MAIN REPORT

Storm Drain Master Plan

Michael Baker
INTERNATIONAL

This page intentionally left blank.

South San Francisco
Storm Drain Master Plan

San Mateo County, California

Prepared for:

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

Prepared by:

Michael Baker International
14725 Alton Parkway
Irvine, CA 92618

Contact Persons:

Rebecca Kinney, RCE 58797
Tim Muli, RCE 72992
Laura Larsen, RCE 63265
Steven Switzer, RCE 84399
Isamar Escobar, EIT

February 2016

This page intentionally left blank.

Table of Contents

Tables

Figures

Exhibits

Technical Appendices (Separate Document)

Abbreviations and Acronyms

1D	One-Dimensional
2D	Two-Dimensional
AMC	Antecedent Moisture Condition
As-builts	Improvement plans revised to reflect changes made during construction
BMP	Best Management Practice (Water Quality Treatment Facility)
CB	Catch Basin
CCTV	Closed-Circuit Television
cfs	Cubic Feet per Second
CWA	Clean Water Act
DBL	Double
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HGL	Hydraulic Grade Line
ID	Identification
LID	Low Impact Development
LiDAR	Light Detection and Ranging, a remote sensing technology used to measure distance by illuminating a target with a laser and analyzing the reflected light
MH	Manhole
N/A	Not Applicable
NAD	North American Datum
NC	Natural Channel
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
RCB	Reinforced Concrete Box
RCC	Rectangular Concrete Channel
RCP	Reinforced Concrete Pipe
RWQCB	Regional Water Quality Control Board
SDMP	Storm Drain Master Plan
SMCFCD	San Mateo County Flood Control District
SWMM	Storm Water Management Model
SWPPP	Storm Water Pollution Prevention Plan
Tc	Time of Concentration
TDA	Tributary Drainage Area
USACE	United States Army Corps of Engineers
WxH	“Width” by “Height”
XPSWMM	XP Solutions’ version of SWMM

Executive Summary

The City of South San Francisco Storm Drain Master Plan (SDMP) provides an analysis of existing storm drain facilities and trash capture opportunities within the jurisdiction of the City of South San Francisco (City). The SDMP divides the City into different drainage areas, named according to their locations and proximity to Colma Creek. The three drainage areas are the Northern Region, the Southern Region, and the Lower Region. Hydrology and hydraulic analyses were completed for each drainage area.

The goal of the SDMP is to provide comprehensive long-range planning for the implementation and development of drainage facility improvements, including storm drains and trash capture devices, determine the cost of implementing such facilities, discuss funding priorities, and provide an implementation schedule of the improvements within the City. Hydrology and hydraulic analyses for the storm drain facilities were modeled using the XP Solutions Stormwater Management Modeling (XPSWMM) program. XPSWMM provides a hydrodynamic modeling approach that facilitates the modeling process, and it is a tool the City could incorporate in future storm drain design projects. Initial setup of the model required research on all available as-built information of the City's entire storm drain system. ArcGIS was used to organize and compile all of the information needed to model each storm drain system, including but not limited to diameter, material, and invert elevations for each component of the City's storm drain system.

The hydrology and hydraulic analyses were completed for the 10- and 100-year storm events for storm drain sizing. A modified version of the Alameda County Hydrology Manual was used as the basis for the hydrology analysis. Each drainage area was divided into subwatersheds tributary to strategic storm drain structures. These structures were selected for modeling at key locations where storm water runoff is collected into the storm drain systems. A hydraulic analysis of the storm drain system was prepared using the results of the hydrology analysis. The results obtained from the hydraulic modeling were used to find deficiencies within the storm drain systems. Several options were run in the model to identify recommended improvements for the deficient systems. These proposed systems are described in Sections 4 through 6. This analysis is a preliminary assessment; therefore, it is recommended that as part of final design, a detailed engineering design study be prepared for each capital improvement project using the SDMP XPSWMM model as a basis.

The hydrology for the 1-year, 1-hour event was also calculated using XPSWMM for water quality evaluation of potential trash capture devices using the integrated Watershed Assessment Tool for Restoration (iWATR™). iWATR™ is a spreadsheet tool developed to identify, evaluate, and select appropriate Trash Capture Device retrofits for watershed restoration. Based on the iWATR™ evaluation, 15 regional trash capture devices were identified for implementation. The locations and descriptions of the devices are shown in Exhibits 11 through 16.

Estimated project costs were prepared for each recommended improvement. The cost per project included project construction, engineering design, and project administration costs. A prioritization scheme was prepared to rank each project then used to develop a recommended Capital Improvement Plan schedule. The recommended improvement projects for this SDMP were prioritized based on risk assessment criteria of 1, 2, or 3, in which Priority 1 areas have the highest risk for potential flood damage. Fifty systems are found to be Priority 1, 166 systems Priority 2, and 26 Systems Priority 3. Associated total project costs are approximately $23 million for Priority 1, $27 million for Priority 2, and $4 million for Priority 3. The total project cost for all recommended improvements is approximately $54 million.

This page intentionally left blank.

1 Introduction

1.1 Purpose

The City of South San Francisco Storm Drain Master Plan (SDMP) is a technical guidance document and long-range planning tool used by city planners, engineers, and developers (collectively referred to as “the City”). Its main goals are to help the City 1) identify and address deficiencies in the existing storm drain system; 2) propose drainage facility infrastructure improvements to meet flood protection standards identified for the City; and 3) integrate water quality treatment facilities into the plan to meet trash reduction requirements. To achieve these goals, a technical study of the City’s storm drain facilities was completed for the SDMP. The objectives of the technical study were as follows:

- Develop computerized hydrology and hydraulic models of the City’s stormwater system.
- Identify known and possible hydraulic deficiencies under present and future conditions.
- Develop proposed drainage facility infrastructure improvements to alleviate deficiencies.
- Review water quality requirements applicable to the City, including the *Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit*, Order No. R2-2009-0074, applicable TMDLs, and trash reduction provisions.
- Analyze the results of the model to determine non-flooded areas and, combined with historical rainfall data, determine optimal locations to install trash capture devices.
- Review existing trash capture devices available on the market and recommend the best device(s) to improve water quality.
- Prepare a list of projects and their estimated costs that could correct deficiencies in the existing system and provide adequate capacity for planned future development.
- Evaluate current maintenance activities and identify opportunities for improvement, including current and future training.
- Establish a Capital Improvement Plan consisting of a cost-effectiveness plan to prioritize the proposed infrastructure improvements and to determine the cost of implementing the facilities.

By applying the recommendations in this SDMP, the City can implement a long-range Capital Improvement Plan to improve the storm drain system’s capacity to meet flood protection standards and provide integrated water quality facilities to comply with current regulatory requirements.

The improvements identified in the SDMP are within the City boundaries. Areas outside the City boundaries that are tributary to City drainage facilities are identified and evaluated for deficiencies and recommended improvements, but further discussion with neighboring cities should be completed. Figure 1-1 shows the existing regional vicinity, and Figure 1-2 shows the local vicinity.

Michael Baker INTERNATIONAL

NORTH

0 10 20 miles
APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Regional Vicinity

Figure 1-1

SOURCE: Google Earth Pro Aerial, June 2015.

Michael Baker
INTERNATIONAL

NORTH
0 10 20 miles
APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Local Vicinity

Figure 1-2

1.2 Background

The City has a long history of flooding during moderate to severe storm events. In 1998, a 50-year flood event on Colma Creek caused significant property damage to nearby businesses. In December 2014, the City suffered major flooding due to high-intensity storm events. Many streets and neighborhoods were affected when sewage mixed with the storm water and broke through manhole covers. A combination of older storm drain systems, high tailwater conditions in Colma Creek and the backwater influenced by San Francisco Bay have caused local flooding issues at several locations within the City. This is the City's first official SDMP devoted to the management and improvement of its drainage system to address these flooding issues. Colma Creek Flood Control Zone was created in 1964 for constructing and maintaining approximately 4.8 miles of flood control channel that extends from San Francisco Bay to the City of Daly City. The system provides flood control protection for surrounding residents.

1.3 Existing Watershed Description

The City is part of the Colma Creek watershed, which is approximately 16 square miles. The watershed generally drains from west to east conveying surface runoff in underground storm drains, street surfaces, gutters, and improved creek channels to eventually discharge into San Francisco Bay. For this study, the tributary watershed is divided into three main regions: the Northern Region, the Southern Region, and the Lower Region. The Northern and Southern Regions consist of relatively steep sloped urban and residential areas located within and along the bottom of the surrounding foothills. The Lower Region is relatively flat and is largely comprised of industrial development areas. Figure 1-3 illustrates the three regions.

Each of the three regions is further divided into subwatersheds A through L as shown in Table 1-1. Figure 1-4 shows the locations of the subwatersheds for the City. Much of the drainage in the steep areas consists of street flow that terminates at low points or sump catch basins. As a result, these sump areas are prime locations experiencing flooding during larger rain events.

Table 1-1: Regions and Corresponding Subwatersheds

Region	Subwatersheds
Northern	B through D
Southern	E through G
Lower	A, and H through L

1.4 Facility Inventory Background

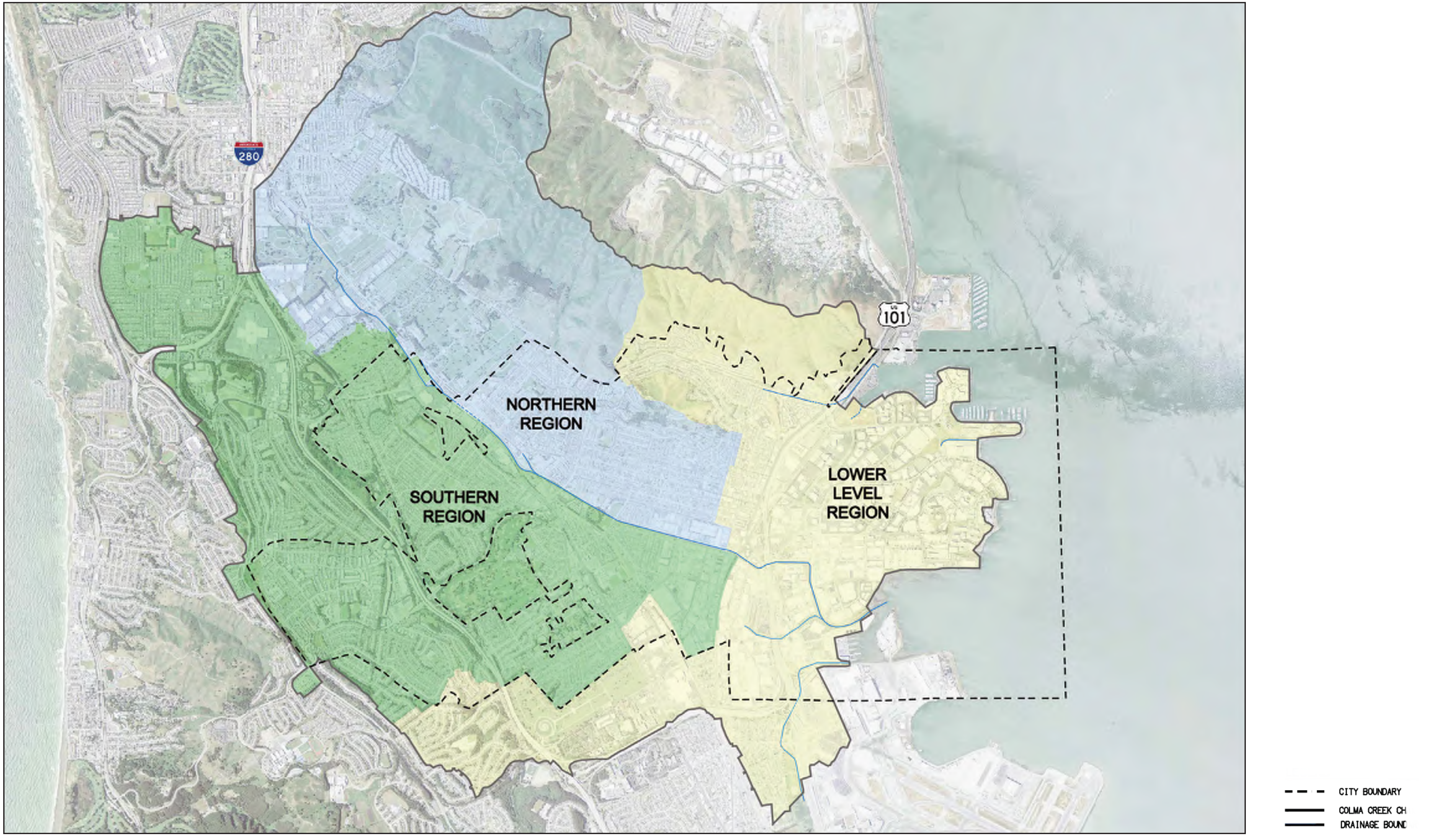
The Facility Inventory included collecting available as-built drawings, index map data, Geographic Information System (GIS) data, and reports. The data was reviewed and compiled to map the City's existing storm drain system and identify where information "gaps" exist. Current as-built inventory covers approximately 60 percent of the existing citywide drainage system.

In some cases, these facilities are inaccessible, requiring engineering judgment to estimate approximate existing facility sizes, depths, and slopes. In most cases, upstream and downstream as-built plans were used to make determinations. If insufficient data existed, conduit slopes were estimated based on existing ground surface gradients.

The current City drainage Index Map, last revised January 1997, contains a summary of known storm drains within the City. Relative slope information was used from this map to identify drainage conduit slopes. Elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). The North American Datum of 1983 (NAD83) was used as the horizontal datum for the project's geographic location on the Earth. Figure 1-5 shows the locations of the existing facilities modeled in the XP Solutions Storm Water Management Model (XPSWMM) program.

Once the database was complete, the information was uploaded to GIS. The GIS database was used to help establish hydrologic drainage boundaries and to compile input data for hydraulic modeling of the existing storm drain capacities. Table 1-2 shows the sources of data used to complete the hydrology and hydraulic modeling.

This page intentionally left blank.



Michael Baker INTERNATIONAL

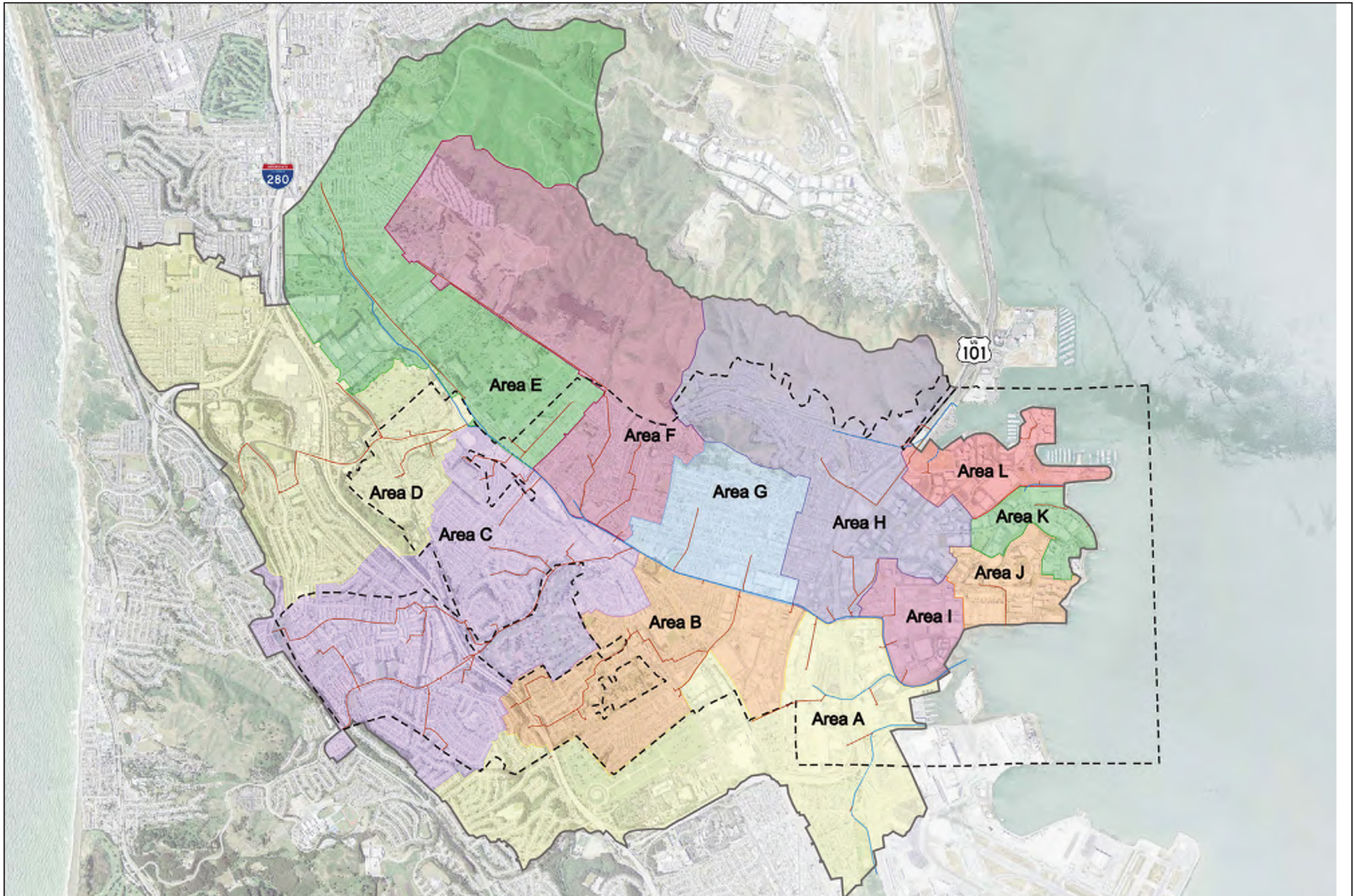
NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Regional Watershed Map

