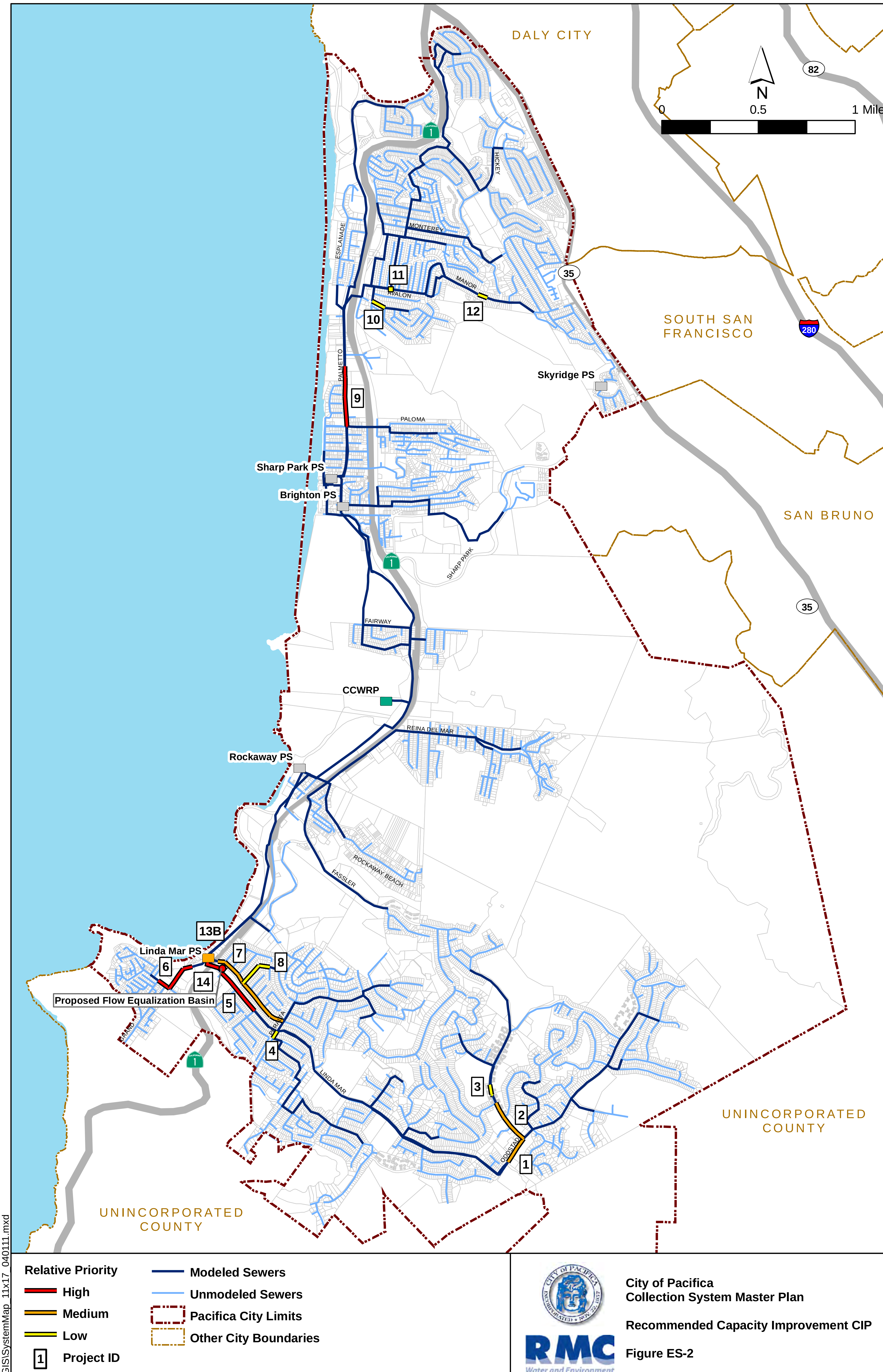
Sewer repairs and replacements to address major structural defects are considered the highest priority with respect to sewer rehabilitation because the present the greatest risk of structural failure, followed by projects to address large offset joints (which do not present a risk of structural failure but may impede inspection or cleaning equipment) and significant root intrusion. Root intrusion increases the risk of SSOs due to blockages, but can be controlled by effective maintenance (rodding and/or root foaming) in the interim period before the sewers are rehabilitated. The City has developed a root control plan as part of its overall maintenance program. **Figure ES-3** shows the sewers recommended for rehabilitation according to the reason for renewal (structural rehabilitation, large offset joints, significant root intrusion) based on based on the CCTV inspection conducted as of June 2011.

In addition to addressing the capital project needs identified in the capacity assurance and near-term sewer rehabilitation plans, the City intends to continue efforts for overall rehabilitation of the sewer system to reduce I/I, focusing on those areas identified as having the highest I/I contributions to the system. In implementing its structural rehabilitation program, the City may choose to conduct more extensive rehabilitation (e.g., manhole-to-manhole pipe replacement or lining rather than just localized point repairs of major defects, or including additional adjacent pipe segments in the rehabilitation work) to match these objectives and will prioritize its structural rehabilitation program accordingly. Therefore the rehabilitation/replacement component of the recommended CIP is formulated as an annual budget allocation rather than a list of specific projects, to allow the City flexibility to tailor the program to meet both structural rehabilitation and long-term I/I reduction objectives. The City is also initiating a sewer lateral replacement program starting in January 2012, which will provide funding for replacement of defective private laterals in the highest I/I areas of the City.

Table ES-4: Recommended Capacity Improvement Projects

Project ID	Location	Project Length (ft.)	Proposed Improvements	Relative Priority
1	Oddstad Blvd. from Terra Nova Blvd. to Toledo Ct.	771	Upsize existing pipes from 15” to 18”	Medium
2	Terra Nova Blvd. from Alicante Dr. to Oddstad Blvd.	1,242	Upsize existing pipes from 12” to 15”	Medium
3	Terra Nova Blvd. between Lerida Way and Alicante Dr.	323	Upsize existing pipes from 8” to 10”	Low
4	Peralta Rd. from Montezuma Dr. to Linda Mar Blvd.	225	Upsize existing pipe from 12” to 15”	Low
5	Linda Mar Blvd. upstream and downstream of De Solo Dr.	1,398	Upsize existing pipes form 12”/15” to 15”/18”	High
6	San Pedro Ave. from Livingston Ave. to Halling Way, Halling Way to Shoreside Dr.	1,279	Upsize existing pipes from 6”/8” to 8”-12”	High
7	Arguello Blvd. from Peralta Rd. to Coast Hwy.	2,497	Upsize existing pipes from 6”-12” to 8”-15”	Medium
8	De Solo Dr. from Fernandez Way to Arguello Blvd.	943	Upsize existing pipes from 8” to 10”	Low
9	Palmetto Ave. from north of Shoreview Ave. to Paloma Ave.	1,442	Replace existing 12” pipe with 18” at same depth/slope as parallel 18”	High
10	Milagra Dr. from Bruce St. to Edgemar Ave.	394	Upsize existing pipe from 6” to 8”	Low
11	Avalon Rd. at Del Mar Ave.	9	Divert flow from 8" pipe to parallel 18" sewer	Low
12	Manor Dr. west of Monterey Rd.	269	Upsize existing pipe from 6” to 8”	Low
13B	Linda Mar Pump Station	--	Add fourth pump	Medium[a]
14	Linda Mar Flow Equalization Facility	--	Construct 2.1 MG basin with diversion and return pipes and pumps	High

a. If flow equalization facility is constructed first, relative priority for pump station upgrade would be lower as pump station would have sufficient *total* capacity to convey design PWWF.



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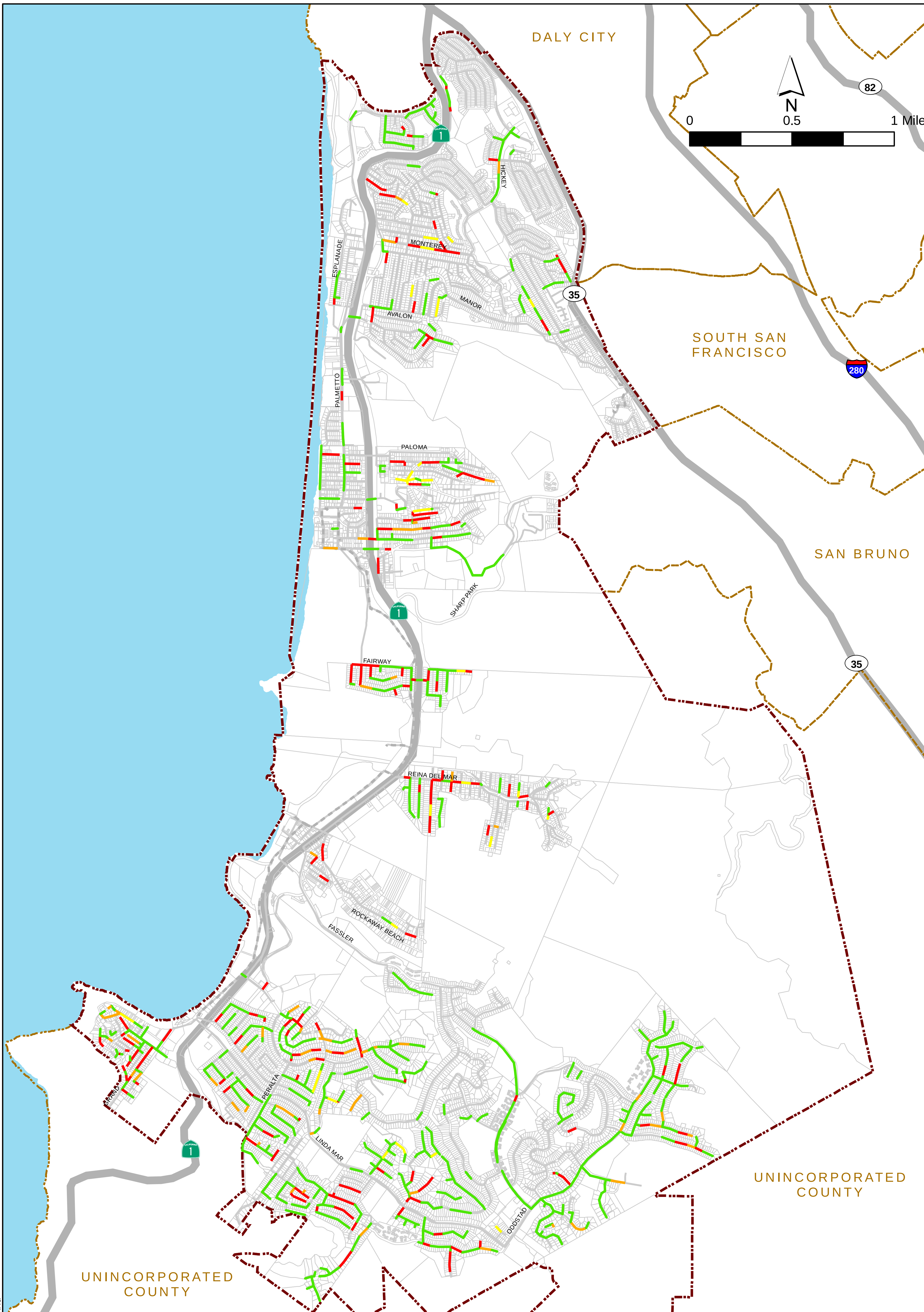
City of Pacifica
Collection System Master Plan

Recommended Capacity Improvement CIP

Figure ES-2

RMC Water and Environment



Relative Priority

- High (major structural defects)
- Medium (large offset joints)
- Low (significant root intrusion)
- No Rehab Needed

- Sewer Line (No CCTV Data)
- Force Main
- Pacifica City Limites
- Other City Boundaries

City of Pacifica
Collection System Master Plan

Recommended Sewer Rehabilitation
(sewers inspected as of June 2011)

Figure ES-3

RMC Water and Environment

G:GIS\Modeled Sewer Network.mxd

Estimated costs for capacity improvement projects and sewer rehabilitation/replacement were based on recent bids provided by the City and cost data from similar projects. The costs are conceptual level estimates, considered to have an estimated accuracy range of -30 to +50 percent, suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed to design and construction. All costs are presented in current (January 2011) dollars and include a 30 percent allowance for contingencies for unknown conditions, as well as an allowance of 25 percent of estimated construction cost for engineering, administration, and legal costs.

Table ES-5 presents the recommended collection system CIP, including specific projects recommended for implementation during the first two years of the program (FY 2012 and FY 2013). Other projects have been assigned to CIP years 3 through 10 or 11 through 20 based on financial considerations and their relative priorities as discussed above. The City will update the long-range CIP in 2014 based on additional sewer inspections and development of a financial plan to be completed subsequent to this Master Plan report.

Table ES-5: Recommended Collection System Capital Improvement Program

Project ID	Project Description		Est. Capital Cost	Avg. Annual CIP Budget
Years 1-2				
14	Linda Mar Flow Equalization Basin Design	Site selection, geotechnical, hydraulic, environmental studies, permitting, pre-design and design	$ 2,000,000	
9	Palmetto Ave. from north of Shoreview Ave. to Paloma Ave.	Replace exist. 12" pipe with 18" at same depth/slope as exist. 18"	$ 571,000	
	Sewer Rehabilitation		$ 2,540,000	
	Subtotal - Years 1-2		**$ 5,100,000**	**$ 2,600,000**
Years 3-10				
14	Linda Mar Flow Equalization Basin Construction	Equalization basin, piping, return pump station	$18,050,000	
6	San Pedro Ave. from Livingston Ave. to Halling Way, Halling Way to Shoreside Dr.	Upsize existing pipes (6"-8" to 8"-12")	$ 251,000	
5	Linda Mar Blvd. upstream and downstream of De Solo Dr.	Upsize existing pipes (12"-15" to 15"-18")	$ 380,000	
13B	Linda Mar Pump Station	Add fourth pump	$ 935,000	
7	Arguello Blvd. from Peralta Rd. to Coast Hwy.	Upsize existing pipes (6"-12" to 8"-15")	$ 418,000	
	Sewer Rehabilitation		$10,160,000	
	Subtotal - Years 3-10		**$30,200,000**	**$ 3,800,000**
Years 11-20				
1	Oddstad Blvd. From Terra Nova Blvd. to Toledo Ct.	Upsize existing pipes (15" to 18")	$ 281,000	
2	Terra Nova Blvd. from Alicante Dr. to Oddstad Blvd.	Upsize existing pipes (12" to 15")	$ 248,000	
3	Terra Nova Blvd. between Lerida Way and Alicante Dr.	Upsize existing pipes (8" to 10")	$ 51,000	
4	Peralta Rd. from Montezuma Dr. to Linda Mar Blvd.	Upsize existing pipe (12" to 15")	$ 45,000	
8	De Solo Dr. from Fernandez Way to Arguello Blvd.	Upsize existing pipes (8" to 10")	$ 137,000	
10	Milagra D. from Bruce St. to Edgemar Ave.	Upsize existing pipe (6" to 8")	$ 48,000	
11	Avalon Rd. at Del Mar Ave.	Divert flow from 8" pipe to parallel 18"	$ 30,000	
12	Manor Dr. west of Monterey Rd.	Upsize existing pipe (6" to 8")	$ 34,000	
	Sewer Rehabilitation		$ 6,200,000	
	Additional Comprehensive Rehabilitation		$ 7,400,000	
	Subtotal - Years 11-20		**$14,500,000**	**$ 1,500,000**
TOTAL CIP			**$49,800,000**	**$ 2,500,000**

Chapter 1 Introduction

This report presents the results and recommendations of the Collection System Master Plan for the City of Pacifica (City). The report was prepared by RMC Water and Environment (RMC) under an agreement with the City dated October 27, 2009. This introductory chapter provides background information on the objectives and scope of the Master Plan, the City's sewer system and service area, and the contents and organization of the Master Plan report.

1.1 Background and Study Objectives

Prior to this study, the City last conducted a comprehensive assessment of its wastewater collection system in 1982. That study was a Sewer System Evaluation Survey (SSES) focused on addressing the problem of excessive infiltration and inflow (I/I) into the collection system. In the period since the 1982 SSES, the City has made various improvements to the collection system, including sewer repairs and replacements and pump station upgrades; has implemented a program of regular cleaning and closed-circuit television (CCTV) inspection of gravity sewers; and has developed mapping of the system in AutoCAD.

Since 2004, the City has been required to monitor and report occurrences of sanitary sewer overflows (SSOs), initially to the San Francisco Bay Regional Quality Control Board (RWQCB or Regional Board), and since 2007 to the State Water Resources Control Board (SWRCB) under the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems adopted in 2006. Under the Regional and State regulations, the City is also required to prepare and adopt a Sewer System Management Plan (SSMP), which must include plans and programs for addressing the operation and maintenance of the system and assessing its condition and capacity. The City initiated this Collection System Master Plan in order to meet specific SSMP requirements, as well as to develop a long-term plan for rehabilitation, replacement, and capacity improvements to its system.

As a result of SSOs that have occurred in the system over the past few years, the Regional Board issued a Cease and Desist Order (CDO) to the City in May 2011, and the City entered into a Consent Decree with Our Children's Earth Foundation in June 2011, requiring it to implement a number of measures targeted at reducing SSOs. The CDO and Consent Decree have similar requirements, including developing and implementing an SSO reduction plan, computerized maintenance management system (CMMS), and programs addressing system-wide cleaning, root control, illicit discharge elimination, private sewer laterals, and staff training; performing a condition assessment of the collection system; preparing a System Evaluation and Capacity Assurance Plan (SECAP); and developing an initial and long-term capital improvement plan (CIP) and financial plan. This Master Plan report specifically addresses the condition assessment of the system (based on inspection data collected to date), the SECAP, and development of a long-term CIP.

1.2 Study Area

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

1.3 Existing Sewer System

The City's wastewater collection system includes approximately 96 miles of gravity sewer mains, 4 miles of pressure (force) mains, and five sewage pump stations. All sewage is pumped via the three largest pump stations (Sharp Park, Linda Mar, and Rockaway) to the Calera Creek Water Recycling Plant (CCWRP), which is located centrally in the system just west of Highway 1 opposite Reina Del Mar in the Vallemar area. The other two pump stations serve smaller areas within the collection system. **Figure 1-2** shows the existing collection system layout. **Table 1-1** tabulates the footage of pipe by diameter. As noted in the table, over 60 percent of the gravity sewer mains are 6 inches in diameter, and over 85 percent are less than 10 inches.

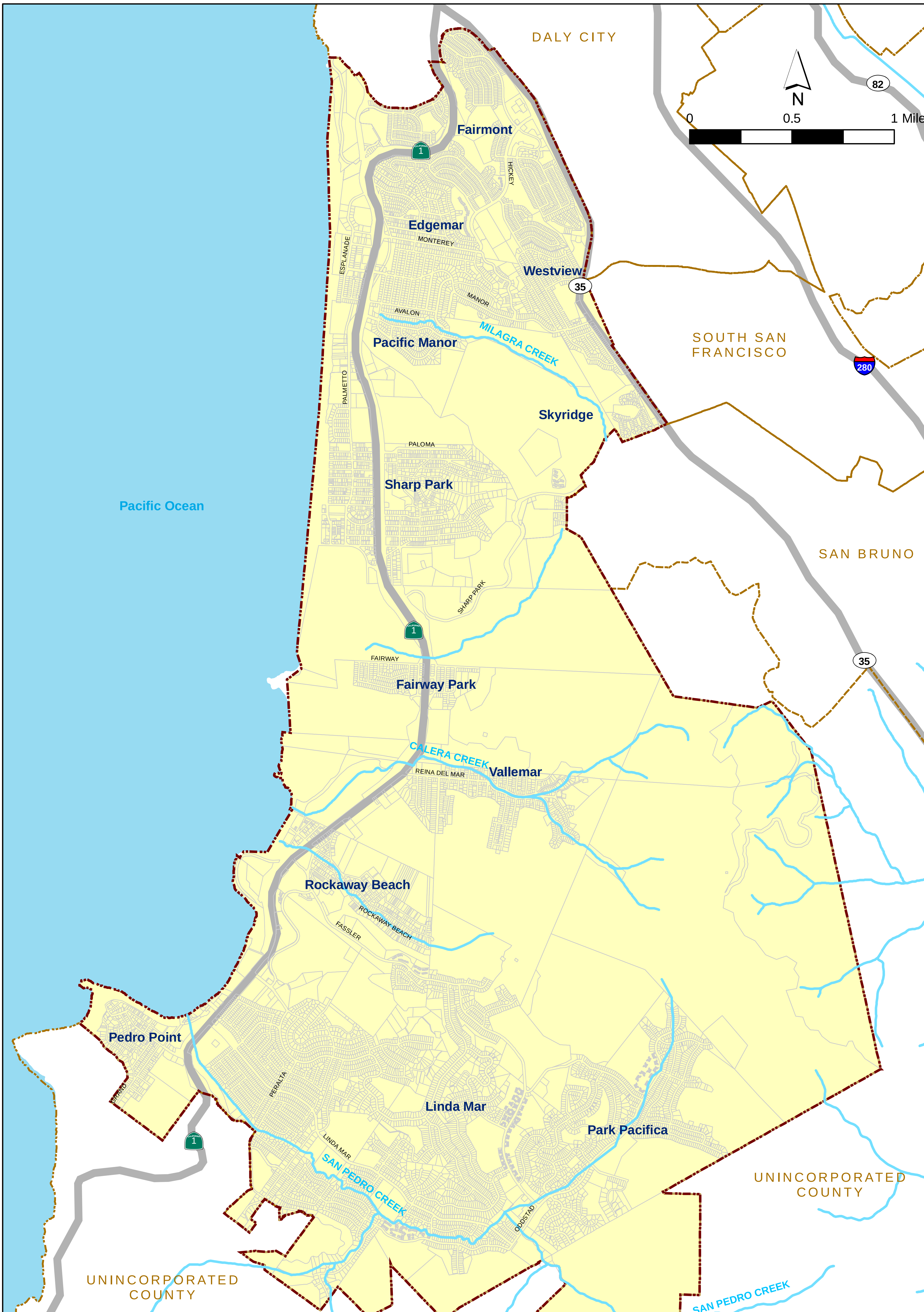
Table 1-1: Collection System Inventory

Pipe Size (in.)	Length (feet)	Length (miles)	Percent of Total
Gravity sewer mains			
<6 or unknown	783	0.1	0.2%
6	319,091	60.4	62.6%
8	116,525	22.1	22.9%
10	21,071	4.0	4.1%
12	24,069	4.6	4.7%
15	14,614	2.8	2.9%
18	8,253	1.6	1.6%
20-21	3,481	0.7	0.7%
24-30	1,671	0.3	0.3%
Total	**509,558**	**96.5**	**100%**
Force mains			
6-12	2,633	0.5	13%
20-26	17,599	3.3	84%
36	649	0.1	3%
Total	**20,882**	**4.0**	**100%**

As is common in most San Francisco Bay Area communities, the primary pipe material in the collection system is vitrified clay pipe (VCP), with some areas of asbestos cement pipe (ACP), primarily portions of the system that were constructed in the late 1960s and early1970s. Some newer and/or rehabilitated sewers have been constructed of plastic materials, and a recent sewer rehabilitation project involved cured-in-place pipe (CIPP) lining of about 9,000 feet of 12- through 18-inch ACP trunk sewer. The estimated age of sewers in the system (based on decade of installation) is shown in **Figure 1-3**. As shown in the figure, the oldest sewers date to the 1940s.

The collection system also includes approximately 12,000 private sewer laterals. The City assumes responsibility for the maintenance and repair of the lower portion of the sewer laterals if they have cleanouts installed at the property line. Currently, an estimated 20 percent of private laterals in the city have such cleanouts.

While most sewer laterals are made of similar material as the sewer mains, there are some areas of the system where the upper laterals are constructed of Orangeburg pipe, a fiberboard material that is known to disintegrate over time. These areas are shown in Figure 1-3.



Pacifica City Limits

Other City Boundaries

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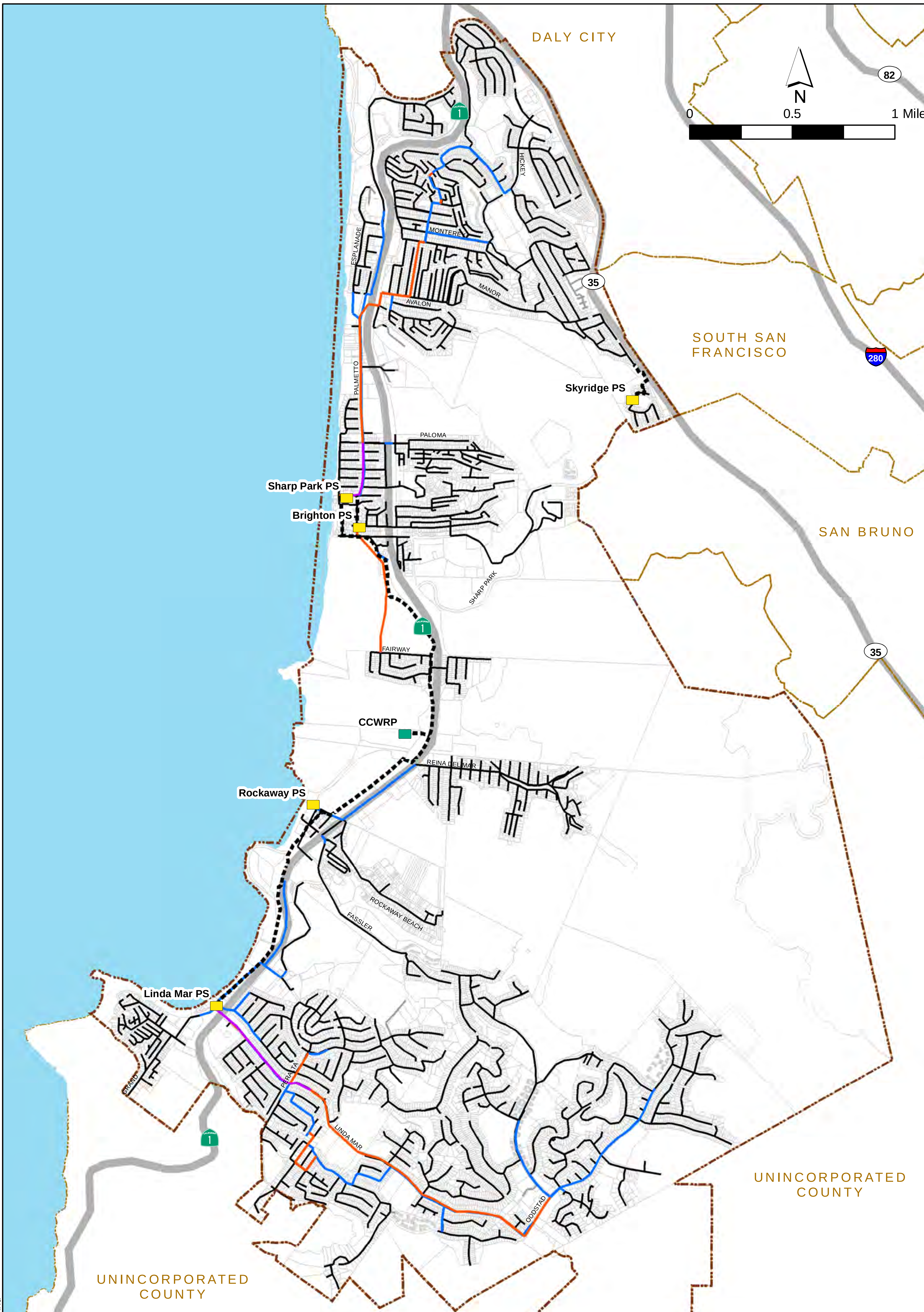
City of Pacifica
Collection System Master Plan

Study Area

Figure 1-1



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

- Forcemain
- Pacifica City Limits
- Other City Boundaries

City of Pacifica
Collection System Master Plan

Existing Collection System

Figure 1-2

RMC Water and Environment

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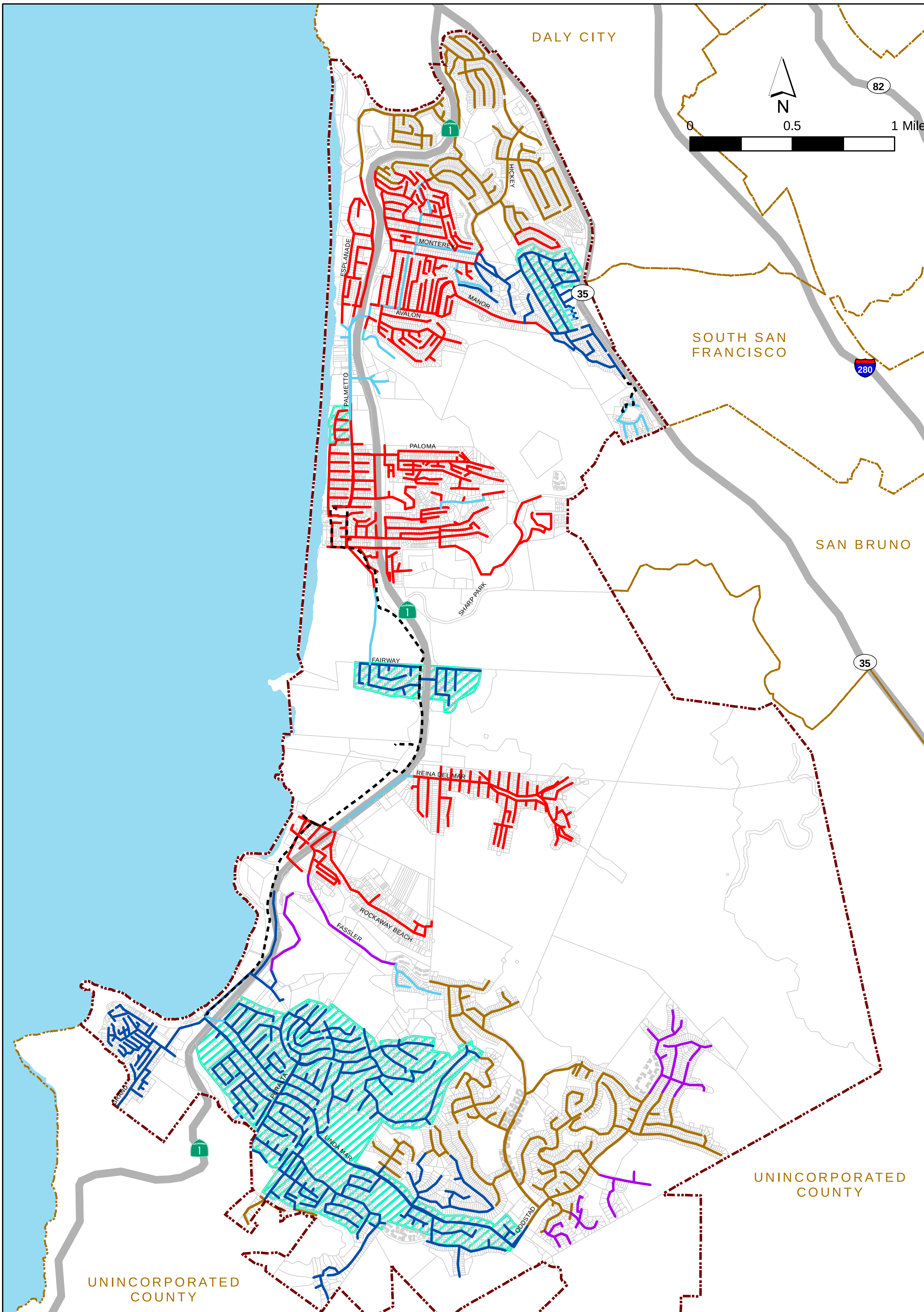


Sewer Installation/Rehabilitation Date

- 1940 - 1949
- 1950 - 1959
- 1960 - 1969
- 1970 - 1979
- 1980 - 2011

- Force Main
- Areas With Orangeburg Laterals
- Pacifica City Limits
- Other City Boundaries

RMC Water and Environment

City of Pacifica
Collection System Master Plan

Age of Sewers

Figure 1-3

G:GIS\PipeAge.mxd

1.4 Scope of Study

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

- **Task 1 – Project Coordination.** Periodic progress meetings and teleconferences were held with City staff to review project status and discuss project issues, and monthly status reports were prepared to document the work completed.
- **Task 2 – Conversion of Wastewater Collection System Map to GIS.** The City's AutoCAD map of the collection system was converted to GIS format by RMC's subconsultant, Engineering Mapping Systems (EMS). Sewer data attributes (manhole IDs and rim elevations, pipe diameters, length, material, type, and invert elevations), where shown on the AutoCAD map, were populated in the GIS database. The AutoCAD map was converted initially at the beginning of the study and used as the basis for building the hydraulic model in Task 5. The map was converted again at the end of the study to reflect more complete information and updates to the map made by City staff during the course of the study. In the future, the City will maintain the map in GIS, which will also be linked to its new CMMS.
- **Task 3 – Data Collection and Review.** This task involved assembling, organizing, and reviewing maps, documents, and data related to the collection system, including the previous SSES report; maps and drawings of collection system facilities and recent sewer improvement projects; pump curves and operating data; pump station and treatment plant SCADA data; water use and customer account data; the City's General Plan and other relevant planning information; sewer maintenance and CCTV inspection data; and sewer design standards and specifications.
- **Task 4 – Flow Monitoring.** A plan for flow and rainfall monitoring in the collection system during the 2009/10 wet weather season was developed. The program included 17 flow meters and three rain gauges installed for a period of approximately two months. The monitoring was conducted by RMC's subconsultant, V&A Consulting Engineers.
- **Task 5 – Hydraulic Model Development.** In this task, a hydraulic model of the City's trunk sewer system was developed using InfoWorks™ CS software. Sewersheds were delineated to define areas loading to the model, and flow loads to the model were compiled using water use and land use data and flow factors representing unit base wastewater flow (BWF) rates, diurnal BWF patterns, and I/I. The model was calibrated for dry and wet weather conditions using the flow monitoring data collected under Task 4.
- **Task 6 – System Performance Evaluation and Improvement Needs.** The model was used to determine collection system capacity requirements and identify capacity deficiencies under peak wet weather flow conditions, defined based on a design storm and system performance criteria. Areas of the system with high rates of I/I were identified, and the potential effectiveness of reducing peak flows by reduction of I/I through sewer system rehabilitation was assessed. Potential solutions to capacity deficiencies were identified and tested in the model, and capacity improvement projects and associated costs were developed based on these analyses.
- **Task 7 – Condition Assessment and Rehabilitation/Replacement Program.** In this task, the City's CCTV inspection standards and data collected to date were reviewed, and a process was developed to utilize the data to develop preliminary rehabilitation/replacement (R/R) decisions. The R/R decision process was implemented by developing a set of database queries with the results linked to the sewer pipes in GIS. Based on the query results, the defect data reports and images from selected inspections were reviewed to confirm the validity of the preliminary R/R decisions. Estimated costs for sewer R/R were developed for incorporation into the long-range CIP in Task 8, including an estimate of budget needs for sewer rehabilitation based on extrapolation of the condition

assessment results for the portion of the system that has not yet been inspected. In addition to the gravity sewer condition assessment, site visits were made to the five system pump stations to assess their condition and identify potential improvement needs.

- **Task 8 – Long-Range Capital Improvement Plan Development.** The recommended capacity and rehabilitation projects were prioritized for incorporation into 10- and 20-year CIPs.
- **Task 9 – Master Plan Preparation.** This report was prepared to present the results and recommendations of the study.

1.5 Report Organization

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

Executive Summary

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

Chapter 1- Introduction

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

Chapter 2 – Hydraulic Model Development

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

Chapter 3 – Capacity Assessment and Capacity Improvement Program

This chapter defines the basis for the capacity assessment of the system, including the selected design storm and performance criteria; describes the identified capacity deficiencies based on the model results; presents the design criteria used to develop capacity improvements; and presents the recommended capacity improvement projects. Each project is documented with a general description, planning level capital cost estimate, and relative priority rating. The chapter also identifies areas of the system with high I/I and discusses the potential benefits of I/I reduction and the methods for detecting and reducing I/I.

Chapter 4 – Condition Assessment and Rehabilitation/Replacement Program

This chapter describes the City's CCTV inspection standards and data and the R/R decision process developed and applied to the data. The results of the R/R decision analysis and recommended rehabilitation program and estimated costs are presented.

Chapter 5 – Long-Range Capital Improvement Program

This chapter presents the sewer projects that are recommended for inclusion in the City's 10- and 20-year CIPs based on the results of the capacity and condition assessments. The CIP includes a recommended schedule for project implementation and associated annual capital costs that will form the basis for the City's financial plan for the wastewater collection system. Recommendations for project implementation are also provided.

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

Chapter 2 Hydraulic Model Development

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

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

2.1 Modeling Terminology

Key modeling terminology are defined below.

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

2.2 Modeled System

The modeled network includes all pipes 10 inches and larger in diameter and additional 6- and 8-inch lines conveying flow from areas larger than about 40 acres. In total, the network includes about 30 miles of pipelines, or about 30 percent of total length of sewers in the system, including about 15 miles of 6- and 8-inch sewers. The model includes the four largest of the five system pump stations. The network has one model outfall at the Calera Creek Water Reclamation Plant (CCWRP). The model network is shown in **Figure 2-1**.

The City's sewered area was divided into 120 sewersheds, called "subcatchments" in InfoWorks, with an overall average size of 34 acres per subcatchment. Each subcatchment "loads" to a manhole in the modeled network. Model subcatchments are shown in **Figure 2-2.**

2.2.1 Network Data and Data Validation

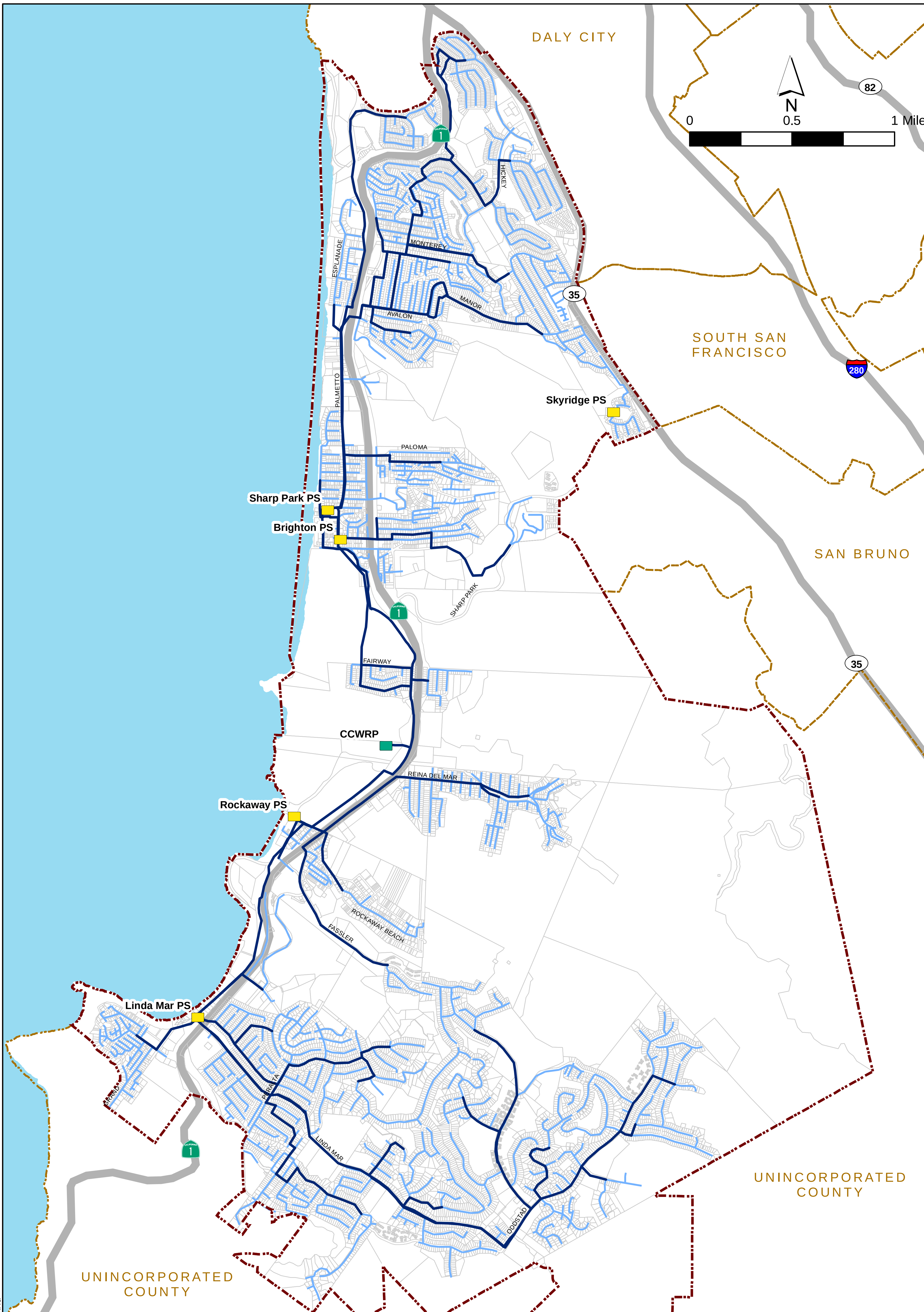
The data used to define the model network and associated attributes were derived primarily from the City's AutoCAD sewer map, which was converted to GIS format as part of this project. The map shows the locations of sewer manholes, sewer mains, and pump stations; manhole IDs and rim elevations; and pipe diameters and invert elevations. The AutoCAD map data were supplemented by information from record drawings for several recent sewer projects constructed by the City. The San Mateo County Digital Elevation Model (DEM) was used to populate ground elevations for manholes that did not have elevations in the AutoCAD map.

Pump stations were added to the model using available record drawings and data sheets filled out by City staff. The data sheets contained information about pump types and capacities, wet well dimensions and elevations, and operating levels and pump curves.

Once the model network was defined, a procedure was followed to fill in missing information and create a fully-connected network.

The data validation process included the following steps:

- Establish a logical numbering system for all model components. Due to duplicate manhole IDs and unnamed manholes in the City's original AutoCAD map, manholes were initially assigned a 4-digit sequential number. After final conversion of the AutoCAD file to GIS, the model manhole IDs were replaced with City manhole IDs. Pipes are named using the upstream manhole name followed by a unique suffix integer, for example, "PP26.1", where PP26 is the upstream manhole ID. For flow splits where there are two pipes with the same upstream manhole, example names would be "ULX2.1" and "ULX2.2". Subcatchments are named using a three-digit sequential number, for example, "SUB045".
- Check the modeled network for connectivity, i.e., verify upstream/downstream manholes were identified and correct for each pipe and all links were present between manholes in the network.
- Populate manhole and pipe attribute data. Use rim, invert, and diameter data from the CAD file. Where rim data was missing, values were populated using San Mateo County's Digital Elevation Model. Where invert elevation was missing, values were interpolated between known points where appropriate. Missing diameters were populated through conversations with City staff and later confirmed in the final CAD file. Pipe lengths were based on graphical length from the sewer map.
- Datum adjustment. The County's Digital Elevation Model, based on the 1988 North American Vertical Datum (NAVD88) was adjusted by 3.5 ft to match the City's rim elevations, which are based on the 1929 National Geodetic Vertical Datum (NGVD29).
- Model load nodes. Assign model loading nodes to all of the subcatchments.
- Populate global parameters which are required by the model, such as manhole diameters (assumed to be 4 feet), Manning's 'n' (assumed to be 0.013 for all pipes), and headloss factors.