Figure 1-3



Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

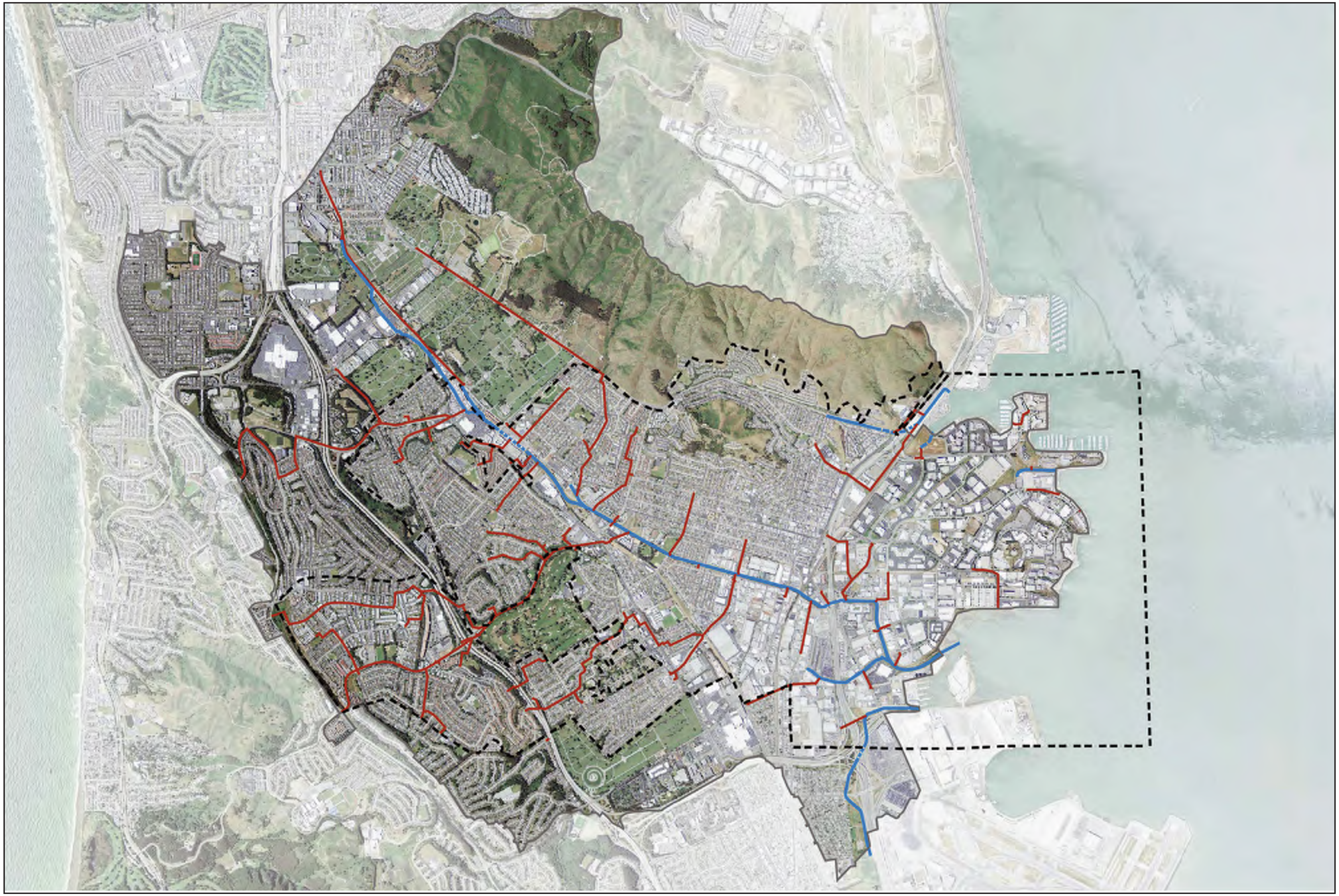
Local Watershed Map

Figure 1-4

Table 1-2: Hydrology Background Information

Base Data	Source	Model Use
Topography	2010 Golden Gate LiDAR	Primarily used for elevations and slopes used in the XPSWMM models. Together with the as-built plans/index map, it provided the general slope of the area, and it was used to determine tributary areas.
As-builts	City as-builts and index Map for storm drains and streets	Used primarily for elevations and slopes of streets and storm drains hydraulics and in hydrology to determine tributary areas.
Hydrologic soil types	Natural Resources Conservation Service – Soils Data	Used in the preparation of the hydrology analysis. The predominant soil type in the City is Type "D."
Land use data	San Mateo County	Used as the basis for the land use determination. The data was then further refined with the aerial photography. The study area consists mainly of Commercial/Industrial and Residential land uses.
Aerial photography	Eagle Earth Imagery 2012	Used to further refine the City's Land Use Data into land use types in accordance with the Alameda County Hydrology Manual.

This page intentionally left blank.



Michael Baker INTERNATIONAL

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Existing Facilities Map

Figure 1-5

This page intentionally left blank.

2 Water Quality Considerations

The SDMP was developed to integrate water quality features into the City's storm drain infrastructure. This SDMP recommends potential applications for redevelopment and retrofitting of existing drainage facilities to accommodate treatment of stormwater runoff. Trash is a high priority pollutant of concern in stormwater runoff for the City, and water quality considerations in this SDMP focus on treatment for this pollutant using trash capture devices. To provide a perspective and understanding of why treatment is included as an integral part of this SDMP, the remainder of this section discusses the background of stormwater management regulations at the federal, state, and municipal levels.

2.1 Regulatory Setting

2.1.1 Federal Laws and Requirements

2.1.1.1 Clean Water Act

In 1972, Congress amended the Federal Water Pollution Control Act, making the addition of pollutants to the waters of the United States (U.S.) from any point source unlawful unless the discharge complies with a National Pollutant Discharge Elimination System (NPDES) permit. Known today as the Clean Water Act (CWA), Congress has amended it several times. In the 1987 amendments, Congress directed dischargers of stormwater from municipal and industrial/construction point sources to comply with the NPDES permit scheme. Important CWA sections are described as follows:

- Sections 303 and 304 require states to promulgate water quality standards, criteria, and guidelines.
- Section 401 requires an applicant to obtain a federal license or permit to conduct any activity, which may result in a discharge to waters of the U.S., to obtain certification from the State that the discharge will comply with other provisions of the act. (This is most frequently required in tandem with a Section 404 permit request).
- Section 402 establishes the NPDES, a permitting system for the discharges (except for dredge or fill material) of any pollutant into waters of the U.S. Regional Water Quality Control Boards (RWQCBs) administer this permitting program in California. Section 402(p) requires permits for discharges of stormwater from industrial/construction and municipal separate storm sewer systems (MS4s).
- Section 404 establishes a permit program for the discharge of dredge or fill material into waters of the U.S. This permit program is administered by the U.S. Army Corps of Engineers (USACE).

2.1.2 State Laws and Requirements

2.1.2.1 Porter-Cologne Water Quality Control Act

The California Porter-Cologne Act, enacted in 1969, provides the legal basis for water quality regulation within California. This Act requires a "Report of Waste Discharge" for any discharge of waste (liquid, solid, or gaseous) to land or surface waters that may impair beneficial uses for surface and/or groundwater of the State. It predates the CWA and regulates discharges to waters of the State. Waters of the State include more than waters of the U.S., such as groundwater and surface waters, which are not considered waters of the U.S. Additionally, it prohibits discharges of "waste" as defined, and this definition is broader than the CWA definition of "pollutant." Discharges under the Porter-Cologne Act are permitted by Waste

Discharge Requirements (WDRs) and may be required even when the discharge is already permitted or exempt under the CWA.

The State Water Resources Control Board (SWRCB) and RWQCBs are responsible for establishing the water quality standards (objectives and beneficial uses) required by the CWA, and regulating discharges to ensure compliance with the water quality standards. Details regarding water quality standards in a project area are contained in the applicable RWQCB Basin Plan. In California, the RWQCBs designate beneficial uses for all water body segments in their jurisdictions, and then set criteria necessary to protect these uses. Consequently, the water quality standards developed for particular water segments are based on the designated use, and they may vary depending on such use.

2.1.2.2 State Water Resources Control Board and Regional Water Quality Control Boards

The SWRCB adjudicates water rights, sets water pollution control policy, and issues water board orders on matters of statewide application, and oversees water quality functions throughout the state by approving Basin Plans, TMDLs, and NPDES permits. RWQCBs are responsible for protecting beneficial uses of water resources within their regional jurisdiction using planning, permitting, and enforcement authorities to meet this responsibility.

2.1.2.3 Statewide Trash Policy

On April 7, 2015, the SWRCB adopted an amendment to the Water Quality Control Plan for the Ocean Waters of California (California Ocean Plan) to Control Trash and Part 1 Trash Provisions of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (collectively referred to as the “Trash Amendments”). These Trash Amendments address all water bodies in the state currently listed as “impaired” due to the presence of trash.

A central element of the Trash Amendments is a land-use based compliance approach that targets high trash generating areas, such as high density residential, industrial, commercial, mixed urban, and public transportation land uses. The permitted agency or entity can choose two alternative compliance tracks. Under Track 1, permittees could elect to install a network of systems to capture trash in the storm drains, located in priority land use areas for municipal systems, and the entire facility for industrial and commercial permit holders. Under Track 2, permittees could use any combination of controls (structural and/or institutional) anywhere in their jurisdiction as long as they can demonstrate that their system performs as well as Track 1. This demonstration is called full capture system equivalency.

2.1.3 Regional and Local Requirements

2.1.3.1 MRP NPDES permit (Section C.10)

On October 14, 2009, the San Francisco Bay Regional Water Quality Control Board adopted the *Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit*, Order No. R2-2009-0074, NPDES Permit No. CAS612008 (amended by Order No. R2-2011-0083 on November 28, 2011) (“Permit”). Within this permit, the City is listed as a permittee and is therefore bound by its requirements and mandates, specifically, section C.10 Trash Load Reduction.

A summary of these requirements include:

- A Short-Term Trash Load Reduction Plan: 40% reduction by 2014 (developed January 24, 2012) (C.10.a(i), C.10.a(ii))
- A Long-Term Trash Load Reduction Plan: 70% by 2017, 100% by 2022 (developed January 31, 2014) (C.10.c)

Attachment J of NPDES R2-2009-0074 requires all permittees to have a Minimum Trash Capture Catchment Area equal to 30% of the total Retail/Wholesale Commercial area. Per Attachment J, the Minimum Trash Capture Catchment Area of the City is equal to 58 acres.

2.1.3.2 TMDLs and 303(d) Listed Waterbodies

In addition to establishing water quality standards required by the CWA, the SWRCB identifies waters failing to meet standards for specific pollutants, which are state-listed in accordance with CWA Section 303(d). If a state determines that waters are impaired for one or more constituents, and the standards cannot be met through point source or non-source point controls (NPDES permits or Waste Discharge Requirements), the CWA requires the establishment of Total Maximum Daily Loads (TMDLs). TMDLs specify allowable pollutant loads from all sources (point, non-point, and natural) for a given watershed.

Although the primary water quality considerations discussed in this SDMP apply to compliance with the San Francisco Regional Municipal Permit, TMDLs are a growing concern for certain water bodies within the City. For example, the City's predominant drainage area drains to Colma Creek, which flows to Lower San Francisco Bay. Both of these water bodies are 303(d) listed. A Trash TMDL for Colma Creek is expected to be completed in 2021. Sources of Trash to Colma Creek are currently unknown. Lower San Francisco Bay is similarly listed for Trash and has an expected completion date of 2021. Sources of Trash in Lower San Francisco Bay are also unknown. Additional TMDLs for Lower San Francisco Bay that have been developed or are in development include Chlordane (2013), DDT (2013), Dieldrin (2013), Dioxin Compounds (including 2,3, 7, 8-TCDD) (2019), Furan Compounds (2019), Invasive Species (2019), Mercury (2008), PCBs (Polychlorinated biphenyls) (2008), PCBs (Polychlorinated biphenyls) (dioxin-like) (2008).

2.1.4 <u>Water Quality Treatment Strategies</u>

To treat stormwater discharges to impaired water bodies in the region, low impact development (LID) strategies are encouraged in the Permit. The idea of disconnecting impervious surfaces leads to "first flush" or small storm partial infiltration. This could be beneficial for new development or redevelopment with respect to slowing the local drainage "Time of Concentration" to produce lower peak flows during small storm events. For (generally over 2-year) large storm events, these "impervious" areas or water quality features are already at capacity and unable to accept any additional flows.

Water quality LID facilities are designed to treat the "first flush," or the smaller, more frequent rainfall events. However, water quality facilities are not capable of treating or handing large flow events. Some volume based best management practices (BMPs) are capable of treating larger areas, such as extended detention basins, retention basins, or large wetlands. Yet even these facilities cannot treat larger storm events. Combined flood control detention basins can be designed to treat water quality as well, but the treatment mechanism in the water quality portion of the basins will only treat the "first flush" storm events.

A comprehensive study of the City's drainage areas has been performed to identify potential areas for post construction BMPs facilities. To maximize the facility benefits, large open space areas (for facility footprint) with a sizable drainage tributary area were evaluated first. In some cases, smaller areas were also considered based on land use and potential to treat large paved or impervious areas.

This page intentionally left blank.

3 Technical Criteria

3.1 Modeling Process

The SDMP model was prepared using XPSWMM (XP Solutions' Storm Water Management Model), a software package approved by the City. XPSWMM is an improved version of the United States Environmental Protection Agency (EPA) SWMM. It is a hydrologic and hydraulic modeling tool used to develop comprehensive storm, sewer, and flood scenarios. The use of this model provided a holistic approach to analyzing the storm drain system of the City. Both the hydrology and hydraulic analyses were prepared within the same model. The data input for XPSWMM was imported from ArcGIS, a tool used to create, compile, and analyze data using various types of geographic information.

The modeling process approach used for this SDMP consists of the following steps:

1. The City's existing storm drain database was obtained. The database included location, material, size, invert (downstream and upstream) elevations, and length of the pipes; and location, type and invert elevations of the structures.
2. The existing storm drain database was reviewed and organized into useful information for hydrology and hydraulic analysis.
3. Each drainage area was divided into subwatersheds to determine the tributary area contributing flow to a node (storm drain inlet or subwatershed outlet).
4. Unique IDs corresponding to subwatershed names and numbers were assigned to each storm drain pipe and structure.
5. The overland flow path and the conveyance flow path were delineated for each subwatershed.
6. Data such as land use and soil type were imported into ArcGIS for each subwatershed.
7. Unique sources of data from each subwatershed were overlayed geographically to create a hybrid layer combining all the required parameters (soil type, runoff coefficient, tributary area, total flow path length, overland velocity, and slope).
8. The ArcGIS data was imported into XPSWMM in the following sequence:
    a. Storm drain structures
    b. Storm drain pipes
    c. Open channels
    d. Subwatershed parameters (soil type, runoff coefficient, tributary area, flow path length, overland velocity, and slope
9. Hydrology and hydraulics calculations were performed using XPSWMM.
10. Results included:
    a. Peak flow rate and runoff hydrograph for each subwatershed
    b. Velocity and hydraulic grade line (HGL) for each storm drain pipe

Hydrology and hydraulic modeling guidelines and procedures are discussed in the following sections.

3.2 Hydrology Methodology

The hydrology analysis was prepared for the 10- and 100-year design events. Currently, San Mateo County does not have a specific methodology for the development of hydrology. Multiple methods were reviewed for this SDMP, and the Alameda County Hydrology Method was selected, due to its close proximity to the City and similar precipitation characteristics. Slight modifications were made to the Alameda method regarding time of concentration (see Section 3.2.2) to accurately model the City's hydrologic patters in XPSWMM.