Modeled Sewers
Unmodeled Sewers
Pacifica City Limites
Other City Boundaries

City of Pacifica
Collection System Master Plan

Modeled Sewer Network

Figure 2-1

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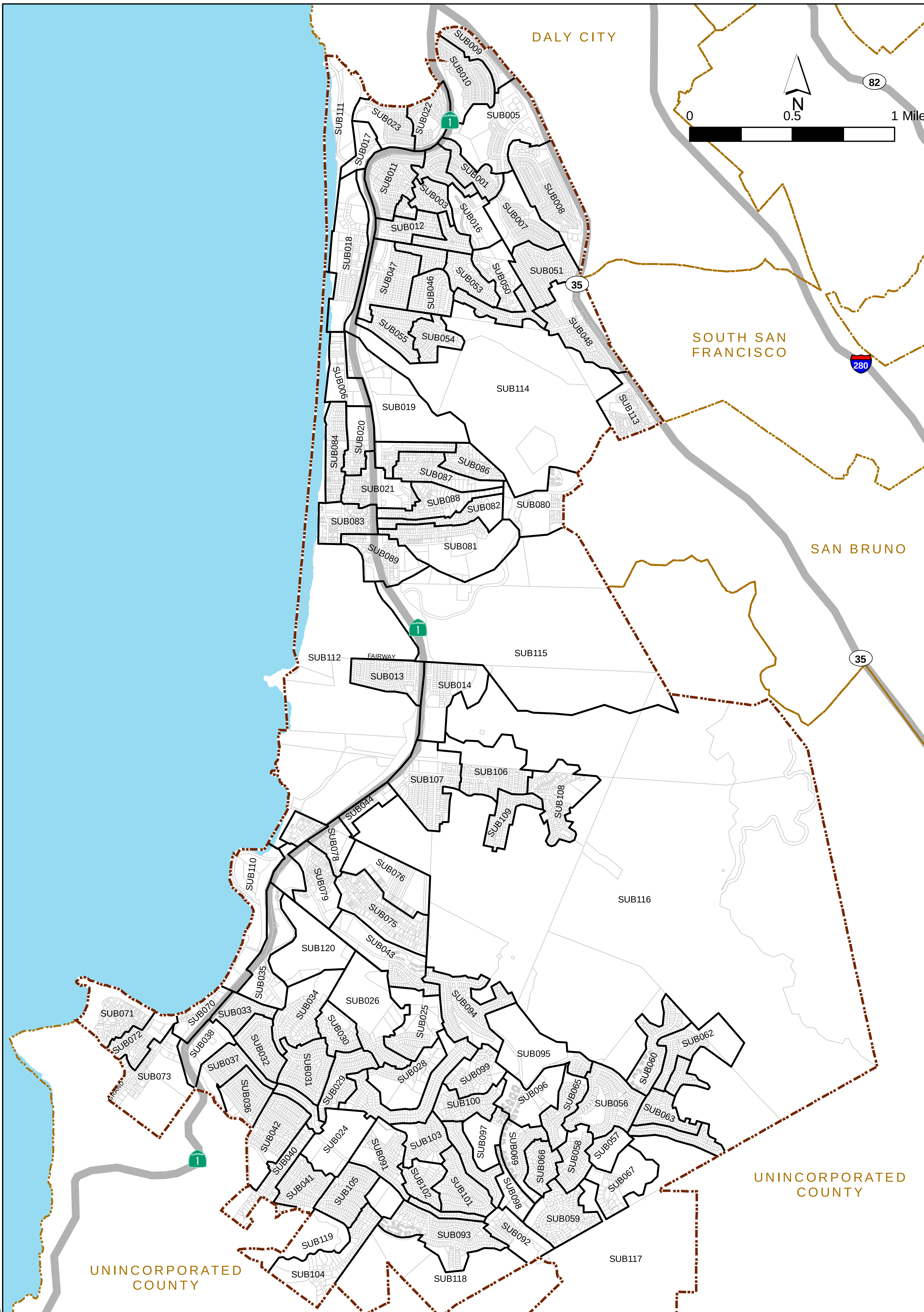

Subcatchments

Pacifica City Limits

Other City Boundaries

City of Pacifica
Collection System Master Plan

Model Subcatchments

Figure 2-2

G:GIS\Model Subcatchments.mxd

2.3 Flow Monitoring Program

As part of the Master Plan, 17 temporary meters and 3 recording rain gauges were installed by V&A Engineers (V&A), subcontractor to RMC, from December 23/24, 2009 to March 11, 2010. **Figure 2-3** shows the locations of the flow meters and rain gauges**.** The figure also shows the associated tributary area of each flow meter. Areas designated by "(I)" indicate that the area represents the incremental tributary area between the flow meter and other upstream flow meters. **Table 2-1** lists the flow meter locations, pipe diameters, and upstream meters.

Table 2-1: Flow Meter Locations

Meter ID	Location	Manhole ID[a]	Pipe Dia. (in.)[b]	Upstream Meters
1	Oddstad Blvd. at Terra Nova Blvd.	PP27[c]	15 /10	2 / --
2	Terra Nova Blvd. northwest of Oddstad Blvd.	PPU10	12	--
3	Arguello Blvd. at Anza Dr.	LLD36[d]	12	--
4	Linda Mar Blvd. at Peralta Rd.	LL7	20	1,2
5A	Peralta Rd. at Linda Mar Blvd.	LL7	12	
5B	Linda Mar Blvd. on east side of Coast Hwy.	LL13	27	4,5A
6	Halling Way at Shoreside Dr.	PT11	8	--
7	West of Coast Hwy., northeast of Linda Mar Blvd.	LLH8	12	--
8A	East side of Coast Hwy. north of San Marlo Way	V28	12	--
8PS	Rockaway Pump Station	RWPS	--	8A
9	Palmetto Ave. betw. Clarendon Rd. & Brighton Rd.	SPQ6A1	15	--
10	Del Mar Ave. south of Nelson Ave.	F38	15	--
11	Johnson Ave. easement south of Nelson Ave.	FM17	8	--
12	Avalon Dr. west of Edgemar Ave.	PM32	8	--
13	Palmetto Ave. at San Jose Ave.	F56	21	10,11,12
14	South of Brighton Rd. at Brighton PS	SP35	10	--
15	Palmetto Ave. at Montecito Ave.	FW52	12	--

a. Meter installed in inlet pipe to manhole unless indicated otherwise.
b. Measured diameter (may differ from diameter shown on sewer map).
c. Meter was initially installed in the outlet (downstream) pipe due to upstream surcharge and was later moved to intended location in the inlet (upstream) pipe after the surcharge was alleviated.
d. Meter installed in outlet pipe.

All of the meters except for Meter 8PS were area-velocity type gravity flow meters, which record flow depth and velocity and compute flow rate based on average flow velocity and the cross-sectional area of flow (a function of flow depth and pipe diameter). As indicated in the table, Meter 8PS was located at the Rockaway Pump Station and consisted of pump on/off loggers, used to determine flow rate based on the time to discharge the volume of flow contained in the wet well between the pump on and off levels.

The purpose of the flow monitoring program was to quantify the flows in the system to provide data with which to calibrate the hydraulic model (discussed later in this chapter), and to quantify the I/I response to storm events in various areas of the system. Approximately 11 inches of rain fell during the flow monitoring period, with about half of that amount during the last half of January 2010. **Figure 2-4** shows a plot of the hourly rainfall for one of the rain gauges, and **Figure 2-5** shows a typical plot of measured flow for one flow meter**. Appendix A** includes plots of the rainfall and flow data for all of the rain gauges and meters.

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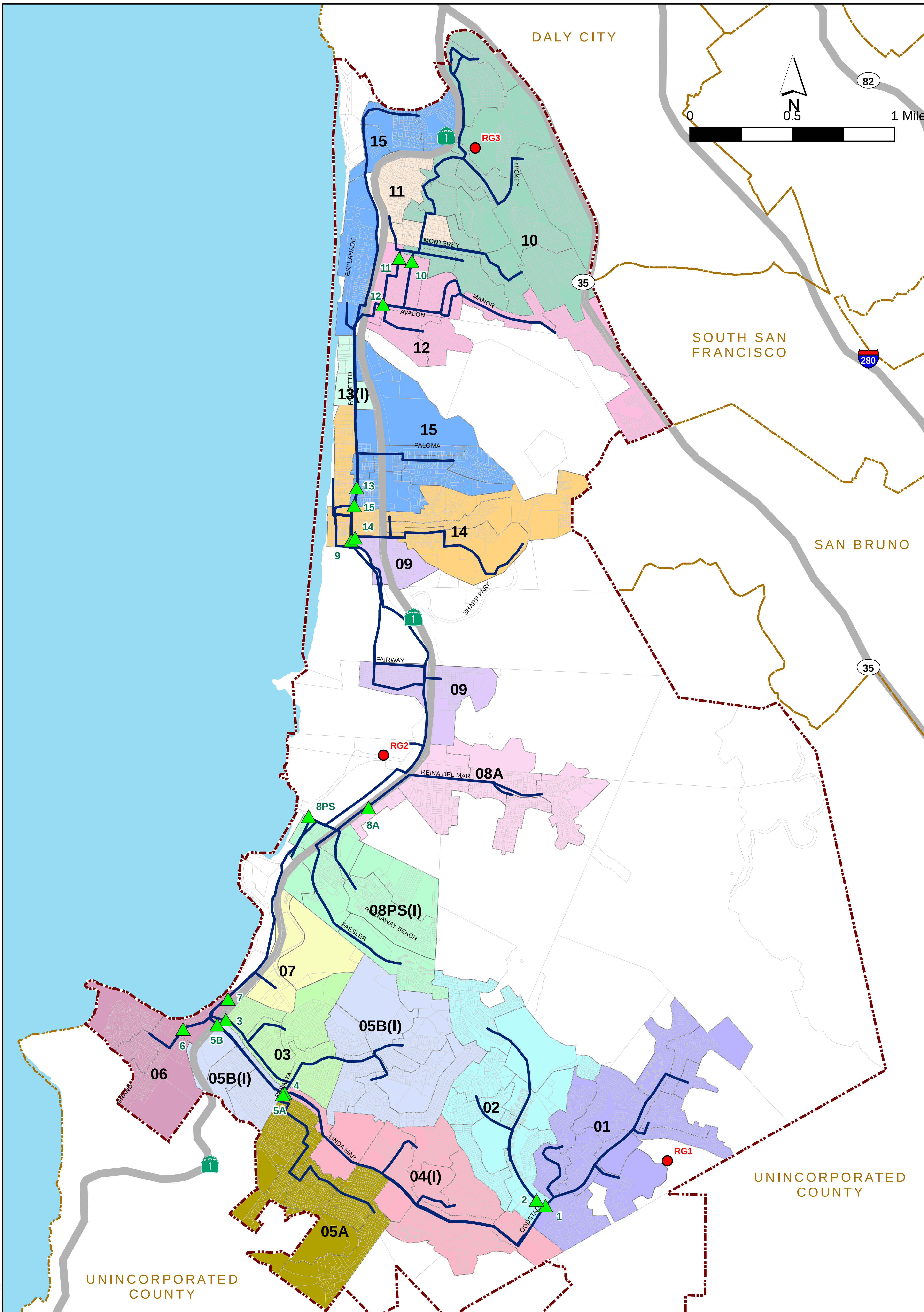

●	Rain Gauge	━━	Modeled Sewers
▲	Flow Meter	▭	Pacifica City Limits
▭	Meter Basin	▭	Other City Boundaries

City of Pacifica
Collection System Master Plan

Flow Meters and Rain Gauges

Figure 2-3

RMC Water and Environment

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Figure 2-4: Plot of Typical Rainfall for Flow Monitoring Period (Rain Gauge 1)

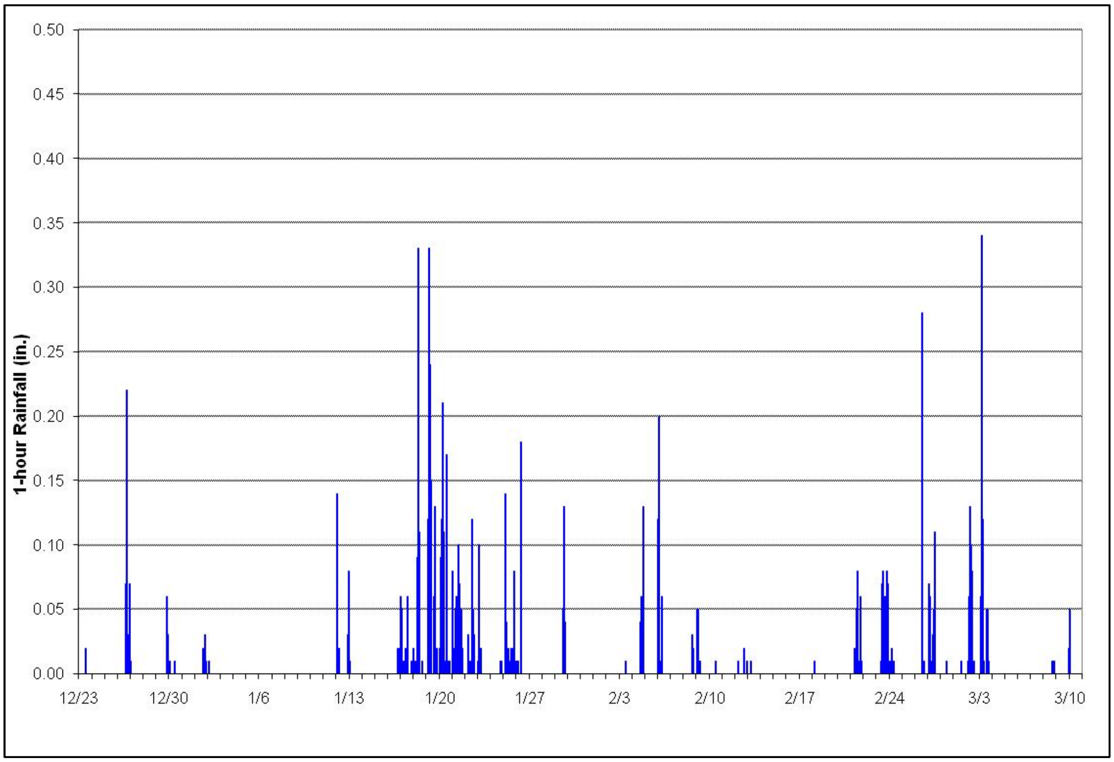
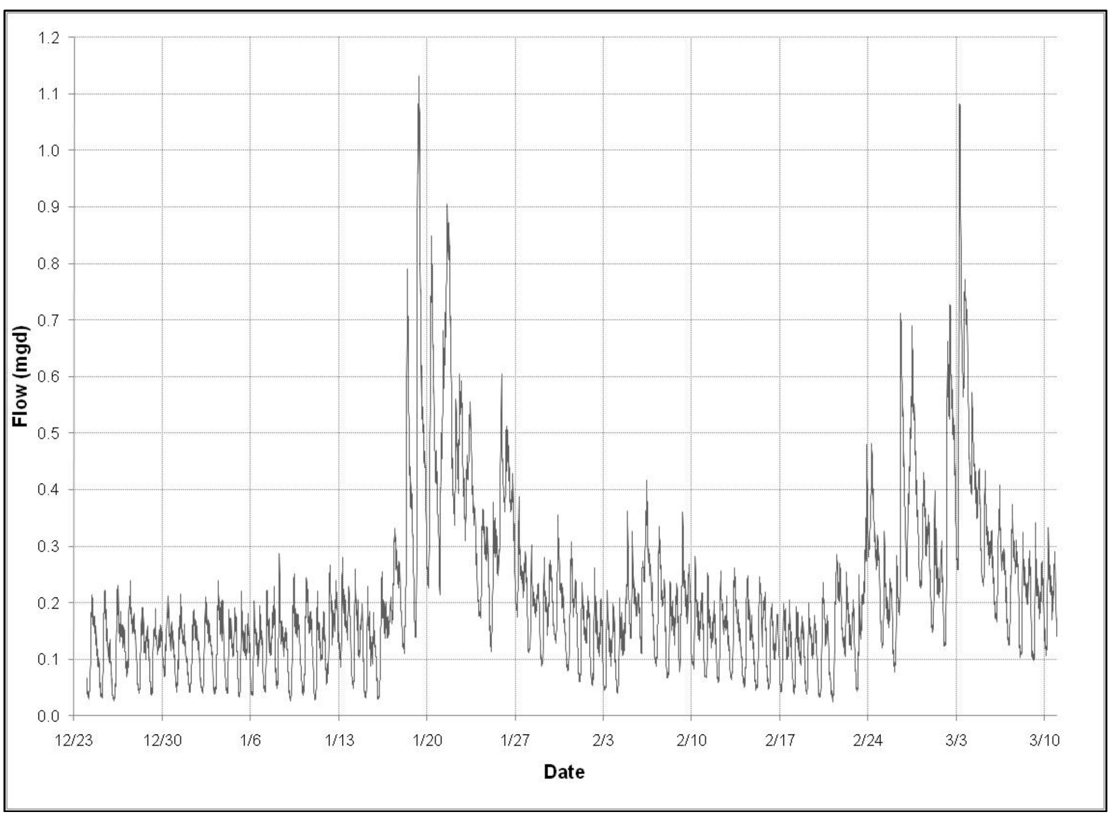


Figure 2-5: Plot of Typical Flow Data for Flow Monitoring Period (Meter 2)



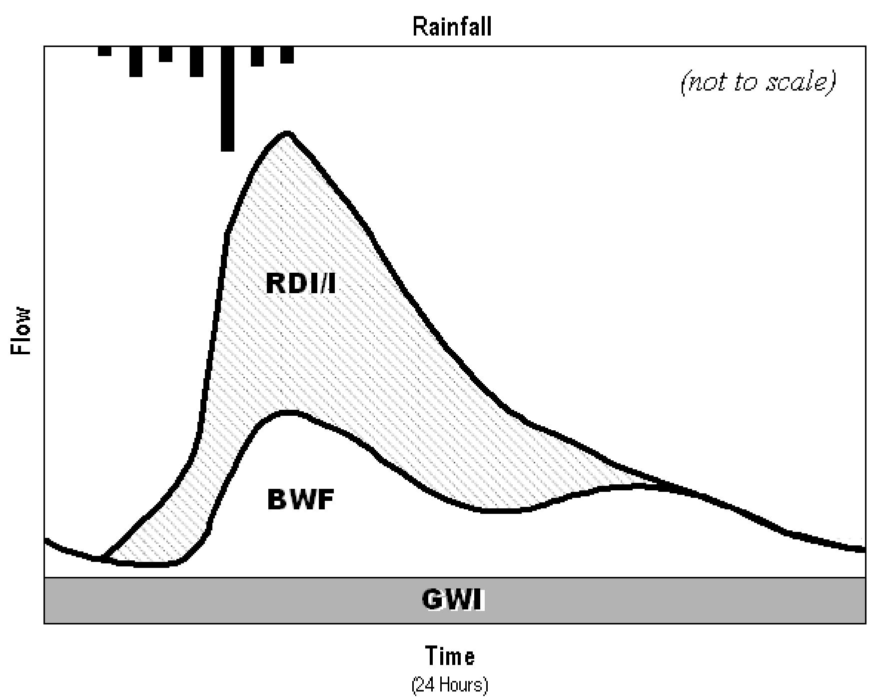
2.4 Flow Estimating Methodology

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

2.4.1 Wastewater Flow Components

Wastewater flows typically include three components: base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall-dependent infiltration/inflow (RDI/I). BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the system. GWI is groundwater that infiltrates into the sewer through defects in pipes and manholes. GWI is typically seasonal in nature and remains relatively constant during specific periods of the year. RDI/I is storm water inflow and infiltration that enter the system in direct response to rainfall events. RDI/I can occur through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains (called "direct inflow"), or through defects in sewer pipes, manholes, and service laterals. RDI/I typically results in short term peak flows that recede quickly after the rainfall ends. These three flow components are illustrated conceptually in **Figure 2-6**.

Figure 2-6: Wastewater Flow Components



Dry weather flow (DWF) consists of BWF plus GWI, while wet weather flow (WWF) adds the RDI/I component.

2.4.2 Base Wastewater Flow

Existing residential and non-residential base wastewater flows were estimated using information compiled at the parcel level (approximately 12,800 parcels) and then aggregated into the 120 model subcatchments. The total residential and non-residential BWF for each model subcatchment were calculated by summing the BWF for all parcels within that subcatchment.

Existing Flows

Existing BWF was determined based on water billing data provided by the North Coast County Water District. Metered water use during the winter months most closely approximates wastewater generation, since outdoor water use is at a minimum. Therefore, meter readings taken in the winter of 2008-2009 were used as the basis for estimating residential and non-residential BWF. A sewer return rate of 100 percent (i.e., BWF equal to 100 percent of winter water use) was assumed, based on comparison of water to wastewater flow rates during the model calibration.

All water billing records were geocoded according to address and assigned a PUC code (through linkage with County assessor parcel files) which characterizes the water customer's land use type. Parcels were assigned to either a residential or non-residential land use type based on the PUC code. A parcel-by-parcel visual assessment of the City using aerial photos confirmed that data were available for all developed parcels. **Figure 2-7** shows the geocoded water billing data by customer type.

Future Flows

Although the City is largely built out, there are a number of vacant, developable parcels, as well as a few identified near-term planned developments. **Figure 2-8** shows the location of planned developments and currently vacant, potentially developable parcels.

The near-term growth scenario was based on projects that were in the planning process with the City's planning department as of October 2009. For each project, information on the number and type of planned residential units and/or the amount of non-residential building square footage was compiled from the development list. The following flow factors were used to calculate BWF from these developments. Flow factors are based on factors commonly used at the master planning level for similar communities or confirmed by water use data for similar developments (e.g., senior living facilities) in Pacifica.

- For residential properties:
  - Single family residential (SFR) = 220 gpd/unit
  - Multi-family residential (MFR) = 170 gpd/unit
  - Senior living facility = 90 gpd/unit
- Non-residential properties = 0.1 gpd/sq.ft of building floor space

The buildout growth scenario assumed that all developable vacant parcels within the city would be developed. Parcels were identified as being "vacant" if they had a PUC Code of 00 or 50 in the County parcel layer. Parcels were deemed "developable" if they were adjacent to a street (not behind backyards) and were not part of established open space. Finally, a land use type (residential or non-residential) was assigned to vacant parcels based on surrounding parcel land use types and the general location of the parcel within the city. All vacant residential parcels were assumed to be developed as single family residences, and non-residential parcels were assumed to have building square footage based on a floor-area-ratio (ratio of building area to parcel area) of 0.25. Based on these assumptions, the same flow factors as used for planned developments were applied to vacant developable parcels.

For developed parcels which have no plan for redevelopment, the current flow based on water billing data was assumed to characterize their BWF in the future.

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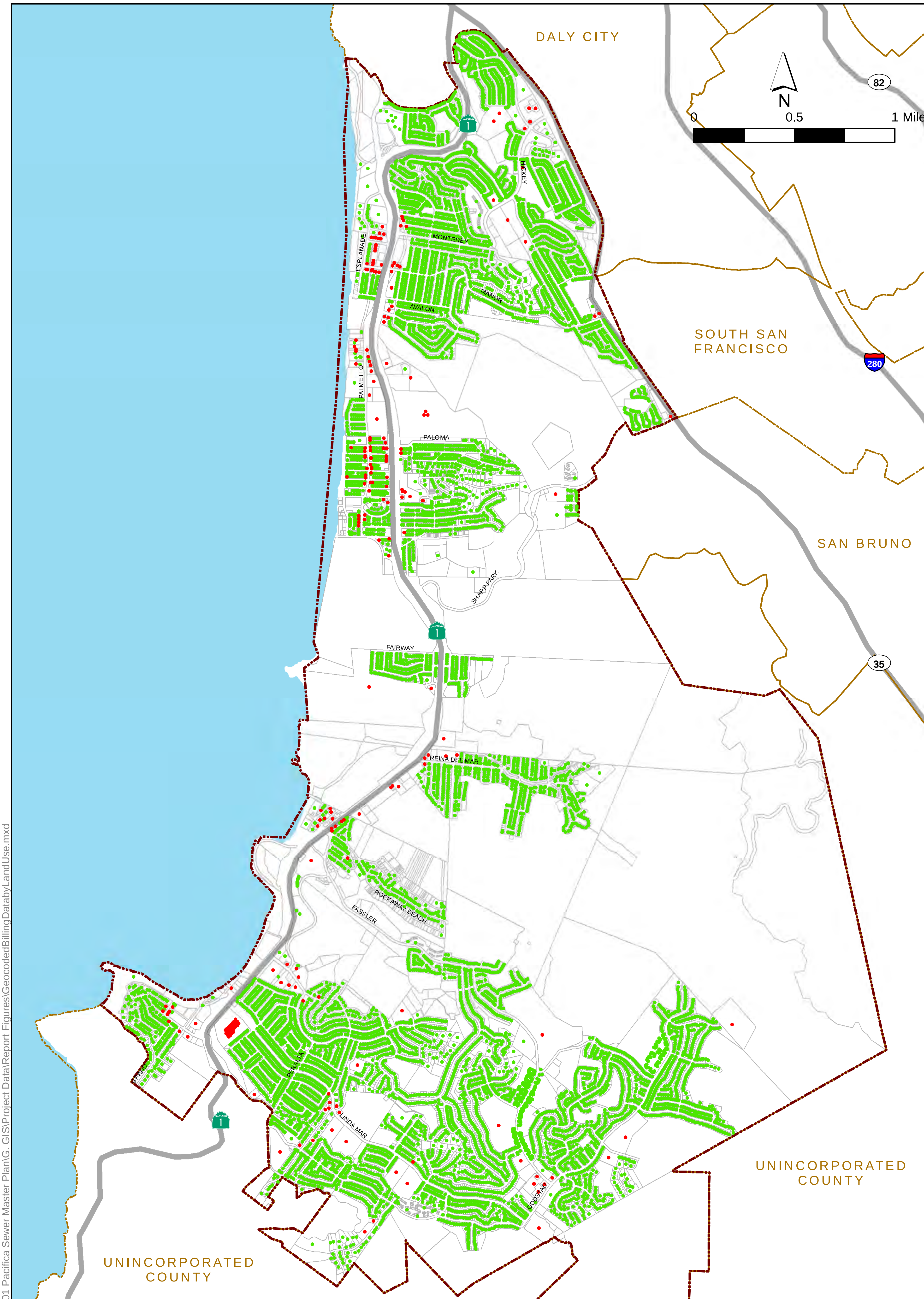


Non-Residential Water Customer

Residential Water Customer

Pacifica City Limits

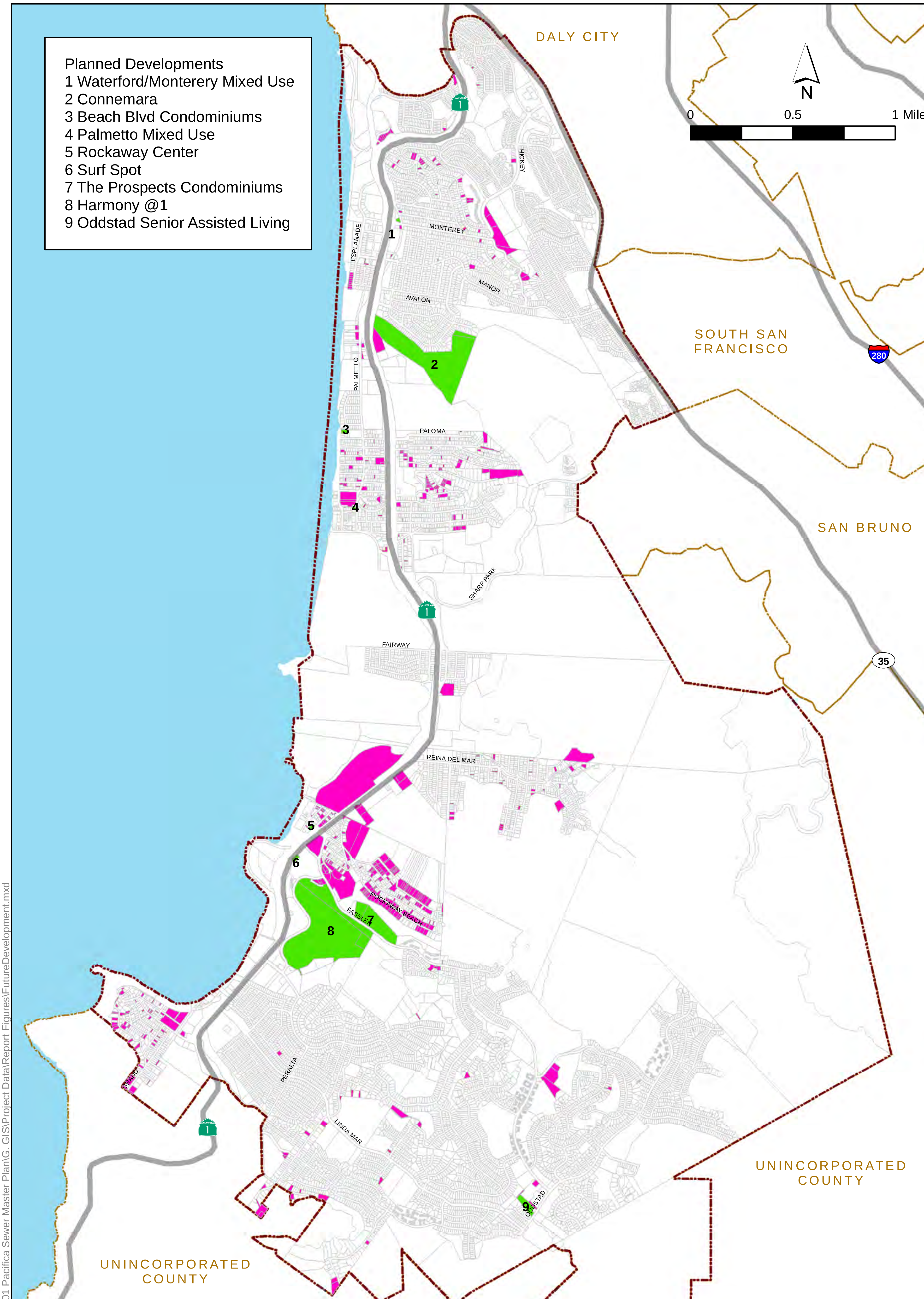
Other City Boundaries

City of Pacifica
Collection System Master Plan

Geocoded Water Billing Data by Customer Type

RMC Water and Environment

Figure 2-7



Planned Developments

Vacant Parcels

Pacifica City Limits

Other City Boundaries

City of Pacifica
Collection System Master Plan

Planned Development and Vacant Land

Figure 2-8

RMC Water and Environment

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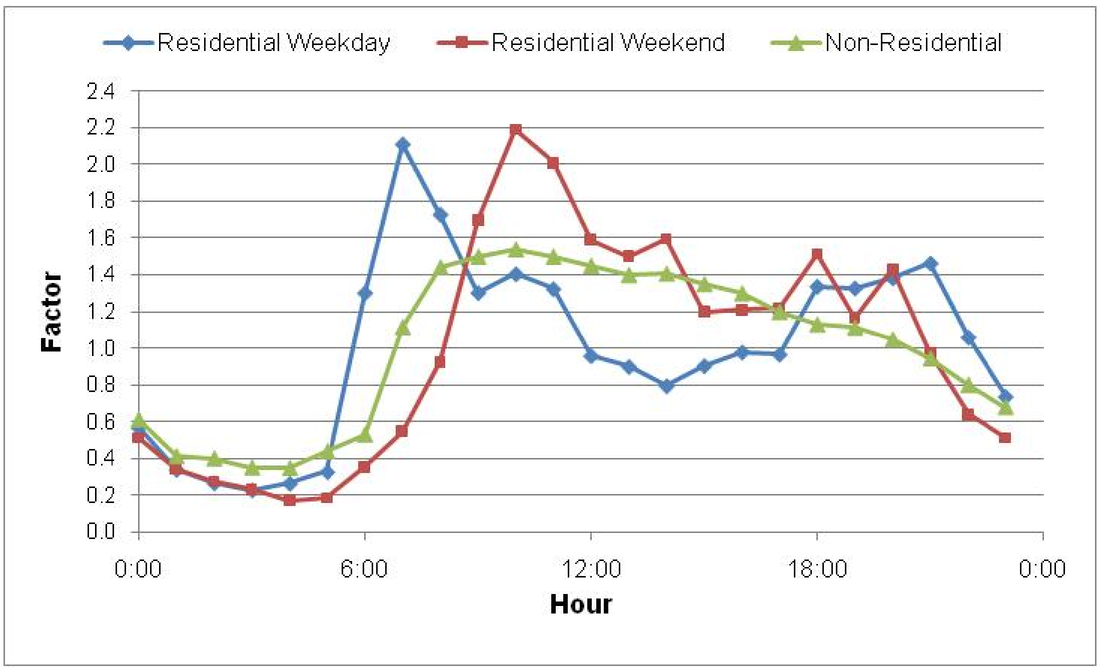
BWF Diurnal Profiles

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

The variations in BWF on a typical day are represented by diurnal profiles. Diurnal profiles are defined by a set of hourly factors that are applied to the average BWF for each subcatchment. For Pacifica, separate sets of diurnal profiles were defined for weekdays and weekends and for residential and non-residential development. Profiles were developed based on monitored flows for smaller meter areas that isolated specific land use types, and are similar to those observed in other similar communities. **Figure 2-9** shows the diurnal profiles used in the model.

Figure 2-9: Diurnal Profiles



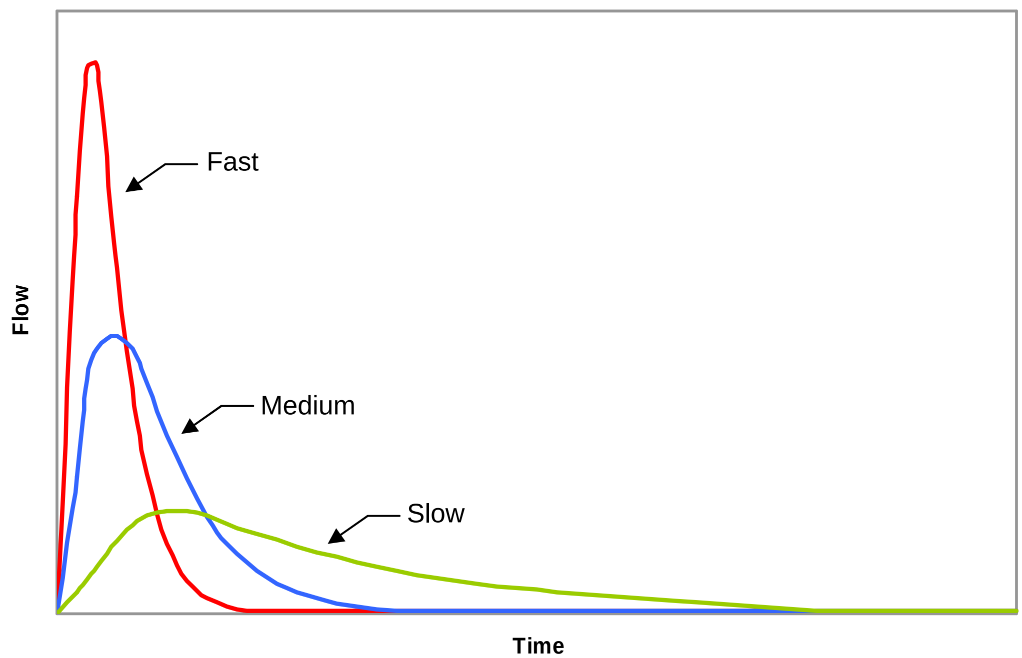
2.4.3 Groundwater Infiltration

GWI is typically applied in the model as a constant load in addition to the BWF. The amount of GWI in any particular area is determined during model calibration by comparing the modeled flows to actual observed dry weather flows at points in the system where flow meter data are available. Where modeled BWF is less than monitored dry weather flow, the difference is assumed to represent GWI. The GWI determined at the monitoring location is then distributed to the meter tributary area on a per-acre basis. GWI was identified in five of the meter areas in Pacifica with rates ranging from about 80 to 450 gpd/acre. Note that because GWI is seasonal in nature, the modeled GWI represents a typical GWI rate during the wet weather season rather than a dry season (summertime) GWI.

2.4.4 Rainfall-Dependent I/I

RDI/I flows result from rainfall events that produce infiltration and inflow of storm water runoff into the sewer system. RDI/I flows are defined by the magnitude, shape, and timing of the RDI/I response. RDI/I varies depending on many factors, including the magnitude and intensity of the storm event, area topography, type of soil, and the condition of the sewers, manholes, and sewer service laterals. In a dynamic model, RDI/I is typically computed as a percentage of the rainfall (sometimes referred to as the “R value”) falling on the contributing area of a subcatchment for each of three or more hydrograph components, representing different response times to rainfall, e.g., fast, medium, and slow, as illustrated in **Figure 2-10.** (The contributing area is assumed to be the sum of the area of all developed parcels, except for large open areas such as parks and parking lots or large warehouse-type buildings.) Summing all of the component hydrographs for the entire duration of the rainfall event results in the total RDI/I hydrograph for the event for that subcatchment. Note that although the “slow” RDI/I component can contribute significantly to the total RDI/I volume, the “fast” component has the biggest impact on the magnitude of the peak wet weather flow.

Figure 2-10: RDI/I Hydrograph Components



The model parameters defining the RDI/I flows to the system within a given meter area are determined by comparing modeled wastewater flow at the meter location to the measured wastewater flow during one or more rainfall events, as discussed in the model calibration section later in this chapter. The same calibrated parameters are generally applied to all subcatchments within each meter area. The specific RDI/I characteristics identified for the City’s service area are presented and discussed in the model calibration section below.

2.5 Model Calibration

Model calibration is the process of comparing model-computed flows to observed (monitored) flows and adjusting various model parameters until the model is accurately simulating flows in the sewer system. The model was calibrated for both dry and wet weather conditions.

2.5.1 Dry Weather Calibration

The 7-day dry period from January 3 to 9, 2010, was used as the dry weather calibration period for comparing flow data to the model results. This period was selected because it was not impacted by previous rainfall and a majority of the meters showed consistent readings. Meter 1 was initially not installed at its intended location due to a localized surcharge condition that was subsequently alleviated; therefore, for the relocated meter (upstream pipe location), data was used from another dry time period: February 15 to 21, 2010, after the meter was moved back to its intended site.

The primary focus of the dry weather calibration was to confirm that the calculated average BWF based on winter water consumption was consistent with the measured flows at the meter locations. The dry weather calibration confirmed that the overall sewer return rate is about 100 percent, indicating that consumptive and outdoor water use is minimal during the winter.

The second objective of the dry weather calibration was to confirm the diurnal profiles used to represent the hourly variations in BWF. The curves shown in Figure 2-9 were developed based on the calibration.

Finally, GWI was added when the observed (metered) dry weather hydrographs were greater than the model-simulated hydrographs by a relatively constant value throughout the day. GWI ranging from 0.02 to 0.09 mgd was applied to five of the meter basins. The additional flow seen at the meters was distributed to upstream subcatchments on an area-weighted basis.

The dry weather model calibration resulted in an excellent match between modeled and metered average flow, within 10 percent for 14 of the 17 meters and within 15 percent for 16 meters. A similar good match for peak dry weather flow was also achieved. However, the total modeled flow to the WWTP was about 15 percent (0.4 mgd) lower than the measured flow at the plant for the dry weather calibration period, which may mean there is some additional GWI entering the system that wasn't captured by the flow meters.

Appendix B includes plots of modeled vs. metered dry weather flow for all of the meters.

2.5.2 Wet Weather Calibration

During wet weather calibration, parameters are adjusted to accurately simulate the volume and timing of RDI/I for monitored storm events. The entire period between January 15 and March 11, 2010 was used for wet weather calibration, with specific attention paid to storm events between January 15 and February 4 and between February 19 and March 11. There were ten consecutive days of rain between January 16 and January 26, with one high-intensity event occurring on January 19. The total rainfall for the analysis period was approximately 10 inches. Rainfall was assigned to subcatchments using data from the closest of three rain gages maintained by V&A during the monitoring period.

The wet weather calibration resulted in a good match between modeled and metered peak flows, within 10 percent for 11 of meters and within 15 percent for 15 meters. Plots of model vs. metered flow, shown in **Appendix C**, illustrate that the volumetric match is also very good.

One special case was Meter 8A, which captures the flow from the Vallemar area. This area exihibited a very large prolonged, volume response to rainfall, which increased significantly during the latter part of the wet weather monitoring period. The flow response measured at the meter agrees with the experience of the City's sewer crews, who have noted that the hillsides in the area continue to drain long after rainfall has stopped.

2.6 Summary of Flows

Table 2-2 summarizes the existing and future average BWF and DWF for the City's sewer system. (Note: In this table, DWF is intended to represent a typical dry season condition rather than a dry (non-rainfall) period during the wet weather season, as was used for the dry weather model calibration.)

Table 2-2: City of Pacifica Dry Weather Flow Summary

Flow Component	Flow (mgd)		
	Existing (2009)	Near-Term	Buildout
Residential BWF	2.00	2.02	2.12
Non-Residential BWF	0.21	0.22	0.29
Total Average BWF	2.21	2.24	2.41
Estimated dry season GWI[a]	0.37	0.37	0.37
Total Average DWF	2.58	2.61	2.78

a. Estimated as the difference between the September 2009 average flow to the WWTP (2.58 mgd) and estimated total BWF.

Table 2-3 lists the wet weather peaking factors (ratio of peak hour wet weather flow to average wet season dry weather flow) for each meter based on the peak hourly flow observed during the January 19, 2010 storm, the largest event of the flow monitoring period. As shown in the table, the WWPFs generally ranged from about 4 to 10. The highest WWPF was found in the Meter 6 tributary area, which corresponds to the Pedro Point area of the city.

Predicted peak flows for a "design event," on which the capacity of the system is evaluated, are discussed in the following chapter.

Table 2-3: Monitored Wet Weather Peaking Factors

Meter	ADWF	PWWF[a]	WWPF[b]
1 (D/S)[c]	0.38	2.36	6.2
1 (U/S)[d]	0.25	1.00	3.9
2	0.12	1.10	8.9
3	0.13	1.03	7.7
4[c]	0.49	2.89	5.9
5A	0.17	1.19	7.0
5B[c]	0.83	6.84	8.2
6	0.04	0.64	17.3
7	0.03	0.15	4.7
8A	0.11	0.84	8.0
8PS[c]	0.20	1.14	5.7
9	0.07	0.70	10.5
10	0.52	2.10	4.0
11	0.06	0.50	8.6
12	0.18	1.50	8.5
13[c]	0.76	4.52	6.0
14	0.13	0.78	6.1
15	0.28	0.78	2.8

a. Based on peak hour flow for January 19, 2010 storm, except for Meter 1 (U/S). For some meters, a higher peak flow may have been recorded during the later season storm on March 3.
b. WWPF = wet weather peaking factor (ratio of PWWF to ADWF).
c. Represents flow for total meter tributary area, including upstream meter areas.
d. PWWF is for March 3, 2010 storm (meter not installed in upstream pipe during January)

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Chapter 3 Capacity Assessment and Capacity Improvement Program

The capacity performance of the system and need for capacity improvements were evaluated using the calibrated hydraulic model described in Chapter 2. This chapter discusses the criteria on which the capacity assessment was based and presents the model results and proposed capacity improvement projects. The potential benefits of reducing I/I in the system are also discussed.

3.1 Design Flow and Performance Criteria

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

3.1.1 Design Storm Condition

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

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

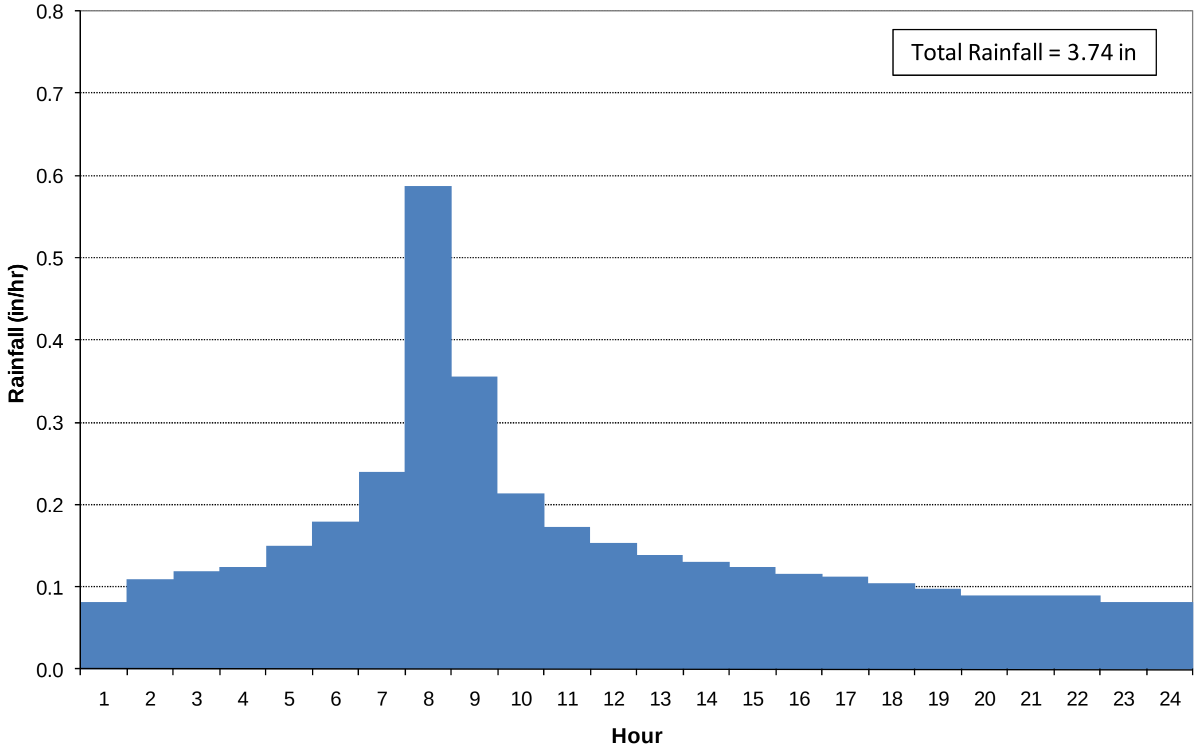
The 10-year design storm for Pacifica was developed in accordance with the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service Technical Release 55 (TR-55) guidance document "Urban Hydrology for Small Watersheds" (June 1986) using an SCS Type 1A synthetic 24-hour rainfall distribution as described in TR-55 Appendix B. The 24-hour rainfall amount for Pacifica was determined based on Rainfall Runoff Data for San Mateo County published by the San Mateo County Department of Public Works. Copies of pertinent pages from these documents are included in **Appendix D.**

The 10-year, 24-hour SCS Type 1A design storm for Pacifica has the following characteristics:

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

The design storm is comparable in size to other notable large rainfall events that have occurred over the past several years, such as the storms of December 31, 2005 and January 25, 2008. **Figure 3-1** shows the design storm rainfall hyetograph.

Figure 3-1: Design Rainfall Event



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

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

3.1.2 Capacity Deficiency Criteria

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

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

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

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

3.2 Capacity Analysis Results

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

3.2.1 Gravity Sewer System Deficiencies

The model results show that under existing design storm PWWF conditions, there are twelve areas of capacity deficiencies in the gravity sewer system. These locations are shown in **Figure 3-2**. Highlighted sections include pipes that are surcharged due to insufficient capacity as well as upstream segments that are surcharged due to backwater, where the deficiency results in either predicted overflows or surcharge to within less than 4 feet of the manhole rims. Under buildout flow conditions, flows increase by approximately 9 percent systemwide, but there are no additional deficiencies predicted.