The point precipitation data for both the City and cities within San Mateo County were evaluated and compared. A review of the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 point precipitation data showed very similar totals for all the adjacent cities in San Mateo and Alameda Counties. This is an indication that the rainfall amounts and pattern are essentially the same. Refer to Appendix A-2: Precipitation Data Comparison for a comparison of the precipitation data for the City and the neighboring City of San Leandro within Alameda County.

The City was delineated into twelve major subwatersheds based on the topographic relief and existing regional facility tributary areas. Each subwatershed was further delineated into drainage areas consisting of storm drain lines or street flow areas for hydrologic calculations. Exhibit 2 shows the twelve subwatersheds and areas tributary to the City. Some of the area tributary to these drainage areas originates outside the City boundary.

The results of the hydrology analyses were used to estimate existing drainage facility capacities and proposed conduit sizes.

3.2.1 Hydrology Criteria for Street Capacity Calculations

San Mateo County's hydrology guidelines require the calculation of pre- and post-project velocities and peak flow rates. Typically, peak velocities are only pertinent to street flow and channel flows.

For new development, the City's "Standard Development Conditions" require the following:

- Minor storm drain laterals shall be designed to accommodate the 10-year storm.
- Major storm drain mains, or trunks, and pipes draining sumps shall be designed to accommodate a 100-year storm, without flooding.
- Initial Time-of-Concentration shall be 5-minutes (minimum).
- Minimum size storm drain = 12-inch pipe diameter (or equivalent);
- Pipes shall be designed to allow for surcharged conditions (systems operating under pressure), such that flooding remains at the levels outlined in Table 3-1.

The surcharged pipe criteria were added to ensure a cost-effective approach to solving surface flood conditions. Allowing the pipes to surcharge can minimize the cost of implementing large facilities.

It is important to identify a level of acceptable flooding. Increasing the level of protection is directly related to the proposed facilities costs. The goal of this SDMP is to identify the most feasible drainage solutions within the City, even if some local flooding is allowed to occur.

Based on the City's current standards for new development, the County's standards, and adjacent City standards, a few recommendations are given as a guideline. In some particular cases, these guidelines may be altered due to specific location requirements with the approval of the City. Table 3-1 summarizes the street design protection levels and guidelines.

Table 3-1: Design Protection Levels for Streets

Type of Street	Storm Frequency	Maximum Allowable Flooding
Local	10-year	1 Dry Lane (12' Total)
	100-year	Right-of-Way
Arterial Highway	10-year	1 Dry Lane (12' Total)
	10-year Sump Condition	2 Dry Lanes (12' in each direction)
	100-year	At Lowest Point in Adjacent Pad Elevation

3.2.2 Time of Concentration

The time of concentration (Tc) is the time required for the runoff from the most remote region of the watershed to reach the point of concentration at which the flow is calculated. It is composed of the initial time of concentration and the downstream conduit travel time.

The Alameda method in XPSWMM calculates the Tc using the following formula:

$$Tc = L/60V$$

Where

Tc = Time of Concentration in minutes

L = Flow Path Length

V = Overland flow velocity in feet per second

Source: Attachment 3 of the Alameda County Hydrology Manual

The Alameda County Hydrology Method has two criteria for the calculation of initial Tc – undeveloped and urbanized watersheds. For this study, the Alameda Method was modified such that each criteria was further broken by slope. The undeveloped watersheds, also referred to as rural/low-density areas, were separated into two groups – slopes less than 1% and slopes greater than or equal to 1%. For these rural areas, the overland lengths were determined by using the above equation with a Tc of five minutes and the velocity extrapolated from Attachment 3 in the Alameda County Hydrology Manual in Appendix A-1. These parameters are illustrated in Table 3-2.

Table 3-2: Tc Parameters for Rural/Low-Density Areas

Slope	Less than 1%	Greater than or equal to 1%
Overland Length	400 ft.	1000 ft.
Velocity (ft./s)	Determined using Attachment 3 in Alameda County Hydrology Manual	Determined using Attachment 3 in Alameda County Hydrology Manual

For urban areas also referred to as high-density urbanized areas, the initial Tc is defined as the time it takes flows to get from rooftop to curb (“roof to gutter”) for the first subarea in the watershed. Since the City is comprised of areas of varying slope steepness, the Alameda method was modified such that multiple definitions of initial Tc were developed. Areas with steep topography contain faster Tc, whereas areas of flatter topography contain slower Tc. This difference greatly affects the overall watershed’s calculated peak flow rate. As a result, Initial Tc calculations had to be divided into categories dependent on slope.

To more accurately calculate the Tc for urbanized drainage areas with various slopes, terrain, and overland lengths, the parameters in Table 3-2 were used to determine initial Tc.

Table 3-3: Tc Parameters for High-Density Urbanized Areas

Slope	Less than 1%	Between 1% and 5%	Greater than or equal to 5%
Overland Length (ft.)	Roof to Gutter	Roof to Gutter	Roof to Gutter
Initial Tc	5 minutes	3 minutes	1 minute
Velocity (ft./s)	$\mathrm{V} = \frac{\text{Overland Velocity}}{\text{Initial } Tc * 60}$	$\mathrm{V} = \frac{\text{Overland Velocity}}{\text{Initial } Tc * 60}$	$\mathrm{V} = \frac{\text{Overland Velocity}}{\text{Initial } Tc * 60}$

3.2.3 Precipitation

The mean annual precipitation (MAP) of the drainage areas was determined using NOAA Atlas 14 precipitation data. The data in Table 3-4 was input as a global control in XPSWMM, and the model computes the rainfall intensity using the Alameda method. The hydrology models were performed using the 24-hour duration, 10- and 100-year storm event precipitation values.

Table 3-4: Rainfall Intensity

Recurrence Interval (Years)	Frequency Factor
2	0.3471
5	0.719
10	1.339
15	1.684
25	2.108
50	2.660
100	3.211

3.2.4 Land Use

The Land-Use data was acquired from the Alameda County GIS database and hydrology manual descriptions. This data was cross-referenced with the aerial photograph and used to establish the land-use information for the hydrology analyses. Table 3-5 shows the Land Use descriptions.

Table 3-5: Land Use Summary

Land Use Descriptions	Percent Impervious	Runoff Coefficient			
		A	B	C	D
Undeveloped land, Parks Golf Course	0%	0.15	0.20	0.25	0.30
Older Residential 1/8 acres	24%	0.33	0.37	0.41	0.44
1980 and Newer Residential 1/8 acres	50%	0.53	0.55	0.58	0.60
Older Residential 1/4 acres	22%	0.32	0.35	0.39	0.43
1980 and Newer Residential 1/4 acres	40%	0.45	0.48	0.51	0.54
Residential Zero Lot Line 3600 SF lots	75%	0.71	0.73	0.74	0.75

Land Use Descriptions	Percent Impervious	Runoff Coefficient			
		A	B	C	D
Residential Duets 4500 SF lots	69%	0.67	0.68	0.70	0.71
Commercial/Industrial	85%	0.79	0.80	0.80	0.81
Townhouses	68%	0.66	0.68	0.69	0.71
Apartment	89%	0.82	0.82	0.83	0.83

3.2.5 Soil Types

The soil data was acquired from the San Mateo County GIS database. The soil types within the City consisted predominately Type "D." Group D soils have the highest runoff potential and very low infiltration rates when thoroughly wetted.

3.2.6 Watershed Descriptions

The City was divided into three Regional Watersheds: the Northern Region, the Southern Region, and the Lower Region, based on their proximity to Colma Creek. These regions are comprised of twelve subwatersheds that are tributary to Colma Creek Channel and San Francisco Bay. Exhibits 1 through 10 show the existing condition hydrology maps of each of the subwatersheds, A-L. The hydrology maps for each subwatershed include drainage area boundaries, flow paths, existing facilities, and concentration points.

Colma Creek flows approximately eight miles from its headwaters in the San Bruno Mountain State and County Park and discharges at San Francisco Bay. Colma Creek, Twelve Mile Creek, and their tributaries make up the Colma Creek watershed in San Mateo County. Drainage areas outside the City were incorporated into the model due to their impact on drainage systems within the City. The City boundary (as seen in Figure 1-5 and the improvement maps in Sections 4-6) was used to define the improvements necessary for the City. Any improvements outside the City boundary should be discussed with neighboring cities. The watershed runoff is conveyed in underground storm drains or improved channels. Land use near Colma Creek is largely comprised of urban, industrial, and residential development.

The area east of the 101 Freeway is mostly within the "Lower Region" and consists of primarily industrial areas that are susceptible to flooding. Many of the known flooded areas are within this region and have been identified as Priority 1.

3.3 Hydraulic Analyses

3.3.1 Existing Conditions

A hydraulic analysis of the existing storm drain system was prepared using the results of the hydrology analysis. The existing condition hydraulic analysis was prepared to identify the deficient storm drain systems. The analysis was prepared using the XPSWMM program for the entire drainage system. XPSWMM used the results of the rational formula hydrology at each of the inlet nodes (catch basin, manhole, or junction structure) to calculate the hydraulic grade line (HGL) for each storm drain pipe and each open/closed channel. Identified street capacities were fully evaluated by using multi-links within XPSWMM. This tool creates a link that joins multiple catch basins in a drainage network for both subsurface pipes and surface streets. These links allow the runoff to overflow into multiple systems, whether through conduits or street sections. The results provided maximum flow, maximum velocity and

HGL profiles for each storm event and each storm drain. The results were analyzed for system deficiencies, and the storm drain capacity for the deficient systems was estimated.

Detailed flood studies were performed for certain areas identified by the City as "Extreme Flooding Hazards." For these areas, calculations were performed beyond the level typically used in master planning. The areas of concern to the City include:

- Valverde Drive: This area corresponds to Subwatershed B, Areas B5, B6, and B11 (shown in Exhibit 2) and is prone to high levels of flooding. Water is known to flow out of the catch basin and into residents' backyards. The City investigated this local system with closed-circuit television (CCTV) to see whether the system may have collapsed or if debris was present inside the pipes. The investigation revealed no major collapse, but identified that the system had sediment residue [or residual sediment] along the invert of the pipes. In some cases, the sediment was 2 to 3 inches deep. In addition, it was found that one segment of pipe was smaller than originally expected. A full XPSWMM run was performed for this site, including a more detailed hydrologic analysis. The proposed solution for this site was the addition of a second, adjacent pipe. Refer to Section 4 for the proposed improvements.
- Francisco Terrace: This area corresponding to Subwatershed B, Areas B36 and B37, (shown in Exhibit 2), which suffered extensive flooding and damage to multiple homes during the most recent major storm in December 2014. The existing storm drain runs between two houses and connects with a storm drain along Spruce Avenue, a large facility that drains approximately 170 acres (tributary to the confluence point at Francisco Terrace). The entire system was evaluated in XPSWMM and identified as a deficient system. Therefore, improvements for a majority of the system have been recommended to alleviate the flooding at Francisco Terrace and Valverde Drive. See Section 4 for the recommended improvements.

Refer to Appendix B for a detailed summary of each of these sites.

3.3.2 <u>Tidal Conditions</u>

One of the greatest concerns to the Bay is the impact of increasing sea levels. For this study, to analyze the effects of rising sea levels, the current mean sea level (MSL), combined with the 100-year storm event, was used as the downstream control of the system. An MSL of 0.2 feet (NGVD29) was identified according to similar studies completed in neighboring cities, such as Brisbane.

Projected sea level rise will worsen existing known hazards by increasing the frequency of flooding, extending coastal flood hazard zones further inland, and accelerating shoreline erosion. To simulate the effects of future rising sea levels on the existing drainage systems, particularly those in the Lower Region and adjacent drainage areas in the Southern Region, the existing condition model was run with the combined 100-year storm event and the projected MSL in 2050. The projected MSL according to NOAA studies completed in San Francisco is approximately 1.5 feet. This projected increase will affect the current infrastructure and further inundate existing deficient storm drains.

3.3.3 <u>Typical Assumptions</u>

The following assumptions were used for the existing condition hydraulic models:

- For storm drain systems in which pipe diameters were known, but invert elevations were missing, a 1-foot minimum cover was assumed to the top of the pipe.
- For storm drain systems in which pipe diameters were unknown, a 36-inch maximum storm drain size was assumed. If the pipe was connected to a system with known data, the diameter was assumed the same size as the (up or downstream) known system.

- For cases in which the adjacent upstream and downstream storm drain pipe invert elevations were known, the slope was calculated and used for the portion of the storm drain system where data was unavailable.
- For the sections of the channel that were unknown, a typical trapezoidal section was used. Typical cross sections were estimated using topography and measuring the channel bottom width and side slopes at different locations along the channel. If the section of channel was connected to a channel section with known data, the channel was assumed to be the same size and have the same slope as the (up or downstream) known system.
- For street conveyance, a natural cross section was used with an adjusted Manning's coefficient. The width was the width of the street with a top of crown to gutter slope dependent on the width, but on average, it was 2%. The depth of the street was either 6 inches or 8 inches, depending on the type of street. Local streets and a few arterial streets have a curb height of 6 inches, and major arterial streets have a curb height of 8 inches.

3.3.4 Deficiency Identification

The purpose of preparing XPSWMM models for the existing condition (drainage system) was to determine existing system deficiencies and identify areas for recommended improvements. The XPSWMM results identified the magnitude of overflow and locations of flooded storm drain structures. This information was used to map existing flooded storm drain structures for each drainage area. Then for each flooded storm drain structure, the downstream storm drain system and overflow section was located. The system was considered deficient if, after completing the downstream capacity analysis (Section 3.3.4), the upstream storm drain structure was still flooded.

3.3.5 Street Capacity Analysis

The street capacity analysis was completed for street segments with storm drain structures flooded in the existing condition and for their ability to convey runoff from one catch basin to another. This analysis was completed using the following procedure in XPSWMM:

1. The street section was added as a multilink to the existing storm drain pipe.
2. The street cross section was determined by measuring the street width and using either a 6-inch or an 8-inch curb with or without a crown, depending on the case.
3. The model was run and the results were analyzed to determine whether the storm drain structure flooded.
4. If the storm drain structure did not flood, the system was considered appropriate. Otherwise, a deficiency removal analysis of the storm drain pipe was completed.

3.3.6 Deficiency Removal and Recommended Improvements

The deficiency removal and recommended improvements analysis was prepared using the criteria and assumptions from previous sections for deficient systems. This analysis is a preliminary design study, and each recommended improvement project will require a detailed engineering design study for the final design of the recommended projects. The improvements to the existing storm drain system included:

a. Upsizing storm drain facilities;
b. Adjusting invert elevations to increase the slope of pipe segments and the hydraulic conveyance capacity; or
c. In one instance, inserting a pump station to drain the ponded area.

When the ideal storm drain pipe size was larger than the downstream pipe size in areas with very steep terrain, the pipe size was increased for only the deficient portion of the storm drain. Otherwise, the downstream system size was also increased, until a larger pipe size was joined, or the system reached the outlet structure.

3.4 Facility Priority Evaluations

A priority ranking system was developed to determine the projects of greatest importance. A process was prepared to determine which projects should be constructed first when funding becomes available. The three priorities are summarized as follows:

- **Priority 1 (*highest priority*)**
  - *Local Streets* – Existing streets and storm drain systems where flood depth is above the right-of-way in the 10-year storm event.
  - *Arterial Streets* – Existing streets and storm drain systems where flood depth is above the right-of-way in the 10-year storm event.
  - *Regional Facilities* – Existing storm drain systems that do not achieve 10-year flood protection AND overflows affect multiple adjacent local facilities.
  - *Known Flooded Areas* – Areas that continually flood and cause damage and/or pose a threat to safety.
- **Priority 2**
  - *Local Streets* – Existing streets and storm drain systems where flood depth is above top of the curb in 10-year storm event and above the right-of-way (ROW) for 100-year storm event.
  - *Arterial Streets* – Existing streets and storm drain systems where flood depth is above top of curb in the 10-year storm event and above the ROW for 100-year storm event.
  - *Regional Facilities* – Existing storm drain systems that do not achieve 10-year flood protection.
- **Priority 3**
  - *Arterial Streets* – Existing streets and storm drain systems where flooded width is at top of curb in the 10-year storm event and above the ROW for 100-year storm event.
  - *Regional Facilities* – Existing storm drain systems that do not achieve 100-year flood protection.

3.5 Cost Estimates

Construction costs and total project costs were estimated for each project identified and are included for each drainage area. The total project costs were calculated by estimating the project construction costs, and soft costs including engineering, project administration, and construction management and inspection. The estimation was completed for each system and compiled separately for each drainage area.

Construction cost data was identified for a range of storm drain pipes and reinforced concrete box (RCB) culverts. The costs are based on construction projects in the area and on previous master plan studies prepared by Michael Baker near San Francisco and throughout California. All costs are in 2015 dollars. Storm drain unit costs are per linear foot and include costs for excavation, shoring, bedding, backfill, compaction, removal of excess material, and trench surfacing. Costs for the RCB culverts are per volume of concrete, and the sizes of the culverts are based on Caltrans standard plans. Table 3-6 shows the unit prices used to estimate the cost of improvements.

Table 3-6: Pipe and RCB Unit Prices

Proposed Pipe Size	Unit	Unit Price
18-inch	LF	$160
24-inch	LF	$190
30-inch	LF	$210
33-inch	LF	$250
36-inch	LF	$290
42-inch	LF	$320
48-inch	LF	$330
54-inch	LF	$350
60-inch	LF	$400
66-inch	LF	$430
72-inch	LF	$470
78-inch	LF	$520
84-inch	LF	$560
90-inch	LF	$590
96-inch	LF	$615
RCB	CY of Concrete	$750

Adjustments were made to each unit price to account for construction and soft cost factors. Construction factors include mobilization and bonding; traffic control; miscellaneous items such as catch basins, manholes, and outlets; and a contingency factor. The contingency factor is an allowance for unexpected costs occurring during design and construction. Soft cost factors represent the professional services provided to complete the project. This includes project administration such as city staff; engineering including surveying and geotechnical; and construction management and inspection.

A list of these factors and their estimated cost based on a percentage of the unit prices are shown in Table 3-7. The adjusted unit prices, reflecting these costs are shown in Table 3-8.

Table 3-7: Cost Adjustment Estimates

Adjustment	Factor	Estimate	Approximate Range
Construction	Mobilization and Bonding	5%	2%-10%
	Traffic Control	5%	1%-8%
	Miscellaneous Items	10%	1%-15%
	Contingency	20%	3%-25%
Soft Cost	Administration	5%	2%-15%
	Engineering	10%	1%-12%
	Construction Management and Inspection	12%	5%-15%

*Percentages estimated from *RSMeans Heavy Construction Cost Data*.

Table 3-8: Adjusted Pipe and RCB Unit Prices

Proposed Pipe Size	Unit	Unit Price	Construction Adjustment	Construction Unit Price	Soft Cost Adjustment	Total Unit Price
18-inch	LF	$160	$64	$224	$60	$284
24-inch	LF	$190	$76	$266	$72	$337
30-inch	LF	$210	$84	$294	$80	$373
33-inch	LF	$250	$100	$350	$95	$445
36-inch	LF	$290	$116	$406	$110	$516
42-inch	LF	$320	$128	$448	$121	$569
48-inch	LF	$330	$132	$462	$125	$587
54-inch	LF	$350	$140	$490	$132	$711
60-inch	LF	$400	$160	$560	$151	$711
66-inch	LF	$430	$172	$602	$163	$765
72-inch	LF	$470	$188	$658	$178	$836
78-inch	LF	$520	$208	$728	$197	$925
84-inch	LF	$560	$224	$784	$212	$996
90-inch	LF	$590	$236	$826	$223	$1,049
96-inch	LF	$615	$246	$861	$233	$1,094
RCB	CY of Concrete	$750	$300	$1,050	$284	$1,334

Because construction will take place over a number of years, the total cost of the master plan implementation will vary from the numbers provided in this study. The estimated construction and soft cost factors are a result of the project's densely populated urban area and existing infrastructure. As improvements are selected and move towards engineering, design, and construction, the contingency factor decreases and other factors can be better estimated knowing a definite construction schedule. The funding programs should be adjusted to future construction cost indexes for the design and/or construction of all recommended improvements.

4 Northern Region

4.1 Watershed Hydrology Analysis

The Northern Region drainage area is part of the Colma Creek watershed, north of Colma Creek. The area consists of three subwatersheds – Areas E, F, and G (Exhibits 7-9). Some areas within the watershed fall outside of the City boundary. However, the areas have been incorporated in the hydrologic analysis due to their runoff contribution to the City. All storm drain systems within the subwatersheds discharge to the Colma Creek channel. There are catch basins on the streets that enter the different storm drain pipeline systems at specific points within the drainage area. The drainage area is comprised mostly of mountainous and undeveloped areas adjacent to residential and commercial areas.

The hydrology results for the 10-and 100-year storm events are provided in Appendix C: XPSWMM Results.

4.1.1 Hydrology Results Summary 10- and 100-year storm events

Table 4-1 summarizes the maximum 10- and 100-year storm event flow rates at the major node locations in the Northern Region.

Table 4-1: Hydrology Peak Flow Summaries – Northern Region

Hydrology Node	Subwatershed	Drainage Area acres	10-Year Flow cfs	100-Year Flow cfs
611.5	Area E	872.9	77.9	85.6
615.5	Area E	789.8	573.2	584.7
619	Area E	203.5	120.6	148.8
716	Area F	1248.6	40.3	40.7
730	Area F	197.1	296.7	309.0
734	Area F	30.6	10.5	12.0
806	Area G	253.9	161.6	220.4
814	Area G	205.4	193.9	260.0

4.2 Hydraulic Analysis

4.2.1 Existing Condition

The Northern Region drainage area consists of two main storm drain systems. One is located northwest of Colma Creek and runs down El Camino Real. A large portion of this storm drain is outside the City boundary, assumptions regarding its size, slope, and inverts were made based on the best available data. Though the storm drain is outside the City boundary, it was modeled to appropriately convey the runoff that travels through the City into Colma Creek. The second major storm drain system is north of the channel as well and runs down Evergreen Drive to outlet at Colma Creek.

Appendix C: XPSWMM Results provides the existing condition hydraulic analysis for the 10- and 100-year storm events.

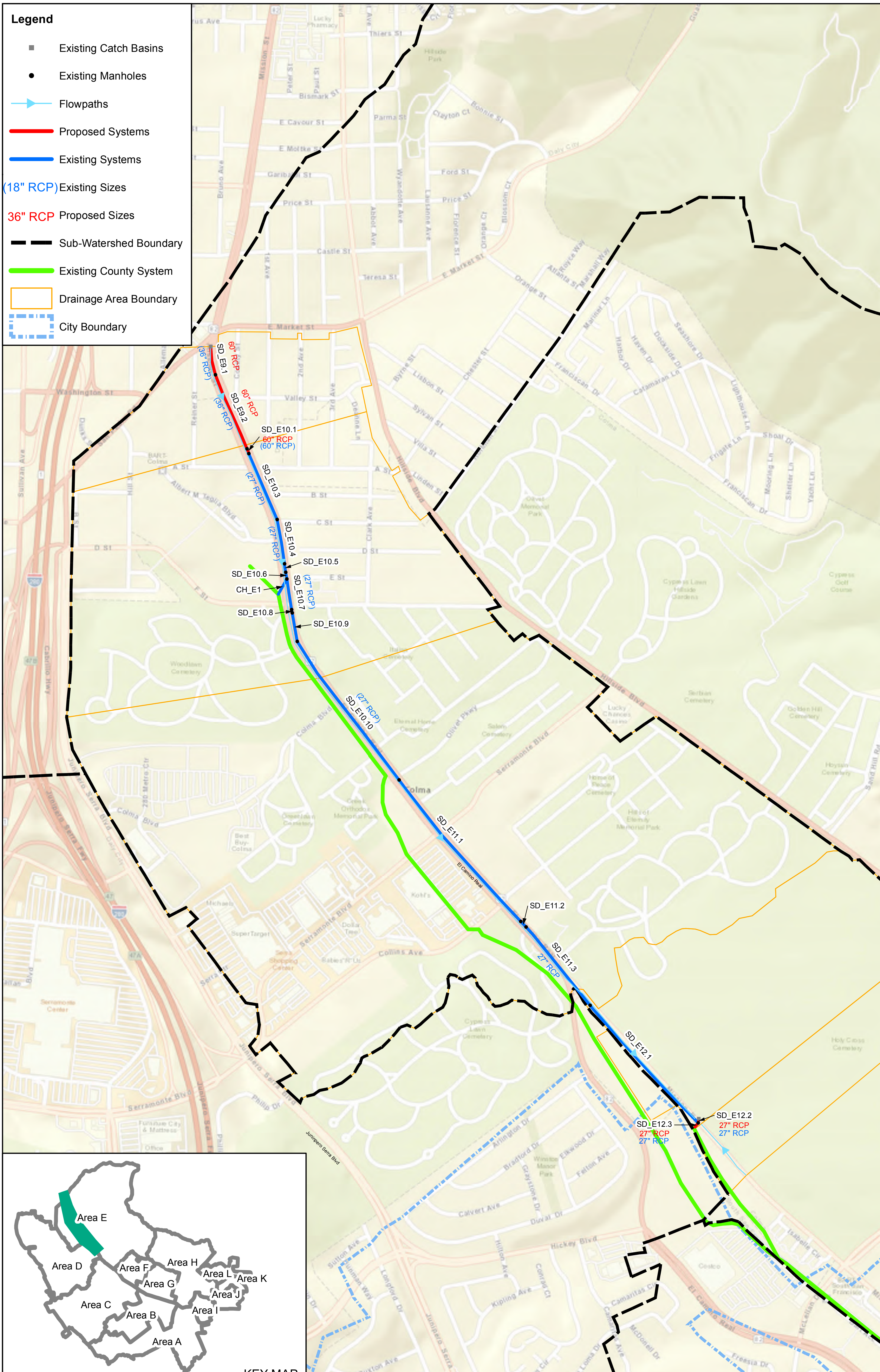
4.2.2 Recommended Improvements

The northern region of the City experiences the least amount of flooding, resulting in no Priority 1 improvements. Portions of the existing drainage systems in Subwatershed E fall outside of the City boundaries. Though improvements are recommended for these systems, further discussion with neighboring cities will be required for future implementation.

Table 4-2 below outlines the proposed improvements in the Northern Region. Figures 4-1 through 4-4 illustrate these improvements.

Table 4-2: Northern Region Recommended Facility Improvements

Subwatershed	Street	Facility Name	Priority	Existing Size (in)	Proposed Size (in)	Improvement Map
E	Mission Rd	SD_E12.2	2	36” RCP	60” RCP	Figure 4-1
	Mission Rd	SD_E12.3	2	84” RCP	96” RCP	Figure 4-1
F	Miller Ave	SD_F11.1	3	18” RCP	24” RCP	Figure 4-2
	Miller Ave	SD_F12.5	3	24” RCP	54” RCP	Figure 4-2
	Miller Ave	SD_F12.6	3	24” RCP	54” RCP	Figure 4-2
	Forest View Dr	SD_F12.7	2	42” RCP	60” RCP	Figure 4-2
	Forest View Dr	SD_F12.8	2	39” RCP	60” RCP	Figure 4-2
	Sunnyside Dr	SD_F12.9	2	12” RCP	60” RCP	Figure 4-2
	Sunnyside Dr	SD_F12.10	3	42” RCP	60” RCP	Figure 4-2
	Forest View Dr	SD_F12.11	2	42” RCP	72” RCP	Figure 4-2
	Forest View Dr	SD_F12.12	2	36” RCP	72” RCP	Figure 4-2
	Forest View Dr	SD_F12.13	2	12” RCP	36” RCP	Figure 4-2
	Forest View Dr	SD_F12.14	2	36” RCP	72” RCP	Figure 4-2
	Nursery Way	SD_F14.1	2	21” RCP	24” RCP	Figure 4-3
	Nursery Way	SD_F14.2	2	21” RCP	24” RCP	Figure 4-3
	Nursery Way	SD_F14.3	2	12” RCP	24” RCP	Figure 4-3
	Nursery Way	SD_F14.4	2	24” RCP	36” RCP	Figure 4-3
	Nursery Way	SD_F14.5	2	30” RCP	36” RCP	Figure 4-3
	Oak Ave	SD_F20.4	3	39” RCP	54” RCP	Figure 4-3
	Oak Ave	SD_F20.5	2	39” RCP	54” RCP	Figure 4-3
	Oak Ave	SD_F20.6	2	39” RCP	5’x5’ RCB	Figure 4-3
G	Orange Ave	SD_G2.1	3	15” RCP	36” RCP	Figure 4-4
	Orange Ave	SD_G3.1	3	24” RCP	48” RCP	Figure 4-4
	Orange Ave	SD_G4.1	3	30” RCP	48” RCP	Figure 4-4
	Orange Ave	SD_G4.2	2	30” RCP	60” RCP	Figure 4-4
	Orange Ave	SD_G4.3	2	36” RCP	72” RCP	Figure 4-4
	Orange Ave	SD_G4.4	2	36” RCP	72” RCP	Figure 4-4
	Spruce Ave	SD_G4.5	2	36” RCP	84” RCP	Figure 4-4
	Spruce Ave	SD_G7.1	3	15” RCP	24” RCP	Figure 4-4
	Spruce Ave	SD_G8.1	3	15” RCP	24” RCP	Figure 4-4
	Spruce Ave	SD_G9.2	2	36” RCP	60” RCP	Figure 4-4
	Spruce Ave	SD_G9.3	2	36” RCP	72” RCP	Figure 4-4
	Canal St	SD_G9.4	2	36” RCP	84” RCP	Figure 4-4
	Canal St	SD_G9.5	2	36” RCP	6’x10’ RCB	Figure 4-4



0 210 420 840 Feet

NORTH

Michael Baker INTERNATIONAL

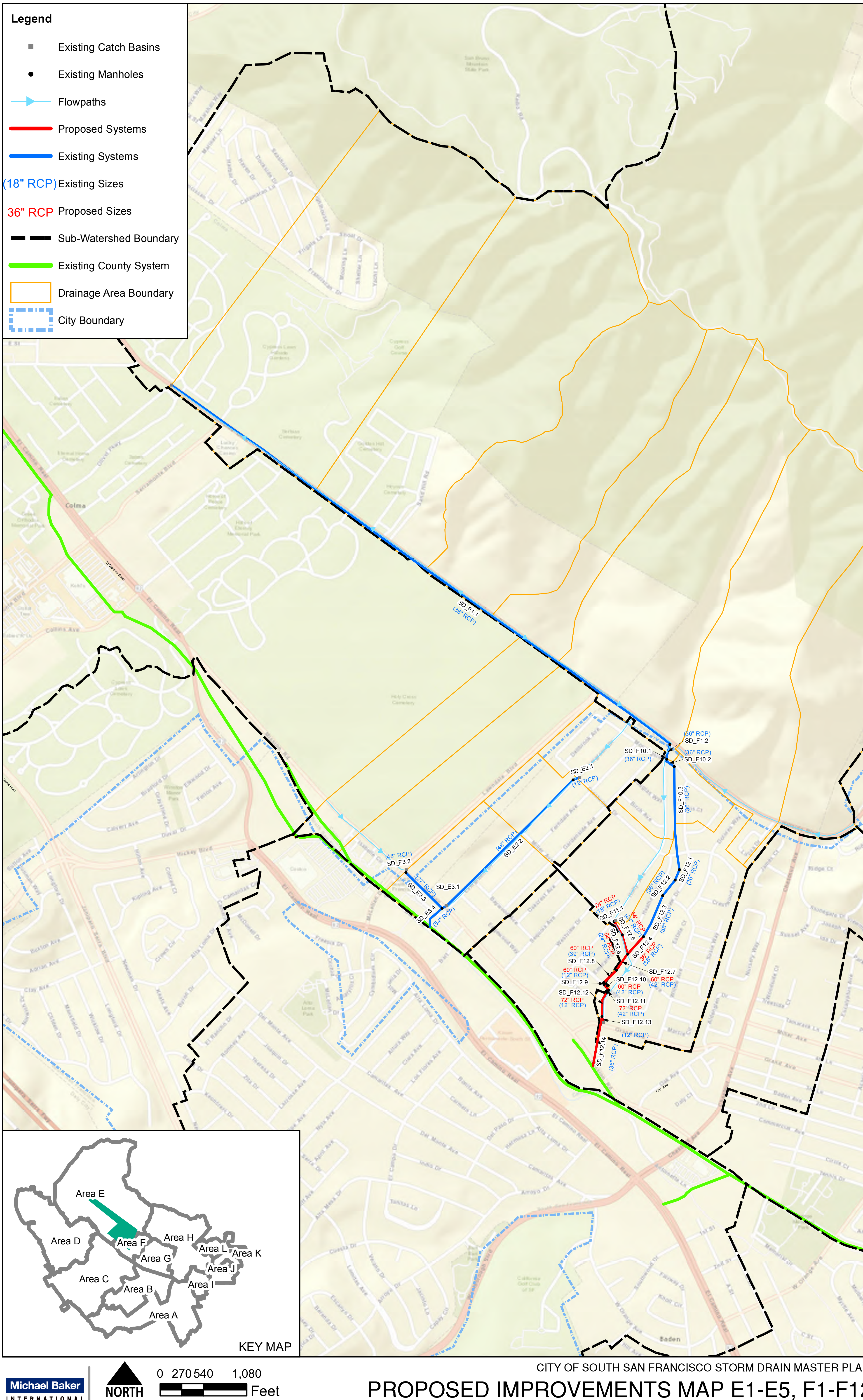
CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP E6-E15