As noted above, predicted surcharge in a particular pipe does not necessarily indicate a capacity deficiency at that particular location, as flows can back up due to a downstream capacity deficiency and cause extensive surcharging or even overflows upstream due to backwater effects. However, relieving upstream deficiencies can also create additional or more severe capacity deficiencies downstream of the relieved pipe. For example, providing relief for the capacity deficiencies identified in Terra Nova Boulevard (Deficiency IDs 2 and 3 on Figure 3-2) would increase the flows to the downstream sewer in Oddstad Boulevard (Deficiency ID 1), thereby increasing the peak flow and predicted surcharge in that line. These effects were considered in developing the capacity improvement projects described later in this chapter.

Based on the model calibration runs, three of the identified capacity deficiencies (Deficiency IDs 5, 6, and 9) were also predicted to occur under the storms observed during the flow monitoring period. Wet weather overflows have, in fact, occurred at or near these locations during past large storm events. Note that one area of previous overflows in the vicinity of Avalon Drive and Edgemar Drive has already been addressed by the City through a recent sewer upgrade project.

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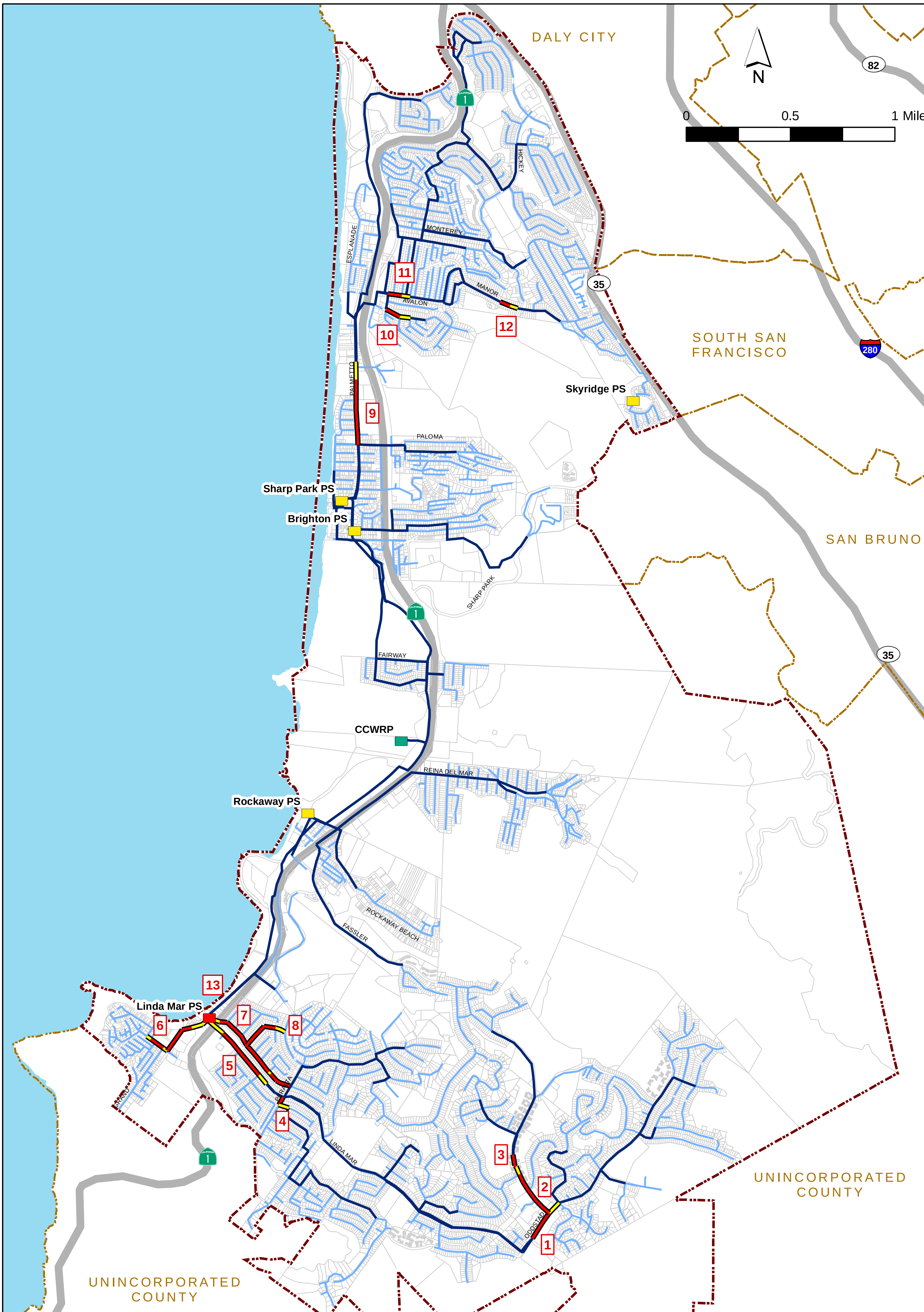

Pump Station Capacity Deficiency

Deficient due to capacity limitation

Flow backup due to deficiency (<4' freeboard)

Modeled Sewers

Unmodeled Sewers

1 Deficiency ID

Pacifica City Limits

Other City Boundaries

City of Pacifica
Collection System Master Plan

Model Results for Design Storm PWWF

Figure 3-2

RMC Water and Environment

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3.2.2 Pump Stations

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

The firm capacities of each pump station were determined using manufacturer pump curves and information from pump station surveys prepared by City staff. The firm capacity also considered the system curve resulting from head losses in the force mains downstream of the pump stations, which is important considering that the WWTP has been relocated and several of the pump stations are now operating under a different system curve than when they were originally designed. Firm capacity was defined as the flow at the intersection of the system curve with the summed pump curves, assuming that one pump must remain on standby.

Table 3-1 compares the total and firm capacity of each modeled pump station to the modeled flows under existing and future flow conditions. The table indicates that Rockaway, Brighton, and Sharp Park Pump Stations have sufficient capacity to convey buildout design storm peak wet weather flows; however, Linda Mar Pump Station is significantly undersized for both existing and future flows. The model results suggest that overflows that have occurred in upstream trunk sewers in Linda Mar Boulevard may have been partly or primarily due to flow backing up from the Linda Mar Pump Station due to insufficient pumping capacity.

Table 3-1: Pump Station Capacity Results

Pump Station	No. of Pumps	Total Capacity (mgd)	Firm Capacity (mgd)	Existing PWWF Constricted[a] (mgd)	Existing PWWF Relieved[b] (mgd)	Near-Term PWWF Relieved (mgd)	Buildout PWWF Relieved (mgd)
Linda Mar	3[c]	9.7	7.2	13.8	14.5	14.5	14.5
Rockaway	3	3.2	2.7[d]	2.3	2.3	2.3	2.4
Brighton	3	3.7	3.4	2.0	2.0	2.0	2.1
Sharp Park	3	13.0	12.1	8.2	9.7	9.8	9.9

a. Constricted system - existing system without capacity relief projects.
b. Relieved system - capacity improvement projects constructed to relieve upstream bottlenecks.
c. The Linda Mar PS is equipped with two electric pumps and one larger natural gas engine-driven pump. Firm capacity is based on operation of the two electric pumps.
d. Based on system curve assuming Linda Mar PS discharging 14.5 mgd.

3.3 Capacity Improvement Projects

This section describes the sewer improvement projects that would be needed to reduce the risk of the overflows in the collection system due to insufficient capacity for design peak wet weather flows. The assumptions that were used to define the projects are also discussed. Each project is documented in further detail in **Appendix E** with an individual plan map and project information sheet that provides project details, key considerations, and a planning-level capital cost estimate.

Capacity improvement projects were identified to address the potential deficiencies identified through the capacity analysis. For each identified gravity sewer capacity deficiency, a project was developed to replace the existing pipe with a larger pipe, or to divert flow to a new pipe or to another existing pipe with available capacity. Improvements were also identified to increase the capacity of the Linda

Mar Pump Station, including construction of a parallel force main. The parallel force main would both increase the firm and total capacity of the existing pump station to 10.4 mgd and 14.4 mgd, respectively (compared to current firm and total capacities of 7.2 mgd and 9.7 mgd), but also provide redundancy to reduce the risk of an overflow in the event of a structural failure of the force main, or allow the existing force main to be taken out of service for inspection, cleaning, or repair. The addition of a fourth pump at Linda Mar would then provide firm capacity to handle projected design peak wet weather flows.

Note that upgrade of the Linda Mar Pump Station and force main would also increase the overall wet weather flows conveyed to the Calera Creek Water Recycling Plan (CCWRP). The potential impact of those peak flows and alternatives to address systemwide capacity assurance are discussed in Section 3.5.

Figure 3-3 shows an overview of the collection system capacity project locations, and **Table 3-2** summarizes all of the identified capacity improvement projects, including location, existing pipe sizes, worst case condition based on the design storm wet weather model runs, proposed improvements, relative priority, flow confirmation level, and estimated planning level costs. The Project IDs shown in Figure 3-3 and Table 3-2 correspond to the Deficiency IDs in Figure 3-2. Explanation of project sizing criteria, basis of cost estimates, project priorities, and flow confirmation levels are provided in the following subsections.

3.3.1 Project Sizing Criteria

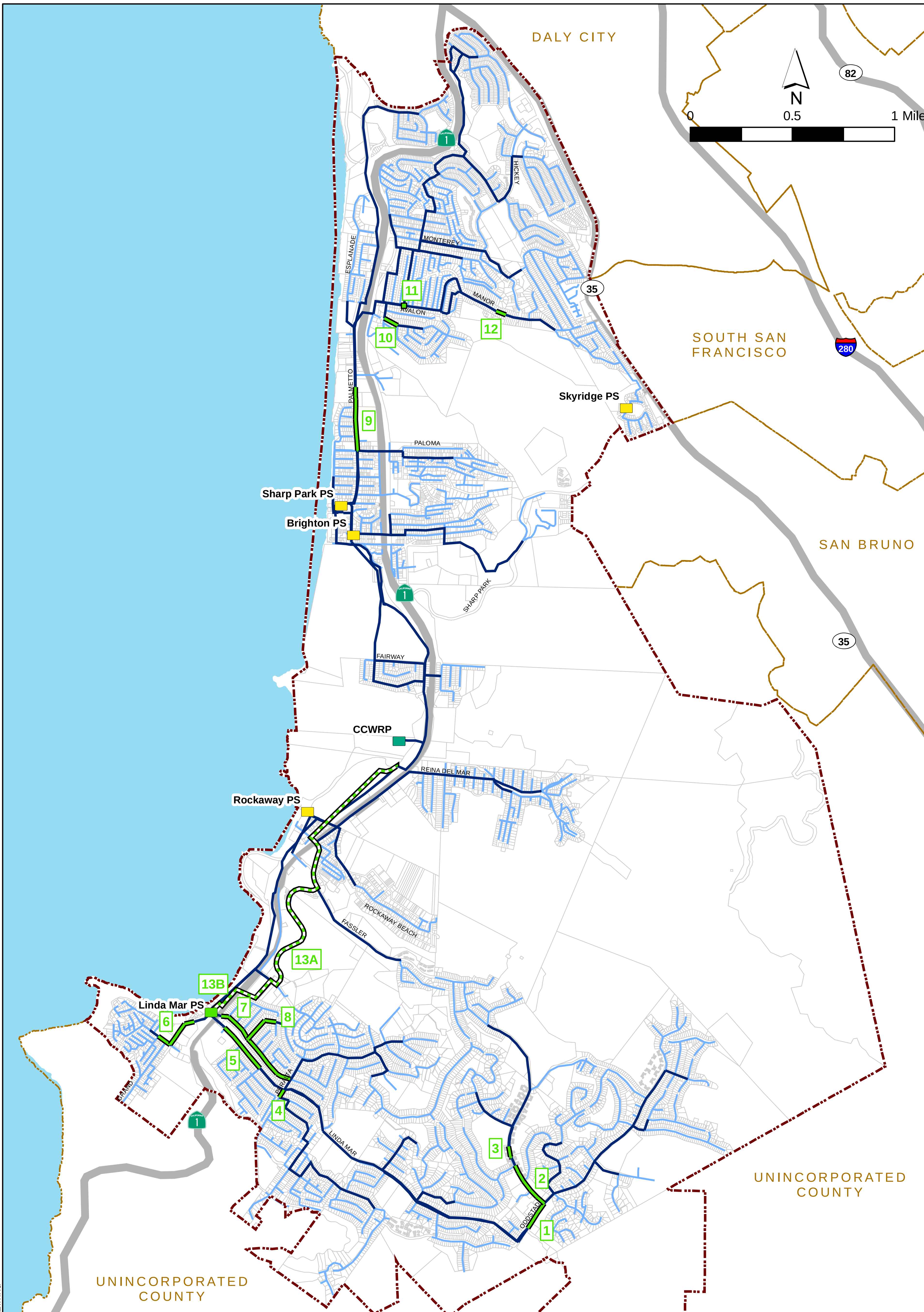
For gravity sewer capacity improvement projects identified as part of this Master Plan, replacement or new pipes were sized to convey the buildout design storm PWWF with no (or only minimal) surcharge. Existing pipe slopes and depths were preserved when upsizing sewers in-place. Diameters were increased as minimally as possible in order to prevent oversizing and subsequent low velocities during dry weather conditions.

Model runs with all capacity projects in place were made to determine the impact of increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

Pump station improvements were identified to provide adequate firm pumping capacity under buildout PWWF, with force mains sized based on a maximum velocity of 8 fps.

3.3.2 Cost Criteria

Costs for capacity improvement projects were estimated based on recent bids provided by the City and RMC experience with similar projects. These cost estimates are planning or conceptual level estimates, and are considered to have an estimated accuracy range of -30 to +50 percent. This level of accuracy corresponds to an “order of magnitude” or “Class 5” cost estimate as defined by the American Association of Cost Estimators. These estimates are suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed into the design and construction phases. All costs have been adjusted to an Engineering News Record Construction Cost Index (ENR CCI) of 10,116, which represents the January 2011 ENR CCI for the San Francisco Area.



Proposed Linda Mar PS Upgrade

Proposed CIP Project

Proposed Parallel Forcemain

Modeled Sewers

Unmodeled Sewers

1 Project ID

Pacifica City Limits

Other City Boundaries

City of Pacifica
Collection System Master Plan

Overview of Capacity Improvement Projects

Figure 3-3

RMC Water and Environment

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Table 3-2: Capacity Improvement Projects

Project ID	Location	US MH	DS MH	Model-Predicted Worst Case Condition Resulting from Deficiency	Exist. Dia. (in.)	Proposed Dia. (in.)	Project Length (ft.)	Proposed Improvements	Relative Priority Score	Flow Confirm. Level	Estimated Construction Cost	Estimated Capital Cost
1	Oddstad Blvd. from Terra Nova Blvd. to Toledo Ct.	PP27	ULX2	4.4' surcharge/4.4' freeboard (would be more severe if Deficiencies 1 & 2 were relieved)	15	18	771	Upsize existing pipes.	7.5 (med)	2	$ 225,000	$ 281,000
2	Terra Nova Blvd. from Alicante Dr. to Oddstad Blvd.	PPU6	PP27	Overflow (backwatered due to Deficiency 1)	12	15	1,242	Upsize existing pipes.	5 (med)	2	$ 198,000	$ 248,000
3	Terra Nova Blvd. between Lerida Way and Alicante Dr.	ULA25	PPU5a	Overflow (backwatered due to Deficiency 1)	8	10	323	Upsize existing pipes.	3 (low)	2	$ 40,000	$ 51,000
4	Peralta Rd. from Montezuma Dr. to Linda Mar Blvd.	LLS11	LL7	0.7' surcharge / 2.7' freeboard (shallow pipe)	12	15	225	Upsize existing pipe.	4 (low)	2	$ 36,000	$ 45,000
5	Linda Mar Blvd. upstream and downstream of De Solo Dr.	LLM12	LL12B	Overflow	12 - 15	15 - 18	1,398	Upsize existing pipes.	10.5 (high)	1	$ 304,000	$ 380,000
6	San Pedro Ave. from Livingston Ave. to Halling Way, Halling Way to Shoreside Dr.	PT6	PT12	Multiple Overflows	6 - 8	8 - 12	1,279	Upsize existing pipes.	9 (high)	1	$ 200,000	$ 251,000
7	Arguello Blvd. from Peralta Rd. to Coast Hwy.	LLD27	LLD37	Multiple Overflows	6 - 12	8 - 15	2,497	Upsize existing pipes.	6 (med)	1	$ 334,000	$ 418,000
8	De Solo Dr. from Fernandez Way to Arguello Blvd.	LLG11	LLD33	3.2' surcharge / 0.8' freeboard (backwatered due to Deficiency 7)	8	10	943	Upsize existing pipes.	2.25 (low)	2	$ 109,000	$ 137,000
9	Palmetto Ave. from north of Shoreview Ave. to Paloma Ave.	F51/ FW41A	F54/ FW46	Overflow	12	18	1,442	Divert flow from 18" trunk to parallel 12" pipe; replace exist. 12" pipe at same depth/slope as parallel 18"; re-connect to 21" trunk sewer at MH F54.	9 (high)	1	$ 457,000	$ 571,000
10	Milagra Dr. from Bruce St. to Edgemar Ave.	PMT9	PMR4	1.4' surcharge / 1.2' freeboard (shallow pipe)	6	8	394	Upsize existing pipe.	3 (low)	2	$ 38,000	$ 48,000
11	Avalon Rd. at Del Mar Ave.	PM29D	F41	4.9' surcharge / 1.2' freeboard	--	8 (diversion)	9	Divert flow from 8" pipe to parallel 18" sewer. This project is needed in addition to the recently constructed Avalon Dr. improvements.	3 (low)	2	$ 24,000	$ 30,000
12	Manor Dr. west of Monterey Rd.	PM10	PM11	Overflow	6	8	269	Upsize existing pipe.	3.75 (low)	3	$ 27,000	$ 34,000
13A	Parallel to Coast Hwy. from Linda Mar Blvd. to Reina del Mar	LMPS	FNC2	Overflow	20	18 (parallel)	10,100	Construct parallel force main.	12 (high)[a]	1	$ 4,460,000	$ 5,575,000
13B	Linda Mar Pump Station	--	--		--	--	--	Add fourth pump.			$ 748,000	$ 935,000

a. If parallel force main is constructed first, relative priority for pump station upgrade would be lower as pump station would have sufficient *total* capacity to convey design PWWF.

Cost criteria include baseline unit construction costs for gravity sewers using open-cut and trenchless (e.g., pipe bursting) methods. Costs for gravity trunk sewers vary with pipe diameter and depth (in the case of open-cut construction), and include an allowance for lower lateral connections and an additional cost for replacement of lower laterals if they are the City's responsibility. Allowances added to the baseline construction cost include mobilization/demobilization and project-specific costs for bypass pumping, traffic control, and extra shoring and dewatering in areas with high groundwater. Costs for pump station and force main improvements were developed on a site-specific basis. A 30 percent allowance for contingencies for unknown conditions was also included for all projects, as well as an allowance of 25 percent of construction cost for engineering, administration, and legal costs.

The itemized cost estimate for each project is detailed on the individual project information sheets included in **Appendix E**.

3.3.3 Project Priorities

Each project was assigned a relative priority based on a calculated priority score, determined based on a risk factor analysis that considered both the severity of the deficiency (i.e., probability of an overflow occurring) and the "consequence" of such a failure.

The severity of the deficiency was determined according to the following two factors:

1. Available freeboard or potential overflow with existing system in place. Deficiencies which are validated by observed (monitored) flows or historical overflows have the highest severity score (score = 2), followed by those which are predicted by the model to result in overflows only under design storm conditions (score = 1.5), and those for which freeboard is less than 4 feet but an overflow is not predicted under the design storm (score = 1).
2. Available freeboard with other capacity relief projects in place. Some project deficiencies are exacerbated by downstream conditions, such as flow backup from a downstream capacity constriction. When the downstream deficiency is relieved, the severity (level of surcharge or potential for overflow) may become less severe. These projects have a lower severity (score = 0.5) than the downstream project. In these situations, it is important that the downstream deficiency (score = 1.5) is relieved before the upstream deficiency, otherwise the additional flow resulting from upstream relief will exacerbate the downstream deficiency.

The consequence of a potential overflow caused by a capacity deficiency was determined according to the following two factors:

1. Pipe size. Pipes with required diameters greater than 15 inches, which in turn have larger flows, are given the highest priority (score = 2) than smaller diameter lines (score = 1 or 0.5, depending on size). This is due to the potential impact on a greater number of residences and businesses, as well as the higher cost of associated fines should an overflow occur.
2. Location. Projects which are located near beaches (score = 2), in high traffic commercial areas (score = 1.5), or near other commercial, office, or community facilities (score = 1) are of a higher priority than projects in residential areas (score = 0.5). This is because these overflows will have a greater impact on the environment, have a greater economic impact, or potentially come in contact with a greater number of people.

Each project was assigned a score for each of the risk and consequence factors. The overall project priority score was then calculated as the sum of the risk factors multiplied by the sum of the consequence factors:

Priority Score = (Severity Factor 1 + Severity Factor 2) x (Consequence Factor 1 + Consequence Factor 2)

Table 3-3 presents the factors that were used to calculate the priority score for each project. The overall relative priority of each project (high, medium, or low) was determined based on its priority score, with projects with the highest priority scores assigned the highest priorities.

Table 3-3: Calculation of Project Priority Based on Risk Factors

Capacity Project	Severity Factor 1	Severity Factor 2	Consequence Factor 1	Consequence Factor 2	Priority Score	Relative Priority Ranking
1	1	1.5	2	1	7.5	Medium
2	1.5	0.5	1.5	1	5	Medium
3	1.5	0.5	1	0.5	3	Low
4	1	1	1.5	0.5	4	Low
5	2	1	2	1.5	10.5	High
6	2	1	1	2	9	High
7	1.5	1.5	1.5	0.5	6	Medium
8	1	0.5	1	0.5	2.25	Low
9	2	1	2	1	9	High
10	1	1	1	0.5	3	Low
11	1	1	1	0.5	3	Low
12	1.5	1	1	0.5	3.75	Low
13	1.5	1.5	2	2	12	High

3.3.4 Flow Confirmation Level

In addition to priority, each project was given a "flow confirmation level", which indicates the level of confidence in the model flows based on metered flows in the area of the identified capacity deficiency. Three levels were used:

- Level 1: Flow meter on or near the project reach is surcharged during monitored storm event, or surcharge or overflows have been observed during historical storms.
- Level 2: Flow meter on or near the project reach confirms the model flow but did not surcharge during the monitored storm event (or a meter located downstream of the project reach did surcharge but it is not known if the surcharge extended to the project location), and surcharge or overflows have not been previously observed.
- Level 3: Flow meter was not located in the vicinity of the project reach, and surcharge or overflows have not been previously observed.

For projects with a confirmation level 1 rating, the need for the project has effectively already been confirmed. Level 2 projects were confirmed to have reasonably accurate model flows, but have no confirmed surcharging. Level 3 projects have no direct confirmation of flows; conducting additional flow monitoring, or field observation of flow levels during rainfall events, would provide a greater level of confidence in the need for the projects.