Figure 4-1

Source:

1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

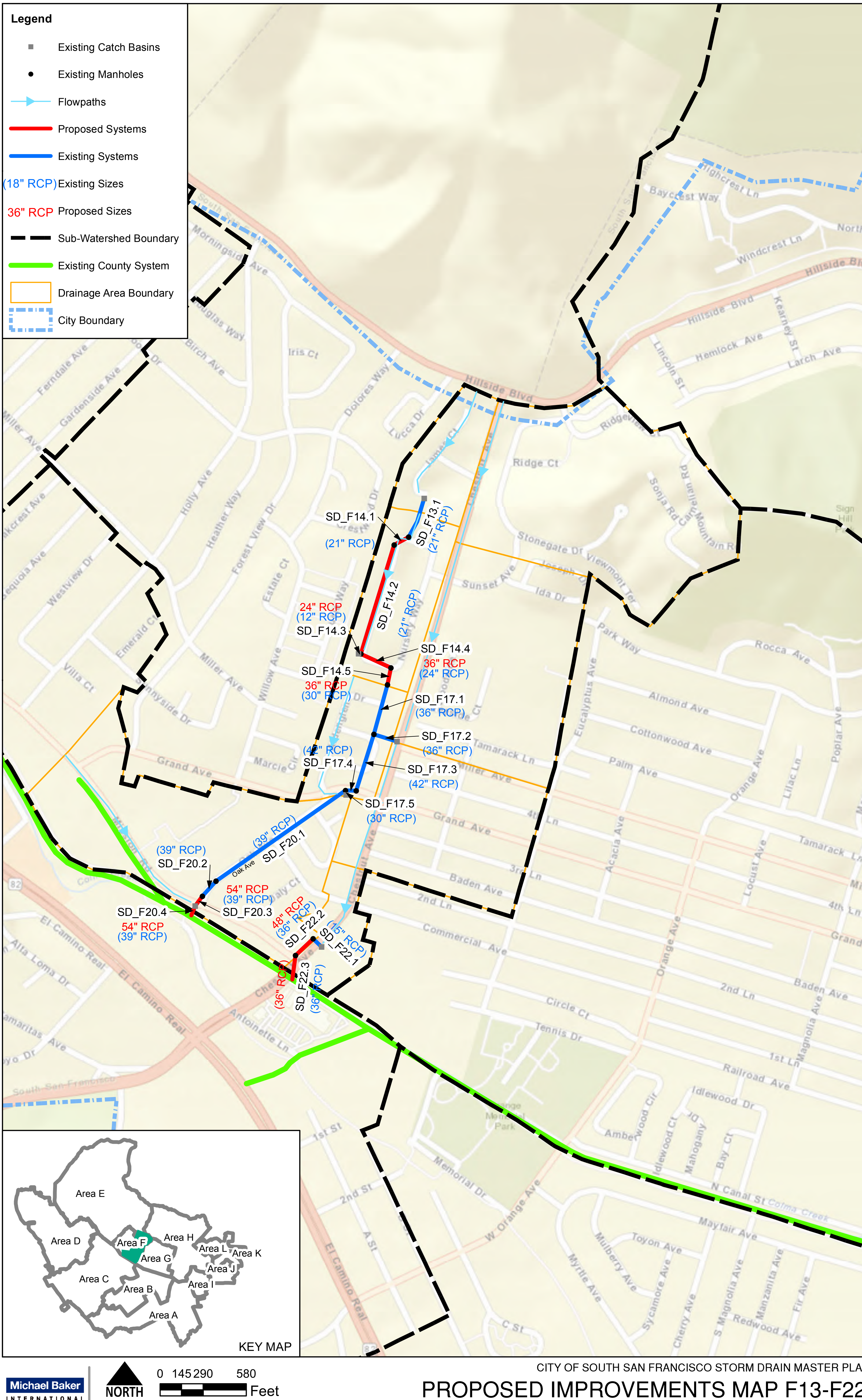


Michael Baker INTERNATIONAL

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP E1-E5, F1-F12

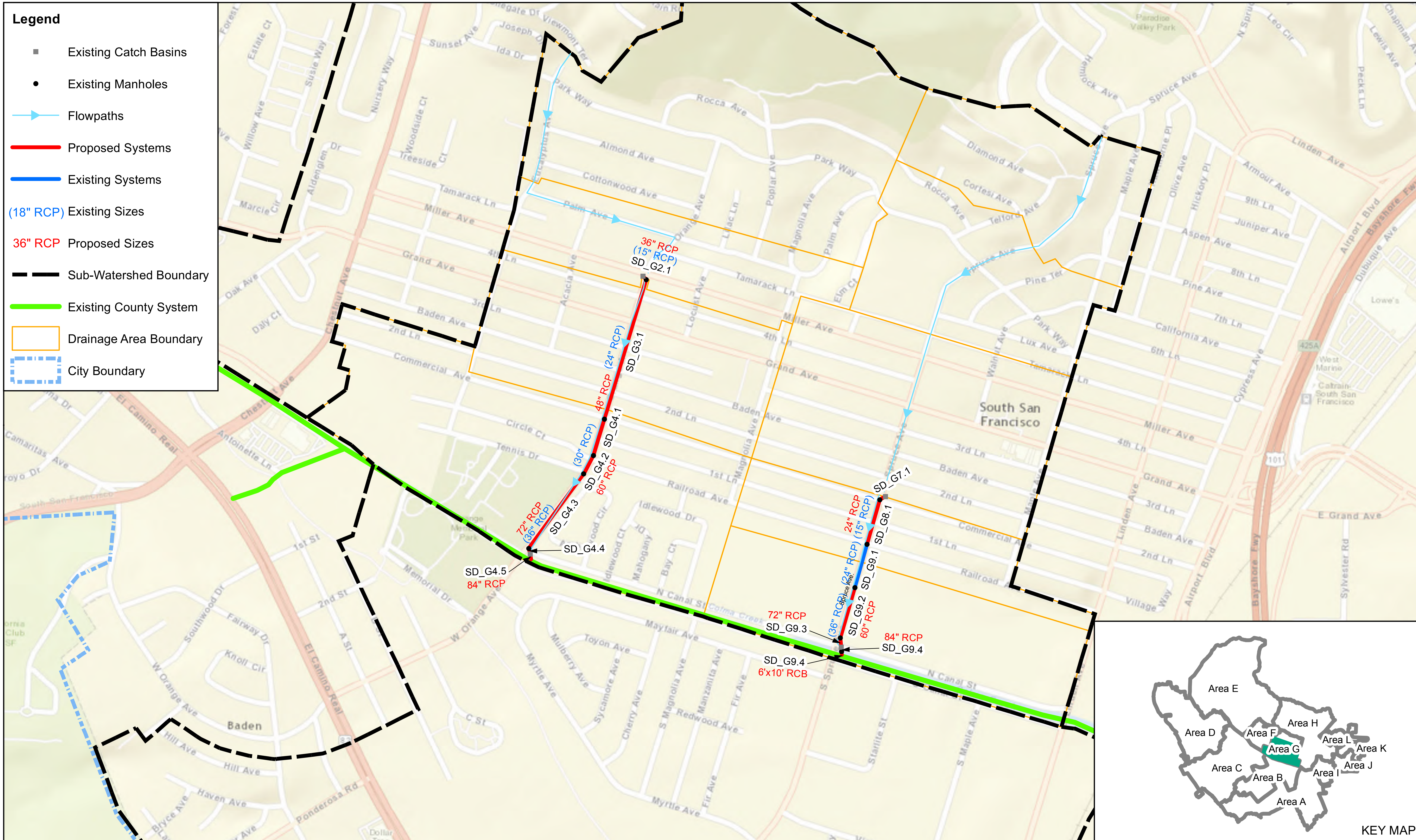
Figure 4-2



CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP F13-F22

Figure 4-3



Michael Baker INTERNATIONAL

NORTH

0 375 750 1,500 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP G1-G9

Figure 4-4

4.2.3 Cost Estimates

Table 4-3 provides an estimate of the construction and total project costs of recommended improvements for this drainage area. See Appendix H: Cost Estimations for detailed cost calculations.

Table 4-3: Northern Region Total Cost Estimate

Watershed	Construction Cost	Total Project Cost
E	$645,000	$818,000
F	$1,945,000	$2,529,000
G	$1,685,000	$2,141,000
Total	**$4,275,000**	**$5,488,000**

This page intentionally left blank.

5 Southern Region

5.1 Watershed Hydrology Analysis

The Southern Region drainage area is part of the Colma Creek watershed, south of Colma Creek and consists of three subwatersheds – Areas B, C, and D (Exhibits 2-6). Some areas within the watershed fall outside of the City boundary. However, the areas have been incorporated in the hydrologic analysis due to their runoff contribution to the City. All storm drain systems within the subwatersheds discharge to the Colma Creek channel. There are catch basins on the streets that enter the different storm drain pipeline systems at specific points within the drainage area. The drainage area is mostly compromised of residential and commercial areas.

The hydrology results for the 10-and 100-year storm events are provided in Appendix C: XPSWMM Results.

5.1.1 Hydrology Results Summary 10- and 100-year storm events

Table 5-1 summarizes the maximum 10- and 100-year storm event flow rates at the major node locations in the Southern Region.

Table 5-1: Hydrology Peak Flow Summaries – Southern Region

Hydrology Node	Subwatershed	Drainage Area acres	10-Year Flow cfs	100-Year Flow cfs
217	Area B	138.5	12.7	11.7
266	Area B	557.6	364.4	378.6
259	Area B	89.1	26.4	26.4
407	Area C	1510.8	922.9	1044.6
412	Area C	74.1	15.9	15.4
418.75	Area C	74.0	27.0	27.1
428.5	Area C	55.7	69.4	71.2
436	Area C	51.4	80.6	88.5
566	Area D	1652.8	1074.5	1338.1

5.2 Hydraulic Analysis

5.2.1 Existing Condition

The Southern Region drainage area consists of three main storm drain systems with many laterals and other smaller systems that all outlet to Colma Creek. A large portion of the main storm drain in subwatershed D is outside the City boundary, assumptions regarding its size, slope, and inverts were made based on the best available data.

Subwatershed B contains two systems that the City has identified as critical known flooded areas. These systems are located along Valverde Drive and Francisco Drive. The systems were not identified to experience flooding in a 10-year storm event. However, due to the history of flooding in the area, the City has requested that these systems be analyzed in detail and designed for a 100-year storm event. The detailed study for these areas can be found in Appendix B.

Appendix C: XPSWMM Results provides the existing condition hydraulic analysis for the 10- and 100-year storm events.

5.2.2 Recommended Improvements

The Southern Region of the City consists of various areas known to flood in major storm events, such as the most recent flash flooding in December 2014. These known flooded areas are in Sub-Watershed B at Valverde Drive and Francisco Terrace Drive. The areas are treated as Priority 1 improvements due to the known flooding impact. These two areas are connected by the same main drainage system that outlets to Colma Creek at Spruce Ave. Since they are affected by the condition of the main system, improvements along the entire system are necessary to alleviate flooding in both areas.

The flooding along Valverde Drive is alleviated by proposing a parallel system at and downstream of the flooding area. In addition to the parallel system, it is recommended that a pumping system be installed near the intersection of Spruce Avenue and Mayfair Avenue. The pumping station will alleviate ponding that occurs in this area due to a sump condition. For the flooding along Francisco Terrace Drive, as well as downstream along Spruce Avenue, a strategic approach is taken due to the amount of flooding in the area. The proposed improvements are modeled such that the existing system is left in place, and additional systems running parallel to it are recommended. The additional systems are identified with an asterisk in Table 5-2, which outlines the proposed improvements in the Southern Region. Figures 5-1 through 5-11 illustrate these improvements.

Table 5-2: Southern Region Recommended Facility Improvements

Subwatershed	Street	Facility Name	Priority	Existing	Proposed	Improvement Map
B	Valverde Dr	SD_B7.2	2	18” RCP	24” RCP	Figure 5-1
	Almanor Ave	SD_B8.1	2	18” RCP	24” RCP	Figure 5-1
	Almanor Ave	SD_B8.2	2	12” RCP	24” RCP	Figure 5-1
	Almanor Ave	SD_B8.3	2	18” RCP	24” RCP	Figure 5-1
	Almanor Ave	SD_B8.4	2	21” RCP	36” RCP	Figure 5-1
	Almanor Ave	SD_B10.1	2	21” RCP	36” RCP	Figure 5-1
	Valverde Dr	SD_B5.3	1	24” RCP	Parallel 24” RCP	Figure 5-1
	Valverde Dr	SD_B5.4	1	21” CMP	Parallel 24” RCP	Figure 5-1
	Valverde Dr	SD_B5.5	1	24” RCP	Parallel 24” RCP	Figure 5-1
	Granada St	SD_B12.1	1	24” RCP	Parallel 24” RCP	Figure 5-1
	Conmur St	SD_B14.1	2	12” RCP	21” RCP	Figure 5-1
	Conmur St	SD_B15.1	2	12” RCP	18” RCP	Figure 5-1
	Conmur St	SD_B12.3	2	12” RCP	Parallel 24” RCP	Figure 5-1
	Granada Dr	SD_B16.1	1	30" RCP	36" RCP	Figure 5-1
	Granada Dr	SD_B16.2	1	30" RCP	36" RCP	Figure 5-1
	Granada Dr	SD_B16.3	1	30" RCP	36" RCP	Figure 5-1
	Avalon Dr	SD_B17.7	1	15" RCP	24" RCP	Figure 5-1
	Avalon Dr	SD_B17.8	1	36" RCP	66" RCP	Figure 5-1
	Avalon Dr	SD_B17.9	1	36” RCP	66” RCP	Figure 5-1
	Alida Way	SD_B20.3	1	15" RCP	48" RCP	Figure 5-1
	Alida Way	SD_B20.4	1	48" RCP	Parallel 48" RCP*	Figure 5-1
	Alida Way	SD_B20.5	1	18" RCP	36" RCP	Figure 5-1