3.3.5 Detailed Project Descriptions

Detailed descriptions and maps of the collection system capacity improvement projects are presented in **Appendix E**. The descriptions are each contained on a single page and follow a standard format that consists of a summary project description (project location, length, pipe sizes, priority rating, flow confirmation level, estimated capital cost, and discussion of any specific project assumptions, issues, or other considerations) followed by a detailed planning level cost breakdown. The maps show the projects on an aerial photo background, indicating the project pipe segments by manhole ID and existing and proposed pipe sizes. Model hydraulic profiles showing the pipe deficiency under design storm PWWF before capacity relief and after construction of the proposed capacity improvements are also included.

3.4 I/I Analysis

The Pacifica wastewater collection system is subject to significant amounts of I/I, resulting in high peak flows during wet weather events. Wet weather peaking factors (ratio of PWWF to average BWF) based on the model-predicted flow for the 10-year design storm range from about 3 to over 20. **Figure 3-4** shows the range of wet weather peaking factors by area. The highest peak RDI/I rates occur in the Pedro Point and lower Linda Mar areas (meter areas 3, 5B, and 6), with other areas of relatively high I/I in other portions of Linda Mar (meter areas 2 and 5A) and in the Fairway Park district (meter area 9). Many of the capacity deficiencies in the system were found in these areas.

The areas with the highest I/I are generally areas with sewers constructed in the 1950s (rather than the oldest areas constructed in the 1940s). In many of these areas, particularly in portions of Linda Mar, the upper laterals are known to be made of Orangeburg pipe (see Figure 1-3), which is subject to deterioration and potentially large amounts of infiltration. It should also be noted that even within a meter area, I/I rates are not necessarily uniform. For example, the relatively new Skyridge development at the very upstream end of meter area 12 would not likely contribute significant I/I, even though the meter indicated a peaking factor greater than 10 for the overall meter area.

The shape of the RDI/I hydrograph may provide some indication of the types of I/I sources. The flow monitoring and wet weather calibration plots shown in Appendices A and C show that some of the meters, for example Meter 6 in the Pedro Point area, have a very spiky and quick response, which can be indicative of direct inflow sources as well as rapid infiltration into shallow pipes and laterals. Other areas may have a less peaky but significant volume response, for example Meter 8A in the Vallemar area, where the flow stays elevated for a prolonged period after rainfall, indicating significant rainfall-responsive groundwater infiltration. This type of response increases the overall volume of flow in the system but may not result in capacity issues.

An analysis was conducted to determine if reducing RDI/I in targeted areas could eliminate the need for some capacity improvement projects. The analysis focused on the Pedro Point and lower Linda Mar areas, which have the most extensive capacity improvement needs (Projects 4 through 8). Model runs were conducted assuming various levels of RDI/I reduction in the subcatchments tributary to these projects. RDI/I reductions ranging from 30 to 70 percent were modeled. The results indicated that RDI/I would have to be reduced by at least 50 percent in these areas in order to reduce flows sufficiently to eliminate the need for these capacity improvement projects. Based on experience and studies done in other areas, such a large overall reduction in I/I would require a comprehensive rehabilitation approach, that is, all or most of the sewer mains and at least the lower portions of the private service laterals would need to be rehabilitated throughout these areas. This would require a significant financial investment over a relatively short period of time, the cost of which would far exceed the cost of the capacity improvement projects alone.

That said, however, the City recognizes the benefit of reducing I/I in the long-term, as reducing I/I also reduces the costs for pumping and treatment, as well the potential risk of bypasses from the wastewater treatment plant if flows exceed plant hydraulic capacity. If achieved through sewer rehabilitation and replacement, I/I reduction provides the added benefit of further improving the condition of the sewer system, which in turn could reduce maintenance requirements and the risk of dry weather blockages and overflows. Therefore, it is in the City's best interest to construct needed capacity improvements in order to minimize the potential near-term risks of wet weather overflows from the collection system, but at the same time, continue a long-term program of sewer rehabilitation to improve the overall condition of the system and reduce I/I systemwide. Potential methods of I/I source detection and control are described below. Specific I/I reduction approaches recommended for the City are discussed in Chapter 5.

3.4.1 I/I Source Detection and Control Methods

A necessary step in identifying potential I/I control measures is a realistic assessment of the actual sources of I/I in the collection system. Based on the pattern and magnitude of flows in the City's collection system, the likely sources of RDI/I flows are defects in sewers and service laterals, and possibly some direct connections (e.g., illegally connected roof and area drains, direct connections from the storm drain system, etc.).

Appropriate I/I control methods depend on the type and sources of I/I. Control methods must include detection as well as correction. Potential methods are described in the following paragraphs.

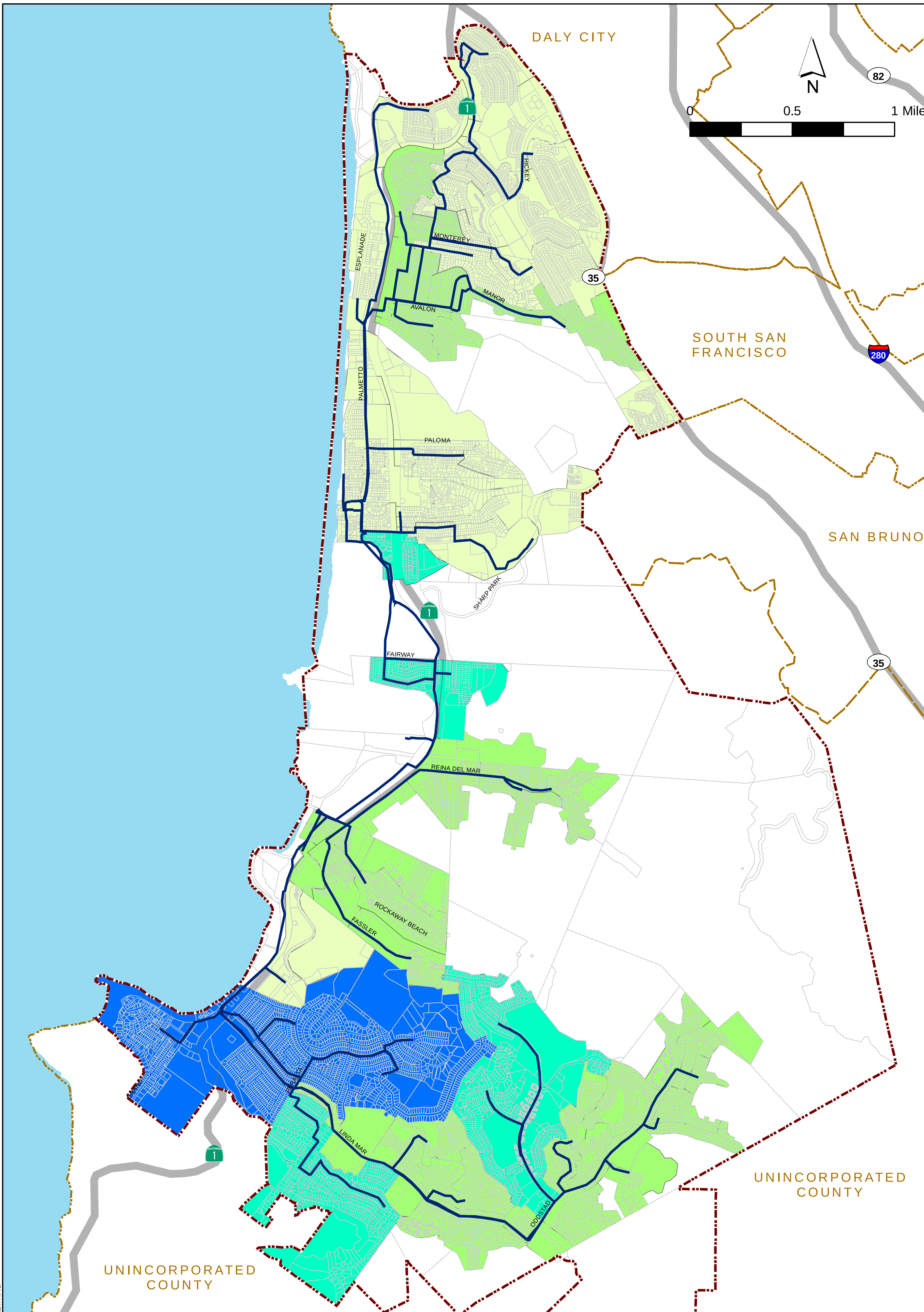
Direct Inflow Sources

Direct inflow sources can contribute significantly to both volume and peak rates of I/I, and have the greatest probability of being cost effective to eliminate. The main methods used to detect and locate direct inflow sources are smoke and dye testing (dye testing is used primarily as a confirmatory test). Smoke testing is considered to be a relatively easy and inexpensive method (cost is approximately $0.50 per foot if a substantial length of pipe is tested), and discovery of just a few direct storm drain cross-connections, for example, can make the effort worthwhile. However, unless there is some indication or knowledge of the existence of direct connections in the system, finding them may require an extensive smoke testing program, which requires public notification measures and access onto private property to document the smoke returns. For this reason, smoke testing is generally targeted at specific areas with high peak RDI/I rates.

Elimination of direct inflow connections requires disconnection of the source and re-direction of the drainage to an appropriate location. This may simply be to the ground surface (as in the case of roof drains), or connection to a nearby storm drain or street gutter. In general, each identified source needs to be evaluated on a case-by-case basis to identify the appropriate corrective measure.

Generally the most numerous type of sources found during smoke testing are not direct inflow connections but defects in shallow pipes, primarily laterals. Rehabilitation of laterals may be a challenging institutional issue (see discussion below on correction of private property I/I sources).

Manholes subject to ponding or located in drainage courses are also considered to be sources of direct inflow. The amount of I/I depends on the manhole location, type of manhole cover (number and size of holes), and the condition of the cover and frame. Physical inspection of manholes is the most effective way to identify such conditions, and correction is relatively straightforward (replace cover, realign frame, raise manhole to grade, remove or relocate manhole in watercourse, etc.). Physical inspection can be conducted in conjunction with sewer inspection or routine cleaning work, or as a separate activity.



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Wet weather peaking factors based on design storm

- <10
- 10-15
- 15-20
- >20

Modeled Sewers

Other City Boundaries

Pacifica City Limits

City of Pacifica
Collection System Master Plan

Wet Weather Peaking Factors

Figure 3-4

Infiltration Sources in Sewer Mains and Manholes

Infiltration sources are defects in sewer pipes or manholes caused by defective materials or construction, general deterioration, or damage caused by physical conditions such as ground movement or settlement, traffic loads, or root intrusion. Infiltration sources (defects) are detected by inspection: visual inspection in the case of manholes and CCTV inspection for sewer mains. However, visual observation of active I/I is generally not feasible since the RDI/I generally occurs for only short periods during rainfall events, and the pipes may fill up during those periods, making CCTV inspection difficult or impossible.

Infiltration correction methods involve rehabilitation or replacement of entire pipe segments or manholes or spot repair of localized defects. There are numerous materials and methods used for this type of rehabilitation. In general, however, the cost per unit amount of I/I removed is relatively high, since the defects individually contribute relatively small amounts of flow. It is recognized that infiltration in the sewer system will "migrate" to other nearby defects that are left un-repaired. Therefore, a fairly extensive area of the system may need to be included in the rehabilitation effort in order to achieve substantial flow reduction. Furthermore, reductions greater than about 30 percent can rarely be achieved without also addressing the infiltration from private laterals. Generally, rehabilitation to reduce infiltration is cost effective only if a significant amount of infiltration can be isolated to a relatively small area, or there are extremely costly improvements required downstream to convey, treat, and dispose of the excess flow.

I/I Sources on Private Property

I/I sources on private property are primarily defective laterals, but may also include broken cleanouts or cleanout caps, or directly connected roof and area drains. Smoke testing is the primary method for detecting private property I/I sources. For more aggressive programs, building or property inspections can be conducted, and/or laterals can be CCTV inspected or tested for leaks using air or water pressure tests. These types of inspections and tests generally require that the lateral have cleanout access, ideally at both the connection to the building plumbing and at or near the property line. However, new technologies are now available, such as cameras that can be "launched" up the lateral during CCTV inspection of the mainline, that make it easier to inspect private laterals. The City is planning to purchase such a camera in the near future to facilitate inspection and identification of problem laterals.

One method that has been implemented by a number of sewerage agencies is an ordinance requiring testing or inspection of the sewer lateral at the sale of the property (and/or other triggers such as change in property use or major remodel). If the lateral fails to pass the inspection or test, then appropriate repairs must be made before the sale can close or as a condition of the building permit. In many areas where the problems caused by I/I and the need for sewer and lateral rehabilitation was effectively communicated to the community, a lateral ordinance was found to be an effective way to implement a private property rehabilitation program with the least financial impact on the public agency. Grant or loan programs can also reduce the financial impact on property owners, or the City may be able to negotiate reduced prices for lateral rehabilitation with contractors, for example, in an area where the sewer mains are also being rehabilitated or replaced as part of a City project.

3.5 Systemwide Capacity Assurance Plan

The capacity improvement projects identified in Section 3.3 would provide assurance that overflows would not occur in the collection system under the design flow event. However, once these capacity improvements are implemented, peak wet weather flows in the system would increase. The model predicts that the design storm PWWF to the CCWRP would reach 26 mgd under these conditions, exceeding the current hydraulic capacity of the treatment plant. The plant is currently rated for a peak flow of 20 mgd (although flows up to about 24 mgd can be handled for short durations, e.g., about two hours). Exceeding the capacity of the CCWRP could result in significant bypasses of untreated or partially treated wastewater, or the risk of flooding out critical facilities at the plant. Therefore, alternatives to address systemwide capacity assurance were evaluated. The three primary alternatives are:

- Systemwide Alternative 1: Capacity Enhancement Only
- Systemwide Alternative 2: Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar
- Systemwide Alternative 3: Collection System Capacity Improvements with Comprehensive Sewer Rehabilitation to Reduce I/I

A discussion and comparison of the alternatives follows.

3.5.1 Systemwide Alternative 1: Capacity Enhancement Only

Under this alternative, the capacity improvements identified in Section 3.3 would be implemented, but would require improvements at the CCWRP to increase hydraulic capacity and/or provide wet weather flow storage as needed to prevent exceeding the existing hydraulic capacity of the treatment plant. Increasing the hydraulic capacity of the treatment plant would require construction of a sixth sequencing batch reactor (SBR) and increasing the size of the pipe from the SBRs to the sand filters, at an estimated cost of over $20 million. Alternately, peak influent flows could be equalized by construction of a storage basin on the site. However, any significant construction at the CCWRP would be very difficult to implement because of potential environmental impacts and permitting requirements, as well as the need for approval from the California Coastal Commission. Furthermore, increasing the hydraulic capacity of the plant would require a revision to the National Pollutant Discharge Elimination System (NPDES) discharge permit for the CCWRP.

3.5.2 Systemwide Alternative 2: Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar

Under this alternative, the capacity improvements identified in Section 3.3, with the exception of the proposed parallel Linda Mar force main, would be implemented, and a flow equalization basin would be constructed in the vicinity of the Linda Mar Pump Station to eliminate the need for a major capacity increase for Linda Mar Pump Station and parallel force main, and to limit the flow pumped to the CCWRP during peak wet weather flow conditions. An underground storage basin with gravity inflow and pumped discharge are assumed for this alternative. An underground basin would allow existing above-ground uses to remain, minimizing aesthetic impacts and disruption to community activities.

Several potential sites for an equalization storage basin were identified in the vicinity of the Linda Mar Pump Station, including the parking area adjacent to the pump station, the Park & Ride/bus transit area on the north side of Linda Mar Boulevard just east of the Coast Highway, the Community Center parking lot off of Crespi Drive, and the Sanchez Adobe County Park on Linda Mar Boulevard east of Adobe Drive. For purposes of the alternatives comparison for this report, the basin has been assumed to be located at the Park & Ride on Linda Mar Boulevard, as this site would have the advantage of close proximity to the Linda Mar Pump Station and influent trunk sewer, as well as a location east of the Coast Highway, which would therefore not require permit approval from the California Coastal Commission. However, if the Linda Mar storage basin is ultimately recommended for implementation, then further siting studies, geotechnical investigations, analysis of environmental impacts and permitting requirements, and community outreach would be required before a final site is selected. Furthermore, additional hydrologic and hydraulic analyses would be needed to confirm the sizing of the basin and ability to handle various flow scenarios, including “back-to-back” storms, as well as determine the most appropriate and practical method of controlling the flow diverted to the basin and the drain back to the system after storms. In addition to the storage basin itself, the facilities associated with the flow equalization basin would include the piping to and from the basin, drain back pumps, and equipment for odor control and cleaning of the basin after use.

Based on model runs for the design event, approximately 2.1 million gallons (MG) of storage volume would be required to limit the PWWF to the Linda Mar Pump Station so it would not exceed its current total capacity (or firm capacity after addition of a fourth pump) and flow to the CCWRP would not exceed its hydraulic capacity. Although a larger basin might be desirable to be able to accommodate larger or potential back-to-back storms, for purposes comparing alternatives on an "apples-to-apples" basis, a 2.1 MG basin, as required for the design event, is assumed. The estimated capital cost of the basin is $20 million. Appendix E includes a more detailed project description, cost estimate, and map of the potential equalization basin project (called Capacity Project 14).

3.5.3 Systemwide Alternative 3: Collection System Capacity Improvements with Comprehensive Sewer Rehabilitation to Reduce I/I

Under this alternative, the capacity improvements identified in Section 3.3, with the exception of the proposed parallel Linda Mar force main, would be constructed, and comprehensive sewer rehabilitation would be conducted in the Pedro Point and lower Linda Mar areas to reduce I/I sufficiently to prevent exceeding the capacities of the Linda Mar Pump Station and the CCWRP. As discussed previously in Section 3.4, studies have shown that substantial reductions in I/I can only be achieved by a *comprehensive* rehabilitation approach that involves rehabilitation or replacement of all sewer main segments and associated laterals in an entire area of the system. Under such an approach, it is estimated that I/I reductions of 70 to 80 percent can be achieved.

For purposes of evaluating the extent of rehabilitation that would be required to reduce peak flows to the level that could be handled by the Linda Mar Pump Station and CCWRP, successive model runs were conducted assuming that I/I would be reduced by 70 percent in meter areas tributary to the Linda Mar Pump Station that have the highest wet weather peaking factors. These model runs indicated that reducing design storm peak flows to this level would require comprehensive rehabilitation in the entire Pedro Point and lower Linda Mar area (flow meter areas 6, 3, 5B, and 5A), which includes approximately 20 miles of sewer mainlines and an estimated 2,700 laterals. It is also assumed that property owners in these areas would be required to rehabilitate or replace all upper laterals associated with the sewer mains and lower laterals included in the rehabilitation work. The estimated cost of comprehensive rehabilitation in the Pedro Point and lower Linda Mar areas is $23 million (not including the cost for upper lateral replacement).

While the I/I reduction achieved through comprehensive rehabilitation would also eliminate most or all of the sewer capacity deficiencies in the Pedro Point and lower Linda Mar areas, it is likely that implementation of such a program would take a period of at least 15 to 20 years or more. Therefore, in order to minimize the risk of localized SSOs due to sewer capacity limitations, it is assumed that those sewer capacity improvement projects would still be constructed in the near-term.

3.5.4 Comparison of Systemwide Alternatives

Table 3-4 provides a comparison of the advantages, disadvantages, and estimated costs of the systemwide capacity assurance alternatives. Based on this comparison, it is recommended that the City proceed with implementation of Systemwide Alternative 2, Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar. This alternative provides the best assurance of meeting regulatory and legal requirements to eliminate capacity-related wet weather overflows in the near-term, and has the lowest estimated capital cost of the three alternatives. As noted previously, the City still plans to continue a long-term program of rehabilitation of its sewer system, which will further reduce the risk of dry weather blockages and overflows, as well as reduce annual costs for operation and maintenance of the sewer system, pumping facilities, and wastewater treatment plant.

Table 3-4: Comparison of Systemwide Capacity Assurance Alternatives

	Alternative	Project Elements	Advantages	Disadvantages	Est. Capital Cost
1	Capacity Enhancement Only	• Capacity Improvement Projects 1 to 12, 13A, 13B • Capacity Expansion of CCWRP	• Eliminates risk of wet weather SSOs due to Linda Mar PS capacity deficiency once parallel force main is constructed • Reduces risk of bypasses from CCWRP once plant expansion or equalization is constructed • Would allow portion of Linda Mar force main to be taken out of service for cleaning or inspection.	• Potential environmental and permitting impediments to construction of parallel force main • Significant environmental and permitting impediments to expansion of CCWRP • Continued risk of bypasses from CCWRP until plant expansion is completed	$34M[a]
2	Collection System Capacity Improvements with Wet Weather Flow Equalization at Linda Mar	• Capacity Improvement Projects 1 to 12, 13B • Linda Mar Flow Equalization Facility (Capacity Project 14)	• Eliminates risk of wet weather SSOs due to Linda Mar PS capacity deficiency once flow equalization facility is constructed • Reduces risk of bypasses from CCWRP • Would allow Linda Mar force main to be taken out of service for cleaning or inspection.	• Potential implementation impediments and community opposition to flow equalization facility	$24M
3	Collection System Capacity Improvements with Comprehensive Sewer Rehabilitation to Reduce I/I	• Capacity Improvement Projects 1 to 12, 13B • Comprehensive sewer rehabilitation in Pedro Point and lower Linda Mar areas	• Reduced flow and associated O&M costs for pumping and treatment • Improved system condition and reduced costs for sewer maintenance and risk of blockages and dry weather SSOs in rehabilitated areas • Ultimately reduces risk of wet weather SSOs and bypasses due to Linda Mar PS capacity deficiency and CCWRP hydraulic limitations	• Continued risk of wet weather SSOs due to Linda Mar Pump Station capacity deficiency until significant amount of comprehensive rehabilitation is completed (could take 15 to 20 years) • Actual amount of I/I reduction achieved cannot be predicted with certainty. • Requires private lateral rehabilitation to achieve I/I reduction target.	$27M[b]

a. Includes estimated cost of $25M for capacity expansion of CCWRP.
b. Would require additional costs for private lateral rehabilitation.

Chapter 4 Condition Assessment and Rehabilitation/ Replacement Program

This chapter describes the process used to assess the condition of the gravity sewer system by closed-circuit television (CCTV) inspection, the methods used to analyze the data to identify needed repairs and rehabilitation/replacement (R/R) needs, and presents the recommended sewer system R/R program. A summary of the condition of the system pump stations, based on staff interviews and site visits conducted as part of this study, is also provided in **Appendix F**. The condition assessment does not include the force mains, which cannot be easily accessed for inspection.

The recommended gravity sewer R/R projects are included in the long-range capital improvement program presented in Chapter 5. The program is based on characteristics of the City's sewer system and results of sewer inspections performed through June 2011. As the City continues its inspection program to include the remaining portions of the system, the R/R program will be updated to reflect additional information.