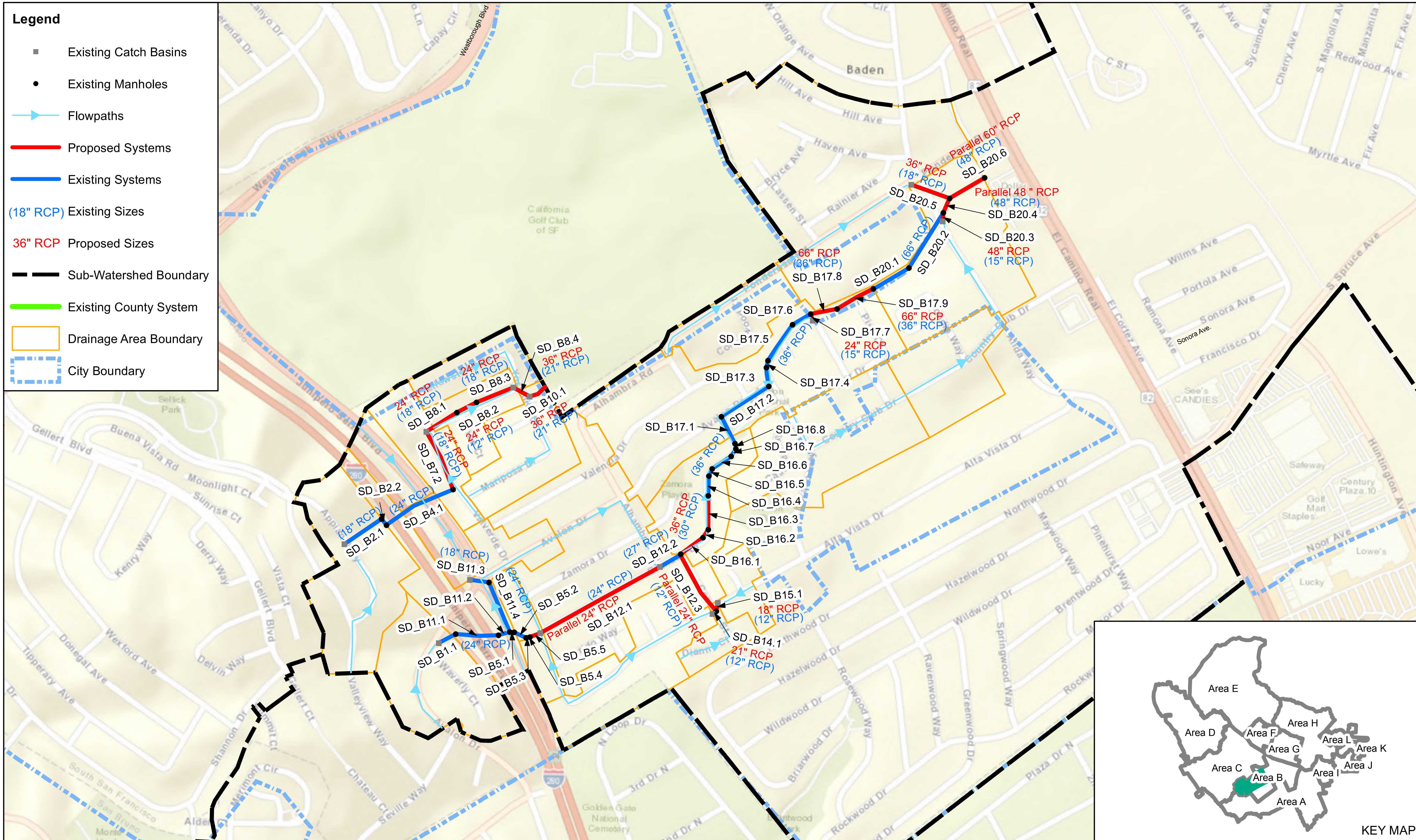
Subwatershed	Street	Facility Name	Priority	Existing	Proposed	Improvement Map
	Alida Way	SD_B20.6	1	48” RCP	Parallel 60” RCP*	Figure 5-1
	El Camino Real	SD_B33.1	1	72" RCP	Parallel 48" RCP*	Figure 5-2
	El Camino Real	SD_B33.2	1	72" RCP	Parallel 48" RCP*	Figure 5-2
	El Camino Real	SD_B34.1	1	60" RCP	Parallel 48" RCP*	Figure 5-2
	El Camino Real	SD_B34.2	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Ramona Ave	SD_B34.3	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Ramona Ave	SD_B34.4	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Ramona Ave	SD_B36.1	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Sonora Ave	SD_B36.2	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Francisco Dr	SD_B37.1	1	60" RCP	Parallel 60" RCP*	Figure 5-2
	Francisco Dr	SD_B37.2	1	60" RCP	Parallel 60" RCP with flapgate*	Figure 5-2
	Northwood Dr	SD_B29.1	2	36" RCP	54" RCP	Figure 5-2
	Hazelwood Dr	SD_B29.2	2	36" RCP	60" RCP	Figure 5-2
	Spruce Ave	SD_B35.1	2	48” RCP	Parallel 48” RCP*	Figure 5-2
	Spruce Ave	SD_B35.2	2	66" RCP	Parallel 36" RCP*	Figure 5-2
	Spruce Ave	SD_B35.3	2	66" RCP	Parallel 36" RCP*	Figure 5-2
	Spruce Ave	SD_B35.4	2	66" RCP	Parallel 36" RCP*	Figure 5-2
	Spruce Ave	SD_B35.5	2	66" RCP	Parallel 36" RCP*	Figure 5-2
	Spruce Ave	SD_B42.1	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B42.2.1	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B42.2.2	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B42.3	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B42.4	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B43.1	1	66" RCP	Dual 5'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B43.1.2	1	66" RCP	Dual 6'x12' RCB*	Figure 5-2
	Spruce Ave	SD_B43.2	2	18” RCP	60” RCP	Figure 5-2
	Spruce Ave	SD_B43.3	1	66” RCP	Dual 7’x12’ RCB*	Figure 5-2
	Spruce Ave	SD_B41.1	2	18” RCP	60” RCP	Figure 5-2
	Mayfair Ave	SD_B39.1	2	18” RCP	Parallel 48” RCP	Figure 5-2
C	Callan Blvd	SD_C5.1	2	15" RCP	36" RCP	Figure 5-3
	Callan Blvd	SD_C3.5	2	15" RCP	36" RCP	Figure 5-3
	Callan Blvd	SD_C6.4	2	15" RCP	36" RCP	Figure 5-3

Subwatershed	Street	Facility Name	Priority	Existing	Proposed	Improvement Map
	Oakmont Dr	SD_C10.1	2	15" RCP	24" RCP	Figure 5-3
	Galway Dr	SD_C12.5	3	15" RCP	36" RCP	Figure 5-4
	Galway Dr	SD_C14.1	2	15" RCP	36" RCP	Figure 5-4
	St. Cloud Dr	SD_C23.1	2	15" RCP	36" RCP	Figure 5-5
	St. Cloud Dr	SD_C23.2	2	21" RCP	36" RCP	Figure 5-5
	St. Cloud Dr	SD_C23.3	2	21" RCP	36" RCP	Figure 5-5
	Dublin Dr	SD_C23.7	2	15" RCP	36" RCP	Figure 5-5
	Dublin Dr	SD_C23.8	3	36" RCP	54" RCP	Figure 5-5
	Dublin Dr	SD_C21.1	2	15" RCP	36" RCP	Figure 5-5
	Gellert Blvd	SD_C26.6	2	15" RCP	36" RCP	Figure 5-4
	Appian Way	SD_C31.1	2	12" RCP	24" RCP	Figure 5-6
	Appian Way	SD_C31.2	2	15" RCP	30" RCP	Figure 5-6
	Appian Way	SD_C31.3	2	18" RCP	30" RCP	Figure 5-6
	Appian Way	SD_C35.1	2	36" RCP	48" RCP	Figure 5-6
	Gellert Blvd	SD_C33.2	2	21" RCP	36" RCP	Figure 5-6
	Junipero Serra Blvd	SD_C35.3	2	18" RCP	42" RCP	Figure 5-6
	Lexi Way	SD_C39.1	2	12" RCP	36" RCP	Figure 5-7
	Lexi Way	SD_C42.1	3	12" RCP	36" RCP	Figure 5-7
	Lexi Way	SD_C42.2	3	12" RCP	36" RCP	Figure 5-7
	Lexi Way	SD_C42.3	2	18" RCP	36" RCP	Figure 5-7
	Lexi Way	SD_C42.4	2	18" RCP	36" RCP	Figure 5-7
	Greendale Dr	SD_C44.2	2	10" RCP	18" RCP	Figure 5-7
	King Dr	SD_C49.2	2	15" RCP	36" RCP	Figure 5-7
	King Dr	SD_C49.3	2	12" RCP	48" RCP	Figure 5-8
	Radburb	SD_C52.2	2	18" RCP	24" RCP	Figure 5-8
	Williams Ct	SD_C52.3	3	18" RCP	30" RCP	Figure 5-8
	Williams Ct	SD_C52.4	3	15" RCP	30" RCP	Figure 5-8
	April Ave	SD_C62.1	2	30" RCP	36" RCP	Figure 5-10
	Alta Mesa Dr	SD_C65.7	2	30" RCP	48" RCP	Figure 5-10
	Alta Mesa Dr	SD_C65.8	2	27" RCP	48" RCP	Figure 5-10
	Alta Mesa Dr	SD_C65.9	2	27" RCP	54" RCP	Figure 5-10
	Alta Mesa Dr	SD_C65.10	2	27" RCP	60" RCP	Figure 5-10
	Alta Mesa Dr	SD_C65.11	2	36" RCP	60" RCP	Figure 5-10
	Arroyo Dr	SD_C65.12	2	18" RCP	36" RCP	Figure 5-10
	Arroyo Dr	SD_C65.13	2	42" RCP	72" RCP	Figure 5-10
	Arroyo Dr	SD_C67.1	2	12" RCP	24" RCP	Figure 5-10
	Arroyo Dr	SD_C67.2	2	15" RCP	24" RCP	Figure 5-10
	Arroyo Dr	SD_C67.4	2	24" RCP	48" RCP	Figure 5-10
	Arroyo Dr	SD_C67.5	2	18" RCP	60" RCP	Figure 5-10
	Arroyo Dr	SD_C67.6	2	18" RCP	60" RCP	Figure 5-10
	Westborough Blvd	SD_C70.2	2	90" RCP	7'x12' RCB	Figure 5-10
	Westborough Blvd	SD_C70.3	2	90" RCP	7'x12' RCB	Figure 5-10
	Westborough Blvd	SD_C70.4	2	90" RCP	8'x12' RCB	Figure 5-10
	Westborough Blvd	SD_C70.5	2	90" RCP	8'x12' RCB	Figure 5-10

Subwatershed	Street	Facility Name	Priority	Existing	Proposed	Improvement Map
	Westborough Blvd	SD_C70.6	2	90” RCP	8’x12’ RCB	Figure 5-10
	Westborough Blvd	SD_C70.7	2	90” RCP	8’x12’ RCB	Figure 5-10
	El Camino Real	SD_C73.1	2	18” RCP	42” RCP	Figure 5-11
	Chestnut Ave	SD_C76.1	2	15” RCP	72” RCP	Figure 5-11
	Del Monte Ave	SD_C78.1	2	15” RCP	24” RCP	Figure 5-12
	Del Monte Ave	SD_C80.1	2	21” RCP	36” RCP	Figure 5-12
	Del Monte Ave	SD_C80.2	2	18” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C80.4	2	24” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C80.5	2	24” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C80.6	2	24” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C80.7	2	21” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C85.2	2	21” RCP	36” RCP	Figure 5-12
	El Camino Real	SD_C85.3	2	30” RCP	54” RCP	Figure 5-12
	Orchid Dr	SD_C91.1	2	24” RCP	36” RCP	Figure 5-12
	Orchid Dr	SD_C91.2	2	24” RCP	36” RCP	Figure 5-12
	Orchid Dr	SD_C91.3	2	24” RCP	36” RCP	Figure 5-12
	Orchid Dr	SD_C91.4	2	24” RCP	48” RCP	Figure 5-12
	El Camino Real	SD_C84.7	2	24” RCP	48” RCP	Figure 5-12
D	Junipero Serra Blvd	SD_D32.2	2	30” RCP	54” RCP	Figure 5-13
	Hickory Blvd	SD_D32.3	2	54” RCP	66” RCP	Figure 5-13
	Hickory Blvd	SD_D32.4	2	54” RCP	66” RCP	Figure 5-13
	Hickory Blvd	SD_D32.5	3	54” RCP	66” RCP	Figure 5-13
	Duval Dr	SD_D31.1	2	12” RCP	18” RCP	Figure 5-13
	Duval Dr	SD_D33.1	2	15” RCP	36” RCP	Figure 5-14
	Duval Dr	SD_D33.2	2	30” RCP	54” RCP	Figure 5-14
	Hickory Blvd	SD_D33.3	2	54” RCP	72” RCP	Figure 5-14
	Hickory Blvd	SD_D33.4	3	72” RCP	84” RCP	Figure 5-14
	Hickory Blvd	SD_D33.5	3	72” RCP	96” RCP	Figure 5-14
	Hickory Blvd	SD_D33.6	3	72” RCP	8’x8’ RCB	Figure 5-14
	Hickory Blvd	SD_D33.7	3	72” RCP	8’x8’ RCB	Figure 5-14
	Junipero Serra Blvd	SD_D39.2	2	12” RCP	18” RCP	Figure 5-14
	Crown Circle	SD_D42.1	2	18” RCP	24” RCP	Figure 5-14
	El Camino Real	SD_D49.1	3	96” RCP	8’x8’ RCB	Figure 5-14
	El Camino Real	SD_D49.2	3	96” RCP	8’x8’ RCB	Figure 5-14

RCB = Reinforced Concrete Box
*These proposed RCP or RCB sizes are in addition to the existing storm drain systems.

This page intentionally left blank.



Michael Baker INTERNATIONAL

NORTH

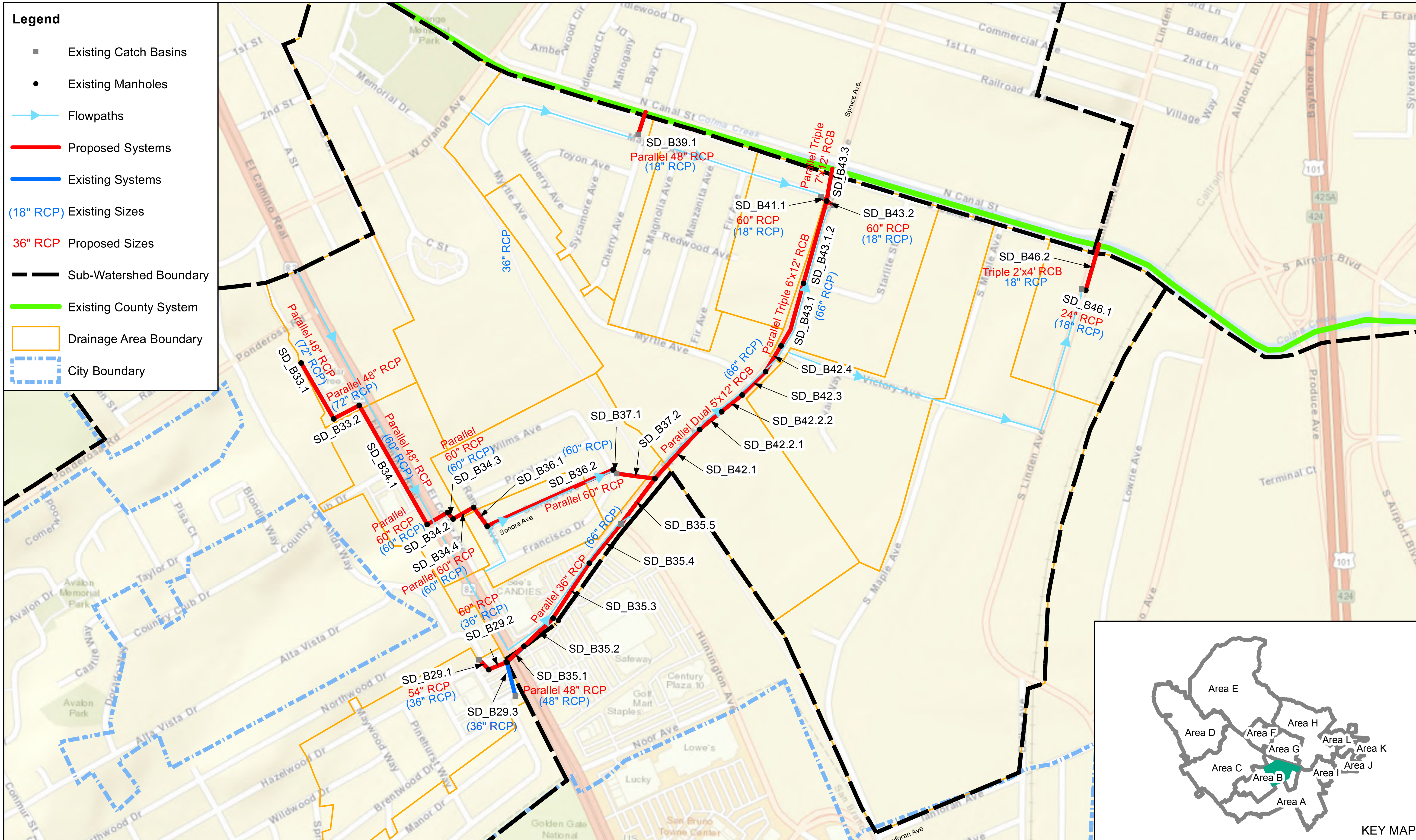
Source:

0 345 690 1,380 Feet

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP B1-B22

Figure 5-1



Michael Baker INTERNATIONAL

NORTH

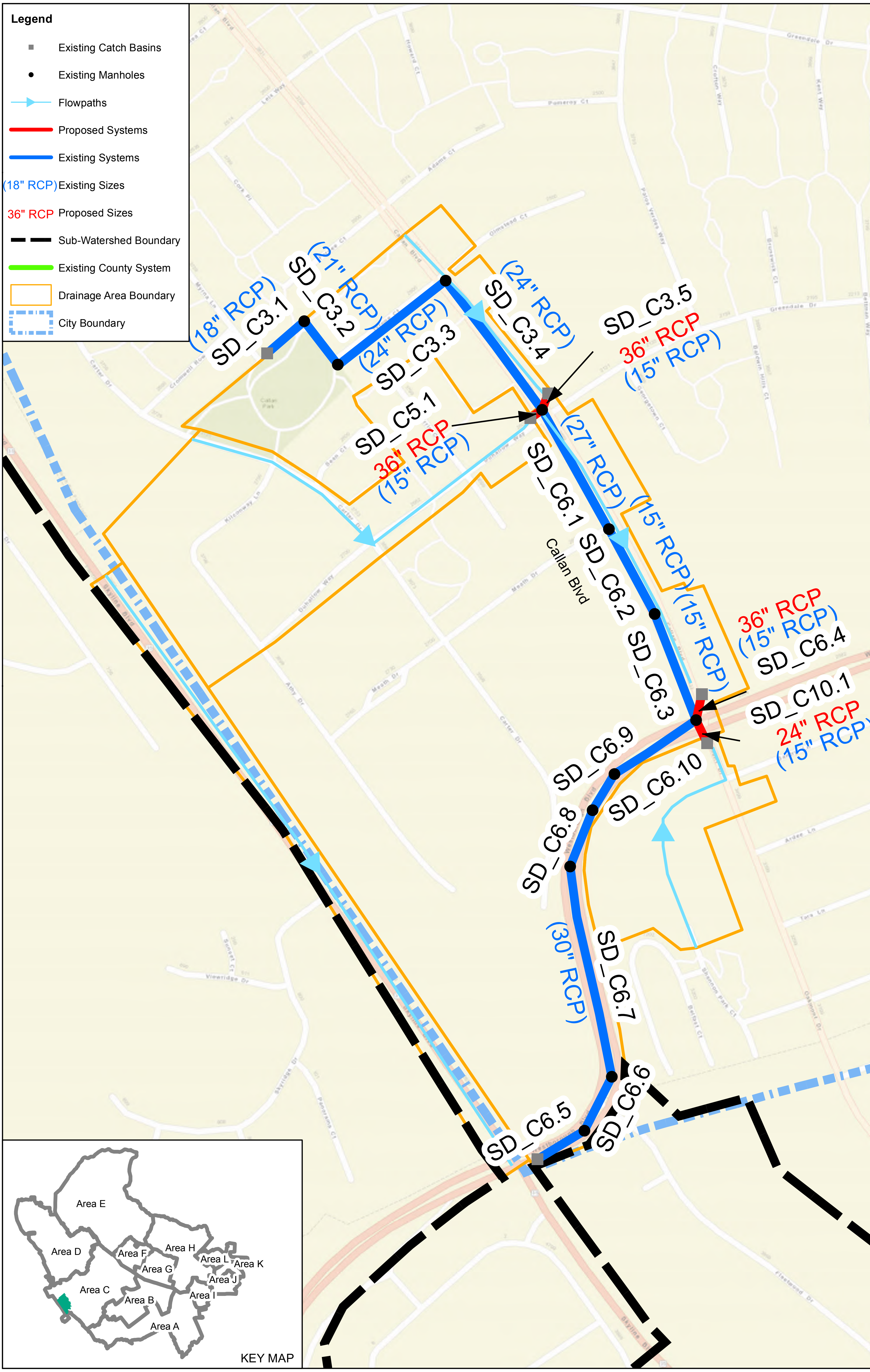
Source:

0 335 670 1,340 Feet

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP B29-B46

Figure 5-2



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

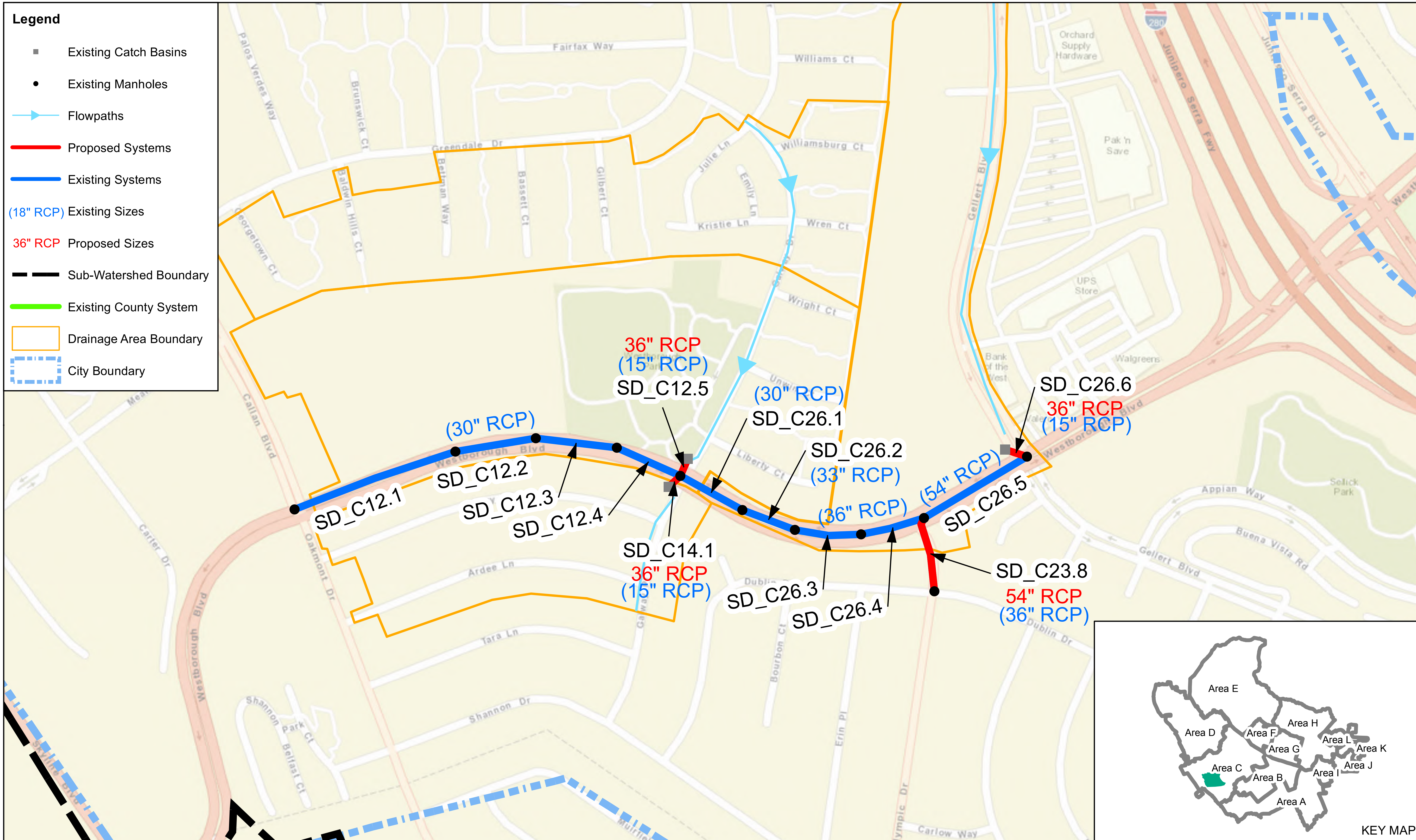
Michael Baker INTERNATIONAL

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C1-C10

Figure 5-3



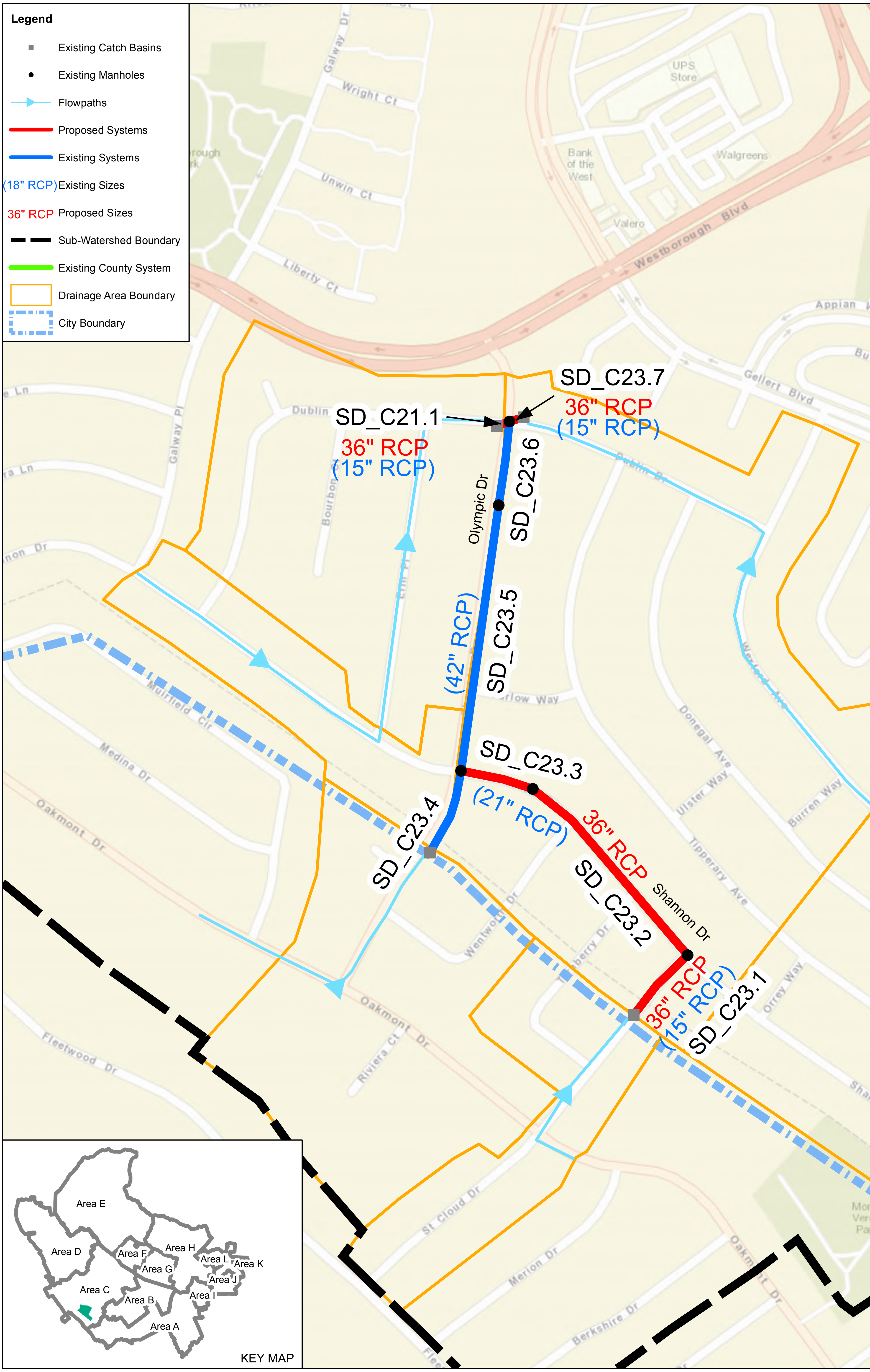
Michael Baker INTERNATIONAL

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C11-C12, C26

Figure 5-4



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

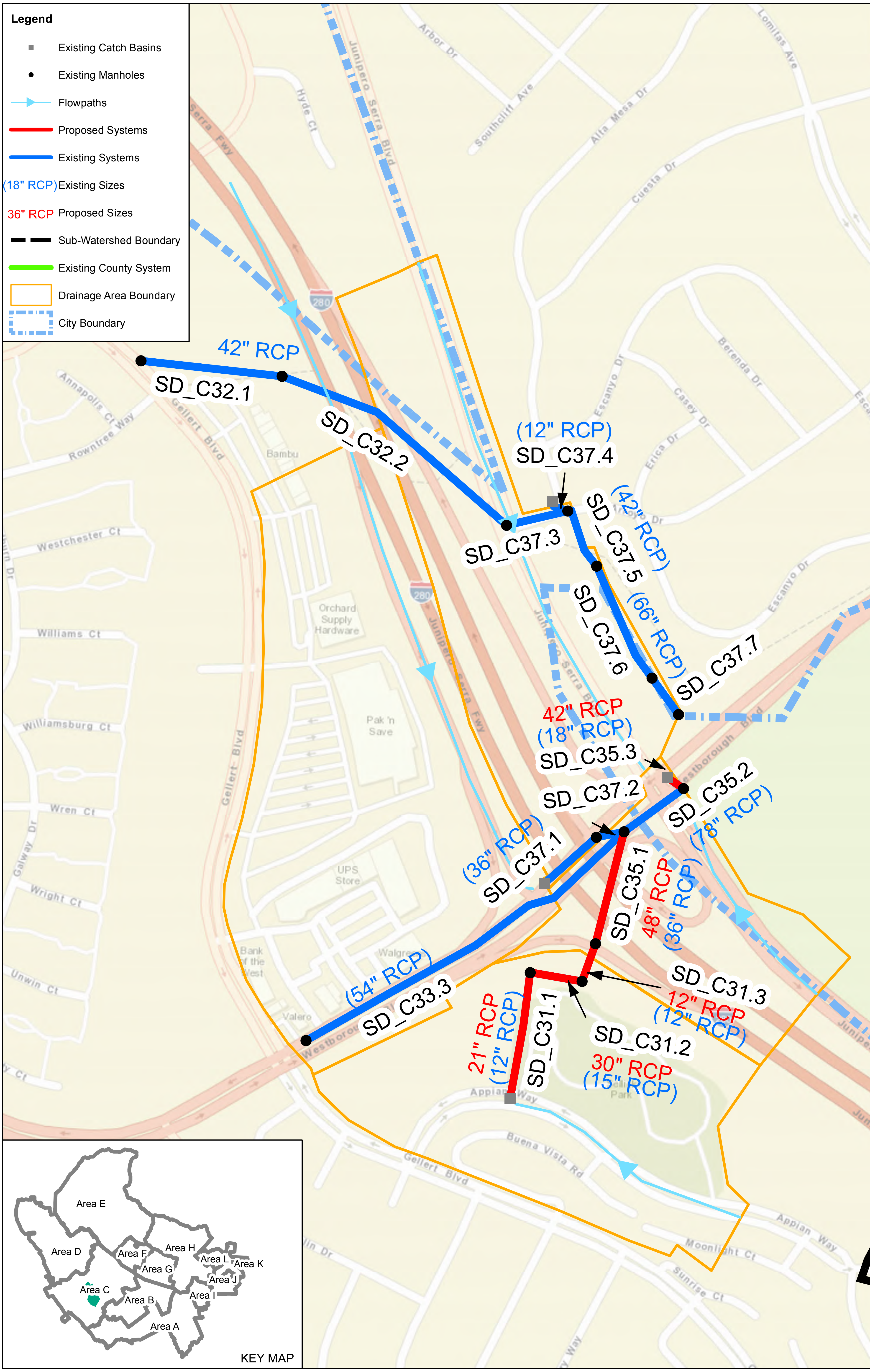
0 70 140 280 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C15-C23

Figure 5-5



Michael Baker INTERNATIONAL

NORTH

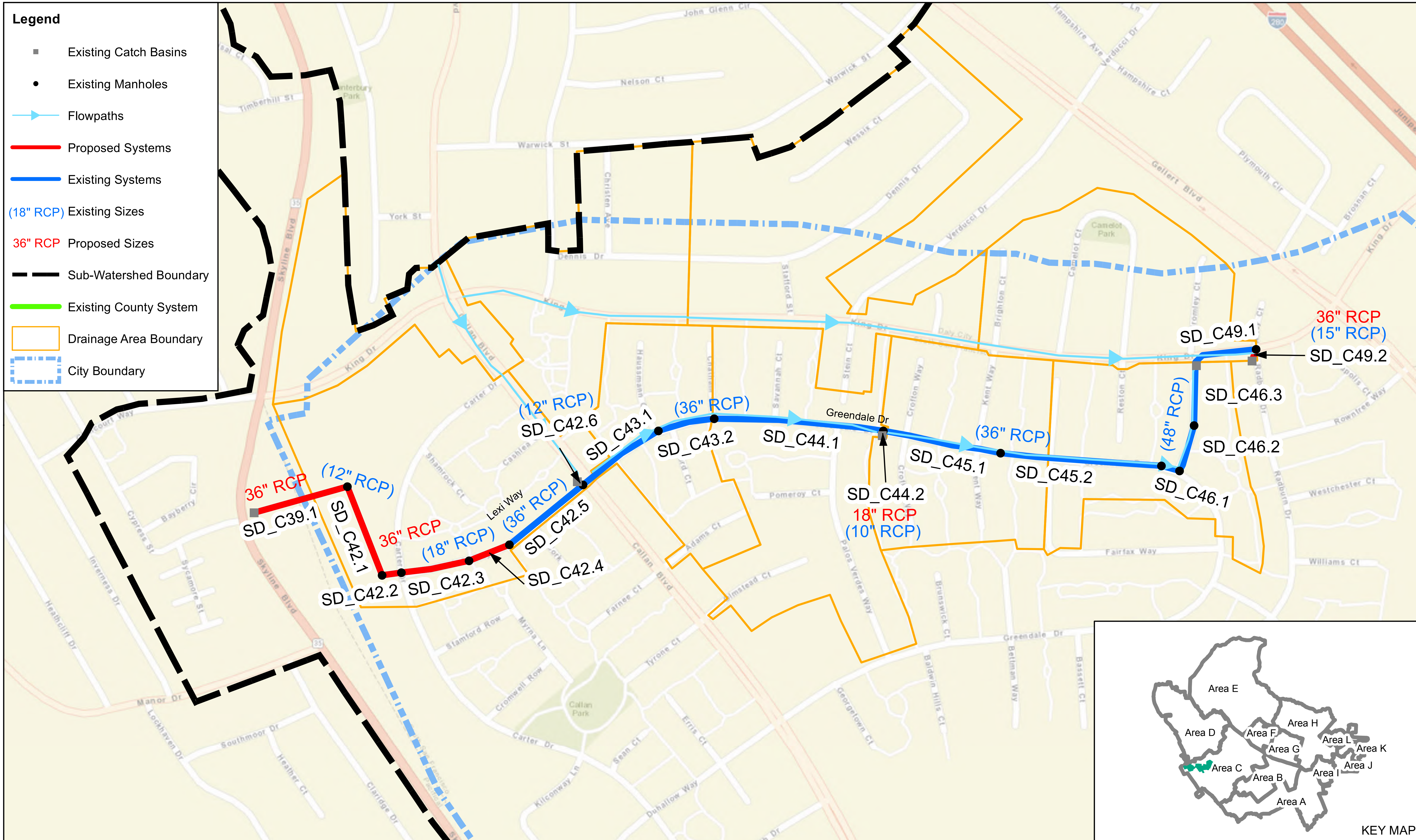
0 75 150 300 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C30-C37