4.1 Condition Assessment Methodology

CCTV inspection is the basic method used by the City to assess gravity sewer condition. This section describes the City's program, including data documentation standards and condition grading.

4.1.1 CCTV Inspection Program

Effective use of CCTV inspection data requires that the data recorded be consistent, complete, and of high quality; and that it is captured in a format that can be readily accessed for analysis. Current industry best practice is to use Pipeline Assessment and Certification Program (PACP) standards developed by the National Association of Sewer Service Companies (NASSCO), which specifies observation codes and grades to be applied to all structural and maintenance-related defects. The City has adopted PACP standards and operator certification requirements for its sewer inspections.

The City owns and operates one CCTV inspection truck that is equipped with WinCan® V8 software to record observations and data. The data are captured in a Microsoft Access database along with still photo images of pipe features and observed defects. Over the past five years, the City has inspected approximately 40 percent of the gravity sewers in the collection system. The past focus of the CCTV work has been on areas with known maintenance or structural problems. More recently, the City has starting scheduling the CCTV work by area, starting in the southern part of the system (Linda Mar area), and working its way through the system with the objective of completing the inspection of the entire system by 2013.

Before using inspection data to perform the condition assessment and develop the recommended R/R program, RMC reviewed a sample of the City's inspection reports for consistency with PACP standards. The review determined that the inspection data were being recorded accurately and consistently, therefore providing a valid basis for rating the sewers based on their condition and developing R/R decisions.

4.1.2 Condition Grading and Rating

Under the PACP standard, all structural defects are assigned a condition grade of 1 to 5, with Grade 5 representing severe defects that require attention in the short-term and Grade 1 representing minor defects. The grades for individual defects observed on a manhole-to-manhole pipe segment can be combined in various ways to determine an overall structural condition rating for the pipe. The PACP manual suggests several formulas for this purpose, including summing the grades of all defects or averaging the grades. While such formulas may be useful for screening pipes in terms of overall condition, they are not particularly useful for deciding which pipes require immediate attention. What is most important in such decisions is the presence of major defects and the number of such defects. For example, a single Grade 5 defect in a pipe requires action, while five Grade 1 defects do not, even though they both sum to 5. The number of major defects is significant since it helps determine whether point repair(s) or manhole-to-manhole rehabilitation (e.g., lining) or replacement would be most appropriate.

Because it provides the best overall rating method for the purposes of decision making, the PACP Structural Quick Rating (SQR) is recommended as the City's primary rating system for condition assessment. The rating is a four-digit code that indicates the number of defects having the two highest grades. For example, a SQR of 5132 indicates the worst defect was a Grade 5 defect (of which there was only one occurrence), and the next worst defect was Grade 3 (of which there were 2 occurrences).

4.2 Rehabilitation/Replacement Decision Process

Based on the inspection data collected under the City's CCTV inspection program, a formal decision process was developed to facilitate the use of the data in determining appropriate actions to repair, rehabilitate, or replace defective sewers pipes or to continue to monitor and maintain sewers that are not in need of renewal in the near future. In the context of the discussion in this report, the terms "renewal" and "rehabilitation/replacement" are used to designate any type of action that results in a structural improvement to the sewer pipe, including a point repair, short-segment lining, or lining or replacement of an entire manhole-to-manhole pipe reach.

The decision process is designed to set clear criteria for pipes requiring accelerated actions, pipes requiring renewal, and selection of an appropriate repair, rehabilitation, or replacement method. The process is illustrated in the flow diagram in **Figure 4-1**. The diagram depicts how the data for each pipe segment is systematically evaluated using decision points to drive an objective preliminary decision outcome based on its condition, the types of defects it contains, and the estimated cost-effectiveness of various renewal methods. The input, decision points, and potential decision outcomes are described in **Table 4-1** and discussed in more detail below.

The decision outcomes resulting from the decision process are intended to support review of the CCTV inspection data. Outcomes from the decision process recommending a renewal action are further reviewed to validate the decision. The review consists of detailed review of CCTV inspection defect data as well as viewing of selected video or defect photo images and CCTV reports as required. In addition, other factors such as pipe capacity, location, maintenance history, and constructability issues might be assessed and considered. Finally, other considerations, such as a goal of reducing infiltration, could also influence the choice of renewal method for a particular pipe or area of the system.

4.2.1 Defect Categorization and Terminology

Under the PACP system, pipeline defects are categorized by type (e.g., structural or operation & maintenance) and severity (Grade 1 to 5). Defects of certain type and severity can be considered "major" defects, requiring some type of renewal action. Examples of major defects include collapsed, broken or fractured pipe, holes, obstacles or laterals ("taps") intruding significantly into the pipe, severe infiltration ("gusher"), large root masses ("root balls"), and significant corrosion in concrete or asbestos cement pipes.

Some types of defects may be able to be addressed by a localized point repair. Defects that can be corrected by point repair are referred to as "point repair" (PR) defects. Major defects that can potentially be corrected by point repair are called "major point repair" (MPR) defects. Some major defects, such as corrosion, may be problematic to address through point repair and may require a more extensive renewal method such as lining or replacement. Once a pipe has been identified as a candidate for renewal due to the presence of one or more major defects, the possibility of renewal of the other non-major PR defects in that pipe segment is also evaluated. If there are a relatively large number of defects requiring point repair, then at some point it becomes more cost-effective to line or replace the entire pipe segment. In cases where lining of the pipe (rather than complete replacement) is being considered, then certain types of defects (e.g., offset joints, protruding laterals) may need to be repaired before the pipe can be lined. These defects are referred to as "lining point repair" (LPR) defects.

4.2.2 Decision Process Recommendations

The decision process can result in several potential outcomes, which are defined below:

- **Maintain** is a decision to maintain the pipe in its current condition as part of an ongoing maintenance program. Depending on its condition rating, subsequent CCTV inspection of the pipe after a designated time interval may be specified.
- **Point Repair** is a decision to perform a localized repair (e.g,, replacement of a short section of pipe or installation of a short-segment liner)
- **Line** is a decision to perform an internal lining of a pipe using a trenchless rehabilitation method such as slip-lining or cured-in-place pipe (CIPP).
- **Point Repair + Line** is a decision to line a pipe, requiring one or more point repairs prior to lining.
- **Replace** is a decision to replace an entire manhole-to-manhole pipe segment. Replacement could be done by open cut construction or pipe bursting.

Figure 4-1: Sewer Renewal Decision Process Flow Diagram

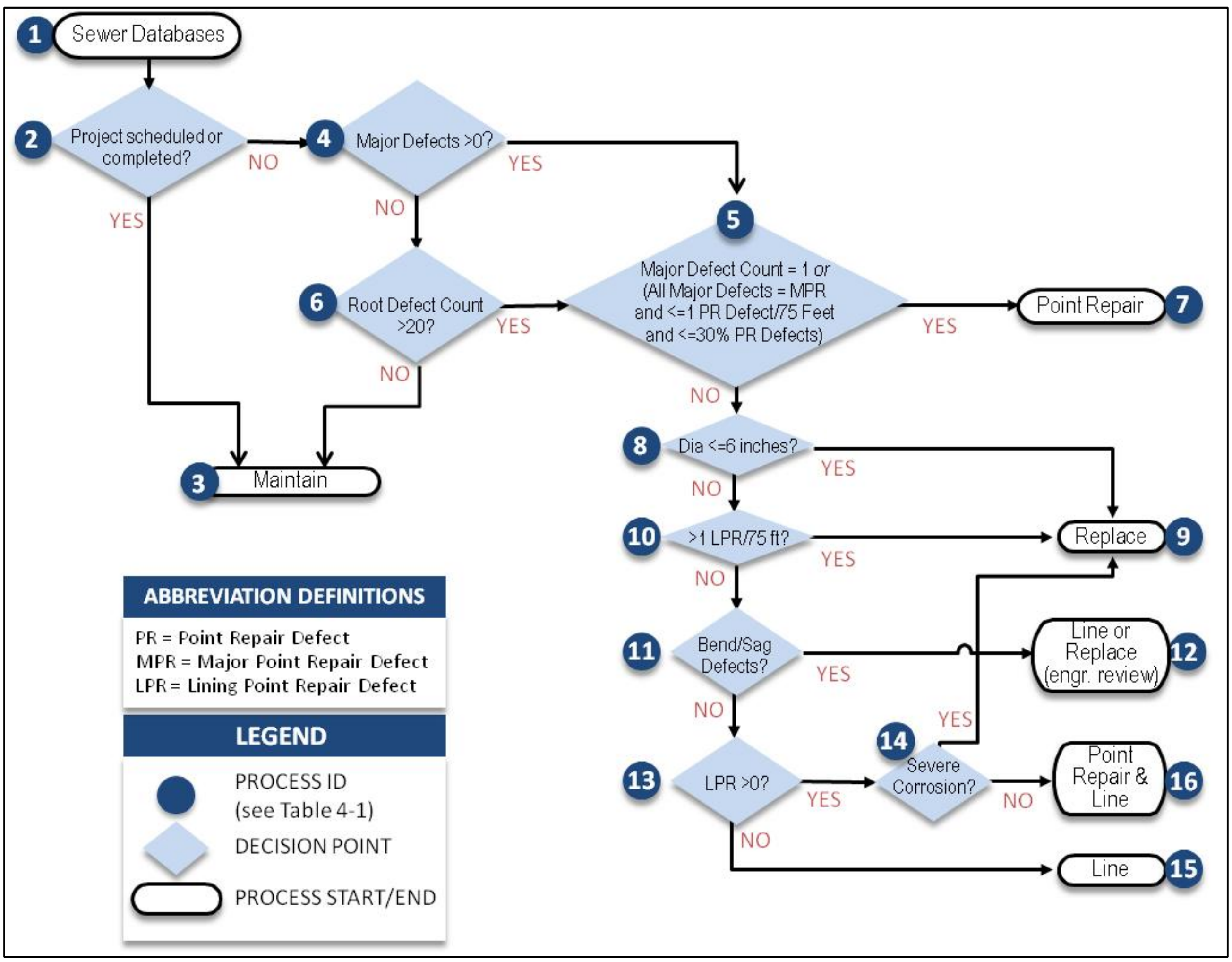


Table 4-1: Sewer Renewal Decision Process Explanations

Process ID	Type	Description	Explanation
1	Input	Sewer Databases	The data sets, including CCTV defects, defect code categorization, and pipe attribute data, used for pipe renewal decision-making.
2	Decision	Project scheduled or completed?	This asks whether the pipe has already been repaired or if there is a project scheduled that will address its existing defects. If yes, then a "Maintain" outcome results. If no, then the pipe will continue through the process.
3	Outcome	Maintain	Decision to continue ongoing maintenance of the pipe segment because, in its current condition, it does not warrant additional action in the near-term.
4	Decision	Major Defects > 0?	This asks whether the pipe segment has any major defects. If yes, then the pipe will continue through the decision process. If no, then a "Maintain" outcome results, unless there are significant root defects (see Decision 6).
5	Decision	Major Defect Count =1 *or* (All Major Defects=MPR & <= 1 PR Defect/75 feet & <= 30% PR Defects)	This determines if a point repair is feasible. This is indicated if there is only one major defect in the pipe segment, or if the following three criteria are met: 1) all major defects can be addressed using a point repair solution (Major Defects = MPR); 2) there are no more than 1 point repair defect per 75 feet of pipe (more than that suggests that the pipe should be lined or replaced); and 3) no more than 30 percent of the pipe should require point repair (anything more is not likely to be a cost-effective solution).
6	Decision	Root Defect Count >20	This asks whether the pipe segment has more than 20 occurrences of roots, indicating that renewal is warranted. If no, then a "Maintain" outcome results.
7	Outcome	Point Repair	Decision to perform one or more localized repairs on the pipe segment to address defects.
8	Decision	Dia <= 6 inches?	This asks whether the pipe is less than 6-inch diameter. If the pipe is smaller than 6 inches, then lining is not considered feasible and the decision will be to "Replace" the pipe. If the answer is no, then this pipe segment will continue through the process.
9	Outcome	Replace	Decision to replace the pipe because it failed one of the conditions necessary for the pipe to be point repaired or lined.
10	Decision	> 1 LPR/75 feet?	This asks whether there is more than 1 LPR per 100 feet. More than 1 LPR per 75 feet would cost the equivalent of replacement. If this is the case, then the decision will be to "Replace" the pipe instead. If this is not the case, the pipe will continue through the process.
11	Decision	Bend/Sag Defects?	This asks whether there are bend or sag defects in the pipe. If so, then further evaluation will be needed to determine if the defect needs to be repaired, can be repaired, and if lining is feasible. If yes, then the decision will be "Renew". If no, then the pipe will continue through the process.
12	Outcome	Line or Replace (engr. review)	This outcome indicates that City staff must evaluate whether to line or replace the pipe segment based on an engineering review of the pipe defects.
13	Decision	LPR > 0?	This asks whether the pipe has any PRs that need to be addressed prior to lining. If yes, then the result will be to continue through the process. If no, the result will be a decision to "Line"
14	Decision	Severe Corrosion?	This asks whether severe corrosion exists in the pipe which would likely preclude point repairs. If yes, then the result will be to "Replace" the pipe. If no, then the result will be to "Point Repair + Line" the pipe.
15	Outcome	Line	Decision to line the pipe.
16	Outcome	Point Repair + Line	Decision to perform necessary PRs and line the pipe.

4.3 Condition Assessment and Renewal Decision Results

The results of the condition assessment and sewer renewal decision process for Pacifica are presented below. **Figure 4-2** presents the pipe condition ratings expressed as the highest structural defect grade for each specific pipe. Approximately 97 segments, or about 10 percent of the inspected pipes, had at least one occurrence of a structural defect of Grade 5. Note that some very severe defects have already been corrected by point repairs by the City following their discovery during inspection, and some pipes have undergone rehabilitation or replacement since they were last inspected.

Figure 4-3 shows the results of the renewal decision process in terms of the recommended renewal method. **Table 4-2** summarizes these results according to the primary reason for the pipe being selected for renewal. Of the 323 pipe segments identified for some type of repair, rehabilitation, or replacement, approximately 90 percent are due to structural defects and 10 percent due to solely to root intrusion. A list of all of the inspected pipes and their associated structural ratings and recommended renewal method is included in **Appendix G**. As City staff implements these recommendations, they may elect to change the renewal method for specific pipes based on further review of the pipe condition as well as the other considerations previously mentioned.

Table 4-2: Sewer Renewal Decision Analysis Results

Sewer Renewal Reason and Decision	No. of Pipe Segments	Percentage of Pipe Segments	Length of Pipe Segments (ft.)	Percentage of Total Pipe Length	Number of Localized Repairs
Major Structural Defects	**214**	**20.9%**	**49,592**	**22.6%**	**155**
Replace	*86*	8.4%	*19,558*	*8.9%*	*0*
Line	*5*	0.5%	*1,531*	*0.7%*	*4*
Localized Repair	*123*	12.0%	*28,503*	*13.0%*	*151*
Large Offset Joints	**75**	**7.3%**	**17,324**	**7.9%**	**73**
Replace	*8*	0.8%	*1,915*	*0.9%*	*0*
Localized Repair	*67*	6.6%	*15,409*	*7.0%*	*73*
Significant Root Intrusion	**34**	**3.3%**	**8,890**	**4.1%**	**2**
Replace	*33*	3.2%	*8,380*	*3.8%*	*0*
Line	*1*	0.1%	*510*	*0.2%*	*2*
Renewal Subtotal	**323**	**31.6%**	**75,806**	**34.6%**	**230**
Maintain/Reinspect in Future	**699**	**68.4%**	**143,366**	**65.4%**	**0**
TOTAL	**1,022**	**100%**	**219,172**	**100%**	**230**

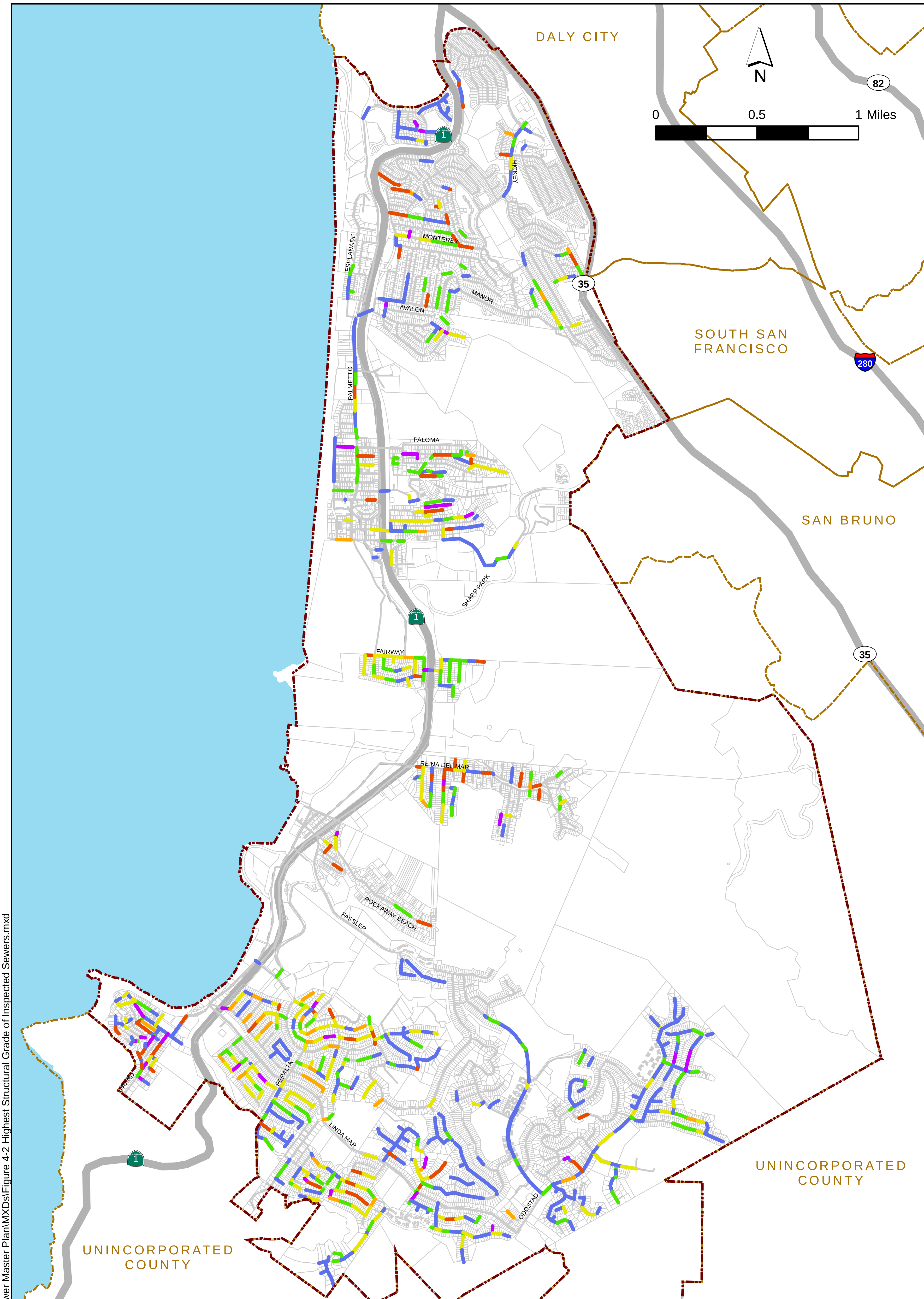
4.4 Projected Sewer Renewal Requirements

Near-term projections for sewer repair, rehabilitation, and replacement were estimated using the results of the sewer renewal decision analysis applied to sewers that have already undergone CCTV inspection. To estimate the renewal requirements for pipes that have not yet been inspected but are planned for inspection over the next two years, the results of the renewal decision analysis for inspected pipes were extrapolated to the uninspected pipes based on pipe age and size. Specifically, the results for the inspected pipes were divided into seven pipe age and four pipe size categories, and the total percentage of pipe length identified as requiring each type of renewal was calculated for each pipe age and pipe size category. The total length of pipe in the sewer system was likewise divided into the same pipe age and pipe size categories, and a projection of the total near-term sewer system renewal requirements was developed by multiplying these lengths by the percentage of renewal identified for the same pipe age and pipe size categories.

Table 4-3 presents the total estimated near-term system renewal requirements for both inspected and uninspected pipes. Note that these quantities will be refined as the City completes the inspection of the remaining portion of the collection system over the next few years.

Table 4-3: Projected Near-Term Sewer Renewal Requirements

Sewer Renewal Reason and Decision	Length of Pipe Segments (ft.)	Percentage of Total Pipe Length	Number of Localized Repairs
Major Structural Defects	**113,431**	**22.3%**	**325**
Replace	*47,721*	*9.4%*	*0*
Line	*6,669*	*1.3%*	*19*
Localized Repair	*59,041*	*11.6%*	*306*
Large Offset Joints	**33,668**	**6.6%**	**143**
Replace	*3,945*	*0.8%*	*0*
Localized Repair	*29,723*	*5.8%*	*143*
Significant Root Intrusion	**23,887**	**4.7%**	**7**
Replace	*22,203*	*4.4%*	*0*
Line	*1,684*	*0.3%*	*7*
Renewal Subtotal	**170,986**	**33.6%**	**475**
Maintain/Reinspect in Future	**338,273**	**66.4%**	**0**
TOTAL	**509,259**	**100%**	**475**



Max Structural Quick Rating (SQR):

- 0
- 1
- 2
- 3
- 4
- 5

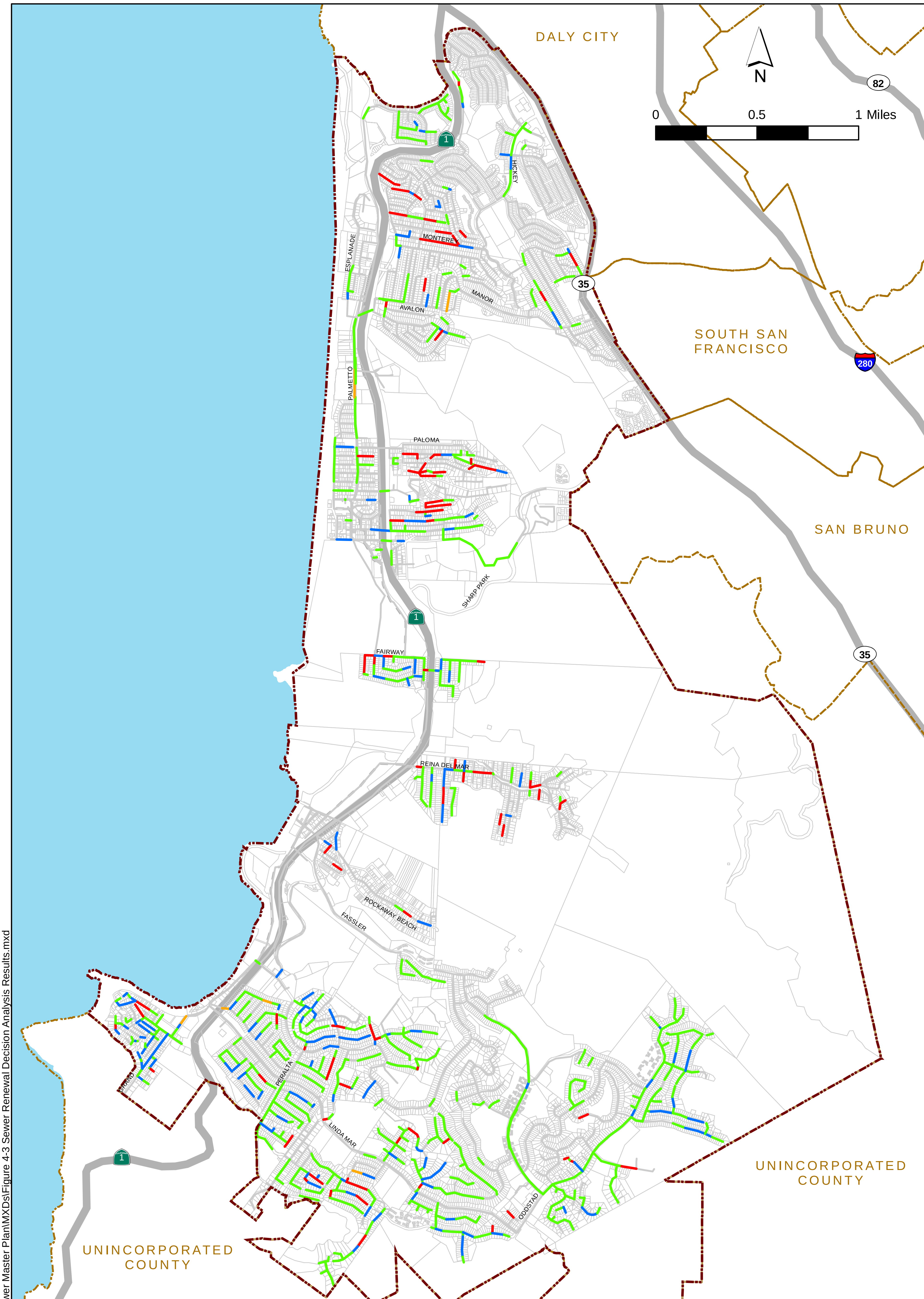
- Sewer Line (No CCTV Data)
- Force Main
- Pacifica City Limits
- Other City Boundaries

City of Pacifica
Collection System Master Plan

Highest Structural Grade of Inspected Sewers

Figure 4-2

RMC Water and Environment



Rehabilitation Decision:

- Maintain
- Localized Repair
- Line
- Replace

- Sewer Line (No CCTV Data)
- Force Main
- Pacifica City Limits
- Other City Boundaries

City of Pacifica
Collection System Master Plan

Sewer Renewal Decision Analysis Results

Figure 4-3

RMC Water and Environment

L:\Projects GIS\0297 Pacifica Sewer Master Plan\MXDs\Figure 4-3 Sewer Renewal Decision Analysis Results.mxd

4.5 Projected Costs for Sewer Rehabilitation and Replacement

Planning-level construction costs were estimated for sewer rehabilitation and replacement using the unit costs shown in **Table 4-4**. These unit costs were based on recent project bids provided by the City and information from similar projects contained in RMC's cost database. The costs are intended to represent the long-term average cost of many projects.

Table 4-4: Unit Construction Costs for Sewer Rehabilitation

Item	Unit	Unit Cost
Pipe Bursting[a]	$/foot	$89 to $109
Open-Cut Replacement[a]	$/foot	$142 to $162
CIPP Lining[a]	$/foot	$112 to $132
Point Repair	$/repair	$7,000
Lower Lateral Replacement[b]	$/lateral	$1,600

a. For pipe sizes in range of 6 to 12 inches. Includes materials, excavation and backfill, pipe or liner installation, traffic control, bypass pumping, surface restoration, manhole adjustment as needed, and lateral reconnection.

b. Applied to sewers where City has identified the majority of properties as having property-line cleanouts; based on assumed lateral spacing of 38 feet.

The unit costs for sewer renewal are based on the following assumptions:

- A very high percentage of projects will consist of smaller diameter pipes in streets with low traffic and favorable soil and groundwater conditions.
- Open-cut pipe replacement as well as trenchless technologies such as pipe bursting and CIPP will be applied as determined by local conditions. The estimated costs for replacement assume that 80 percent of sewers requiring replacement will be replaced by pipe bursting and 20 percent by open-cut construction.
- Most manholes will not need to be replaced; minor repair and benching will be adequate.
- The projects will be over a mile in length, allowing for economies of scale.
- Laterals will be reconnected, including replacement of the factory connection and a short segment of pipe, and lower laterals will be replaced (if needed) if a property line cleanout already exists. Neither upper laterals nor lower laterals where there is no property line cleanout will be replaced as part of the pubic sewer main project. However, laterals will be inspected, and property owners may be required to repair or replace them if determined to be poor condition.

A 30 percent allowance for contingencies for unknown conditions was added to determine total estimated construction costs. Estimated capital costs include an additional allowance of 25 percent of construction cost for engineering, administration, and legal costs.

Based on the unit costs and cost allowances applied to the estimated amount of identified and projected sewer renewal as presented in Sections 4.3 and 4.4, the projected costs for the sewer rehabilitation/replacement program were estimated, as presented in **Table 4-5**. These costs represent the estimated capital investment in the system required over approximately the next 10 years to address significant structural deficiencies and root problems. Over the long-term, additional sewer renewal will be needed to continue to maintain the structural integrity of the system as it ages, as determined through future sewer inspection.

Note that the costs presented below are focused primarily on structural rehabilitation of the system, which may not necessarily, by itself, result in significant reductions in I/I. Based on the City's desired long-term goal of reducing the overall amount of I/I in the system, it may elect to expand its rehabilitation program to include a larger number of sewers in target areas and more extensive rehabilitation methods (e.g., more lining or replacement rather than localized repair). Further discussion on the City's proposed approach and schedule for rehabilitation work is presented in the following chapter of this report.

Table 4-5: Estimated Near-Term Costs for Sewer Rehabilitation and Replacement

Reason for Renewal	Estimated Construction Cost[a]	Estimated Capital Cost[b]
Major Structural Defects	$10,141,000	$12,676,000
Large Offset Joints	$1,812,000	$2,265,000
Significant Root Intrusion	$3,129,000	$3,911,000
Total	**$15,082,000**	**$18,852,000**

a. Includes 30% allowance for contingencies.

b. Includes 25% allowance for engineering, administration, and legal costs.

Chapter 5 Long-Range Capital Improvement Program

The previous two chapters presented the recommended capacity assurance and sewer rehabilitation/replacement (R/R) programs for improvements to the wastewater collection system. These projects are focused on reducing the risk of sanitary sewer overflows (SSOs) due to structural failures in sewer pipelines or wet weather flows exceeding system capacity, and are targeted to meeting the SSO performance goals required by the City's Cease and Desist Order and Consent Decree.

This chapter summarizes the recommended Capital Improvement Program (CIP) including estimated costs, priorities, and schedule for near-term (10-year) and long-term (20-year) improvements. Guidelines for implementation of the CIP are also presented.

5.1 Recommended Capital Improvement Program

The recommended CIP includes 14 capacity improvement projects, including construction of the proposed Linda Mar flow equalization facility, as well as structural rehabilitation of sewers throughout the collection system. In addition to the flow equalization facility, three of the collection system capacity improvement projects are considered high priority, including the replacement of the existing 12-inch parallel sewer in Palmetto Avenue with a larger pipe; upsizing of the trunk sewer serving the Pedro Point area; and upsizing the 12- and 15-inch parallel trunk sewer in lower Linda Mar Boulevard. These projects would address areas that have experienced severe surcharging and historical overflows due to high wet weather flows and/or are in locations where overflows would have the greatest potential impact on the community or the environment. Other capacity improvement projects have been assigned lower priority because there have not been documented overflows at these locations and the potential impact of overflows is lower. The recommended capacity improvement CIP is shown in **Figure 5-1**.

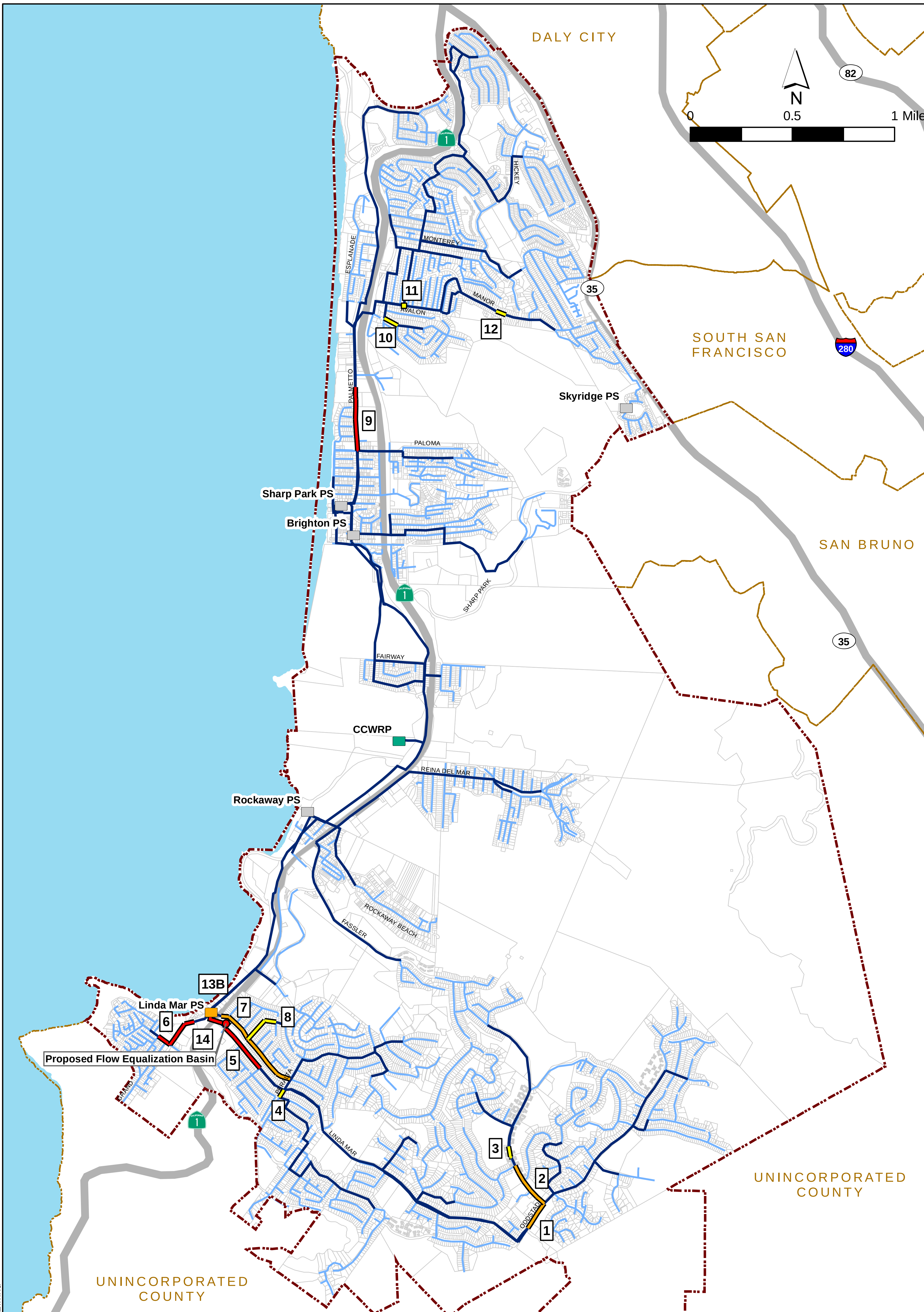
Sewer repairs and replacements to address major structural defects are considered the highest priority with respect to sewer rehabilitation because the present the greatest risk of structural failure, followed by projects to address large offset joints (which do not present a risk of structural failure but may impede inspection or cleaning equipment) and significant root intrusion. Root intrusion increases the risk of SSOs due to blockages, but can be controlled by effective maintenance (rodding and/or root foaming) in the interim period before the sewers are rehabilitated. The City has developed a root control plan as part of its overall maintenance program. **Figure 5-2** shows the sewers recommended for rehabilitation according to the reason for renewal (structural rehabilitation, large offset joints, significant root intrusion) based on based on the CCTV inspection conducted as of June 2011.

In addition to addressing the capital project needs identified in the capacity assurance and near-term sewer rehabilitation plans, the City intends to continue efforts for overall rehabilitation of the sewer system to reduce I/I, focusing on those areas identified as having the highest I/I contributions to the system. In implementing its structural rehabilitation program, the City may choose to conduct more extensive rehabilitation (e.g., manhole-to-manhole pipe replacement or lining rather than just localized point repairs of major defects, or including additional adjacent pipe segments in the rehabilitation work) to match these objectives and will prioritize its structural rehabilitation program accordingly. Therefore the R/R component of the recommended CIP is formulated as an annual budget allocation rather than a list of specific projects, to allow the City flexibility to tailor the program to meet both structural rehabilitation and long-term I/I reduction objectives.

Table 5-1 presents the recommended collection system CIP, including specific projects recommended for implementation during the first two years of the program (FY 2012 and FY 2013). Other projects have been assigned to CIP years 3 through 10 or 11 through 20 based on financial considerations and their relative priorities as discussed above. The City will update the long-range CIP in 2014 based on additional sewer inspections and development of a financial plan to be completed subsequent to this Master Plan report.

Table 5-1: Recommended Collection System Capital Improvement Program

Project ID	Project Description		Est. Capital Cost	Avg. Annual CIP Budget
Years 1-2				
14	Linda Mar Flow Equalization Basin Design	Site selection, geotechnical, hydraulic, environmental studies, permitting, pre-design and design	$ 2,000,000	
9	Palmetto Ave. from north of Shoreview Ave. to Paloma Ave.	Replace exist. 12" pipe with 18" at same depth/slope as exist. 18"	$ 571,000	
	Sewer Rehabilitation		$ 2,540,000	
	Subtotal - Years 1-2		**$ 5,100,000**	**$ 2,600,000**
Years 3-10				
14	Linda Mar Flow Equalization Basin Construction	Equalization basin, piping, return pump station	$18,050,000	
6	San Pedro Ave. from Livingston Ave. to Halling Way, Halling Way to Shoreside Dr.	Upsize existing pipes (6"-8" to 8"-12")	$ 251,000	
5	Linda Mar Blvd. upstream and downstream of De Solo Dr.	Upsize existing pipes (12"-15" to 15"-18")	$ 380,000	
13B	Linda Mar Pump Station	Add fourth pump	$ 935,000	
7	Arguello Blvd. from Peralta Rd. to Coast Hwy.	Upsize existing pipes (6"-12" to 8"-15")	$ 418,000	
	Sewer Rehabilitation		$10,160,000	
	Subtotal - Years 3-10		**$30,200,000**	**$ 3,800,000**
Years 11-20				
1	Oddstad Blvd. From Terra Nova Blvd. to Toledo Ct.	Upsize existing pipes (15" to 18")	$ 281,000	
2	Terra Nova Blvd. from Alicante Dr. to Oddstad Blvd.	Upsize existing pipes (12" to 15")	$ 248,000	
3	Terra Nova Blvd. between Lerida Way and Alicante Dr.	Upsize existing pipes (8" to 10")	$ 51,000	
4	Peralta Rd. from Montezuma Dr. to Linda Mar Blvd.	Upsize existing pipe (12" to 15")	$ 45,000	
8	De Solo Dr. from Fernandez Way to Arguello Blvd.	Upsize existing pipes (8" to 10")	$ 137,000	
10	Milagra D. from Bruce St. to Edgemar Ave.	Upsize existing pipe (6" to 8")	$ 48,000	
11	Avalon Rd. at Del Mar Ave.	Divert flow from 8" pipe to parallel 18"	$ 30,000	
12	Manor Dr. west of Monterey Rd.	Upsize existing pipe (6" to 8")	$ 34,000	
	Sewer Rehabilitation		$ 6,200,000	
	Additional Comprehensive Rehabilitation		$ 7,400,000	
	Subtotal - Years 11-20		**$14,500,000**	**$ 1,500,000**
TOTAL CIP			**$49,800,000**	**$ 2,500,000**



Relative Priority

- High
- Medium
- Low
- 1 Project ID

- Modeled Sewers
- Unmodeled Sewers
- Pacifica City Limits
- Other City Boundaries

City of Pacifica
Collection System Master Plan

Recommended Capacity Improvement CIP

Figure 5-1

RMC Water and Environment

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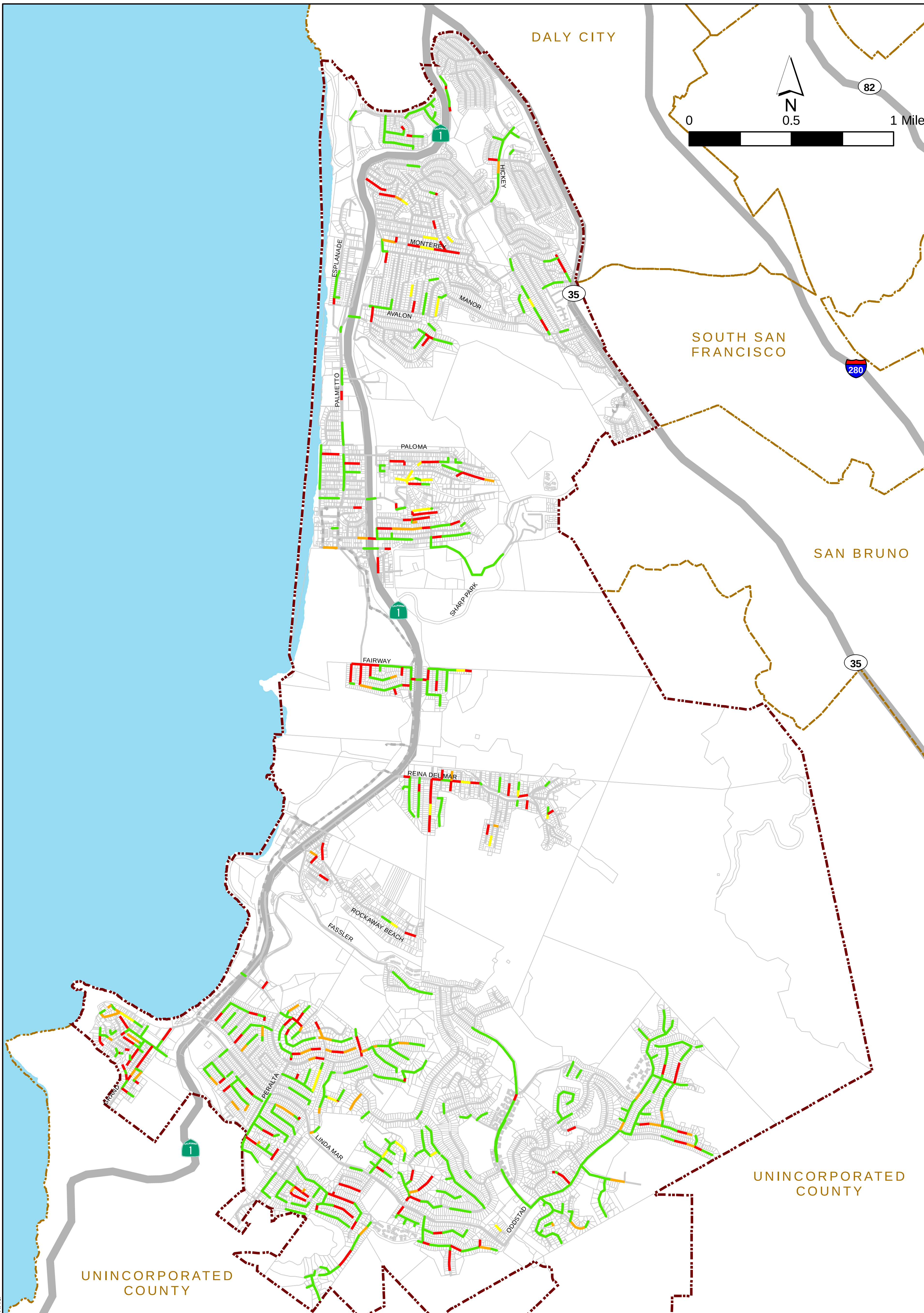

Relative Priority

- High (major structural defects)
- Medium (large offset joints)
- Low (significant root intrusion)
- No Rehab Needed

- Sewer Line (No CCTV Data)
- Force Main
- Pacifica City Limites
- Other City Boundaries

RMC Water and Environment

City of Pacifica
Collection System Master Plan

Recommended Sewer Rehabilitation (sewers inspected as of June 2011)

Figure 5-2

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5.2 Implementation Recommendations

The following paragraphs provide guidelines for implementing the CIP.

5.2.1 Flow Verification

While the model was calibrated as best possible based on available data, there are areas where there was no flow meter near enough to the project deficiency location to verify the need for a project or where the model results indicated capacity issues that have not been visually observed in the system. In these cases, it is recommended that additional investigation be conducted to further verify the flows and deficiency results for those projects. Verification could be conducted by temporary flow or surcharge monitoring, or by visual observation of flow levels during storm events.

5.2.2 Parallel vs. Replacement Pipes

The capacity improvement projects identified in the Master Plan have largely been based on replacement of deficient sewers with larger diameter pipes, primarily by pipe bursting. Capacity relief may also be provided by installation of a parallel sewer. The parallel sewer could be designed as an overflow relief pipe for wet weather flows only, thereby reducing the potential maintenance issues due to low dry weather flow velocities in a larger pipe. The decision to replace or parallel a deficient sewer should also consider the physical condition of the existing pipe and its predicted remaining useful life, the availability of pipeline corridors for new sewer construction, and operation and maintenance concerns. This decision should be coordinated with the City's on-going condition assessment program and process for identifying sewer rehabilitation or replacement needs.

5.2.3 Alternative Alignments

While efforts were made as part of the master planning work to identify potential constructability issues associated with proposed pipeline projects, some projects could be difficult to construct in existing or proposed alignments due to unknown utility conflicts, lack of available corridors for new pipelines, significant traffic or neighborhood disruption, or other factors. Therefore, evaluation of alternative alignments (e.g., construction in parallel streets) for some projects may be warranted.

5.2.4 Diversions

Several of the recommended capacity improvement projects consist of diversions of flow from a capacity-deficient sewer to an existing or new sewer with available capacity. Under dry weather conditions, however, this could result in very low flow velocities in the sewers downstream of the diversions, which could cause potential problems with sediment or grease deposition and odor. Therefore, before implementation, diversion projects should be evaluated to identify potential low velocity issues. Potential solutions might include channeling of the flow in the diversion manhole or constructing overflow weirs to allow dry weather flow to continue downstream in the original flow direction. In some cases, more frequent cleaning of the potential problem areas might be required.

5.2.5 Pre-Design Activities

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

5.2.6 Model and Master Plan Updates

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