Figure 5-6



Michael Baker INTERNATIONAL

NORTH

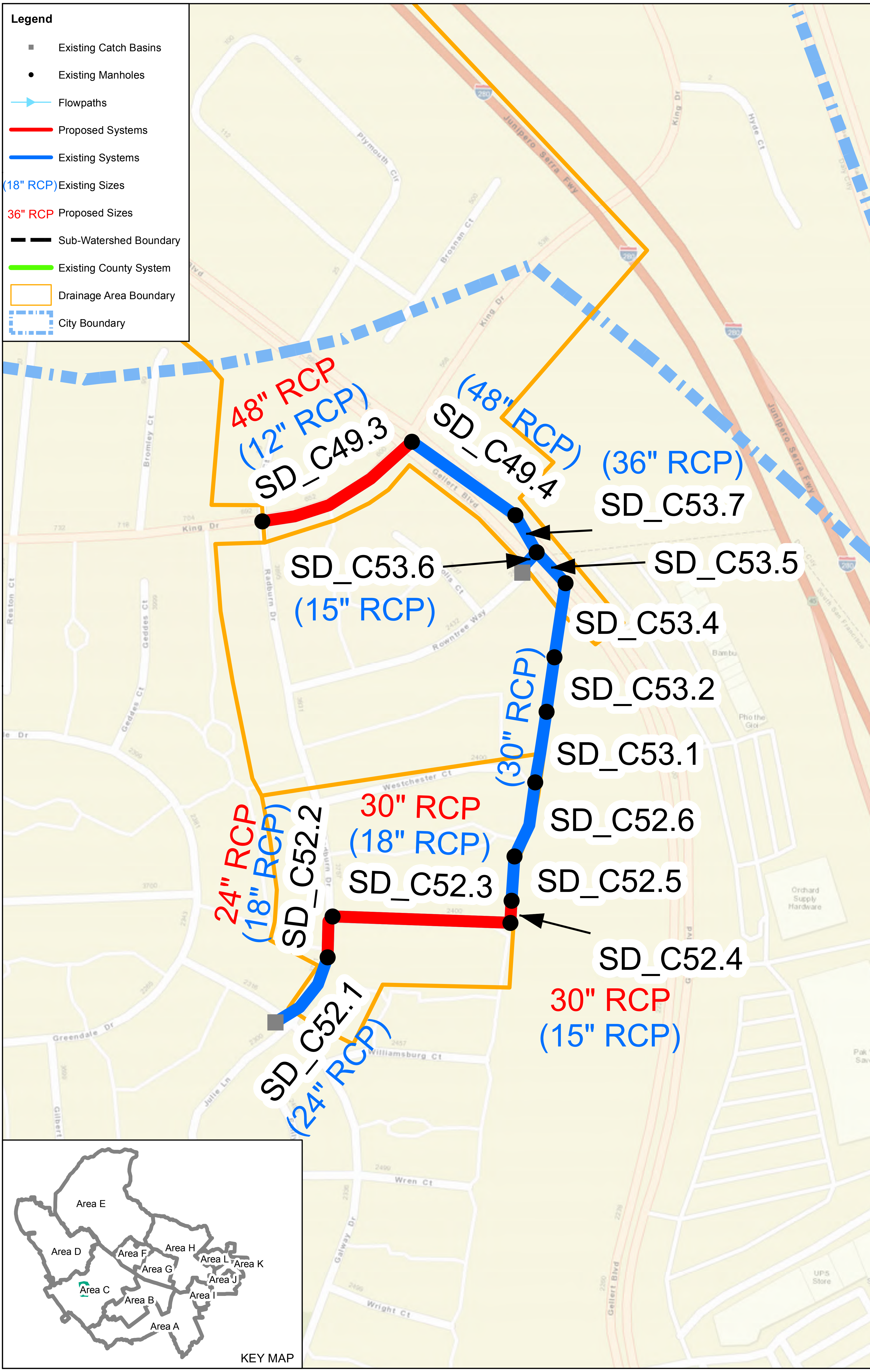
Source:

0 220 440 880 Feet

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C42-C49

Figure 5-7



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

0 50 100 200 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C25, C52, C53

Figure 5-8

Michael Baker INTERNATIONAL

NORTH

Source:

0 170 340 680 Feet

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C55-C58, C68-C69

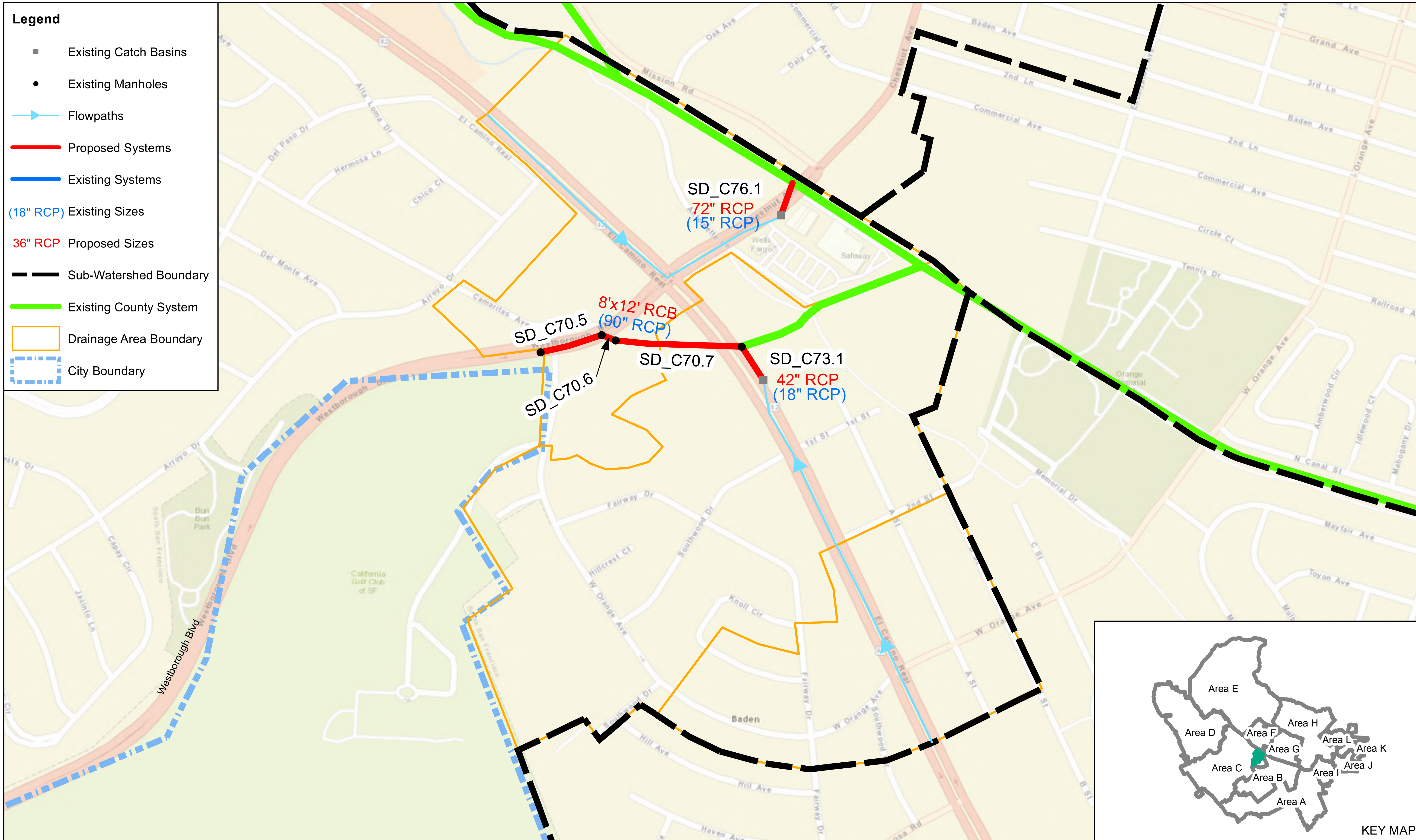
Figure 5-9

Michael Baker INTERNATIONAL

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C60-C65, C70

Figure 5-10



Michael Baker INTERNATIONAL

NORTH

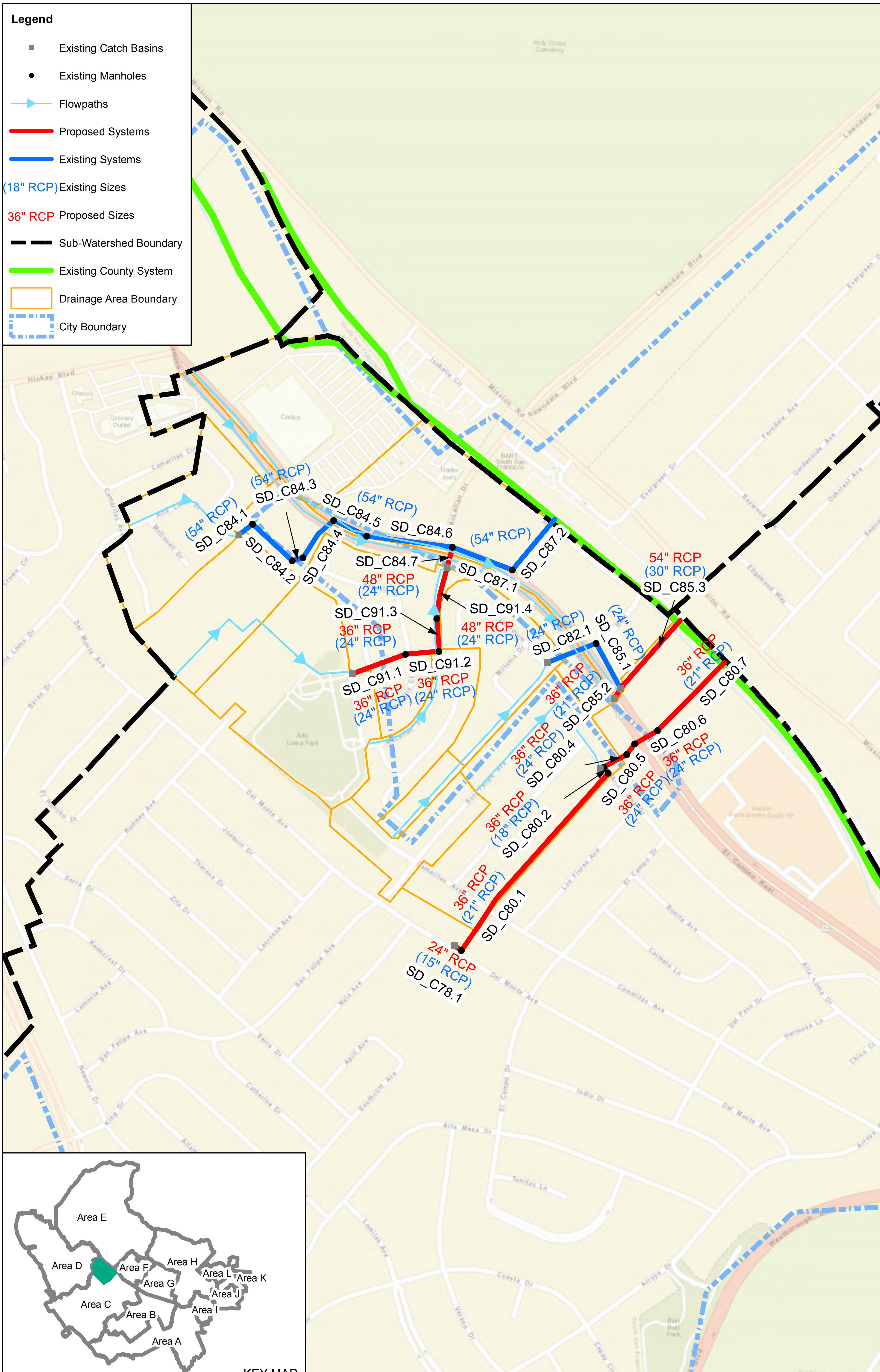
Source:

0 230 460 920 Feet

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C67, C73, C76

Figure 5-11



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

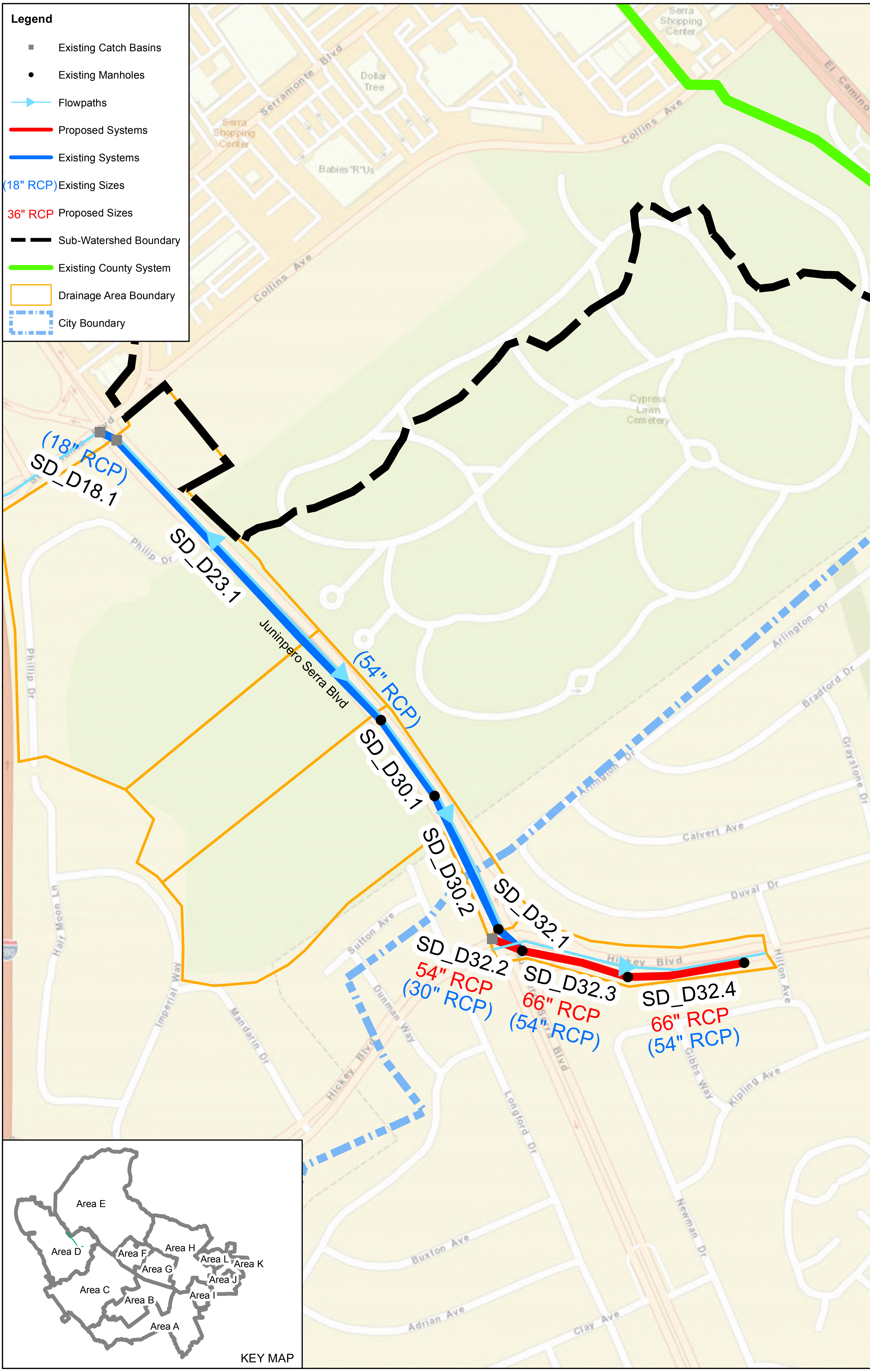
0 120 240 480 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP C77-C87

Figure 5-12



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

NORTH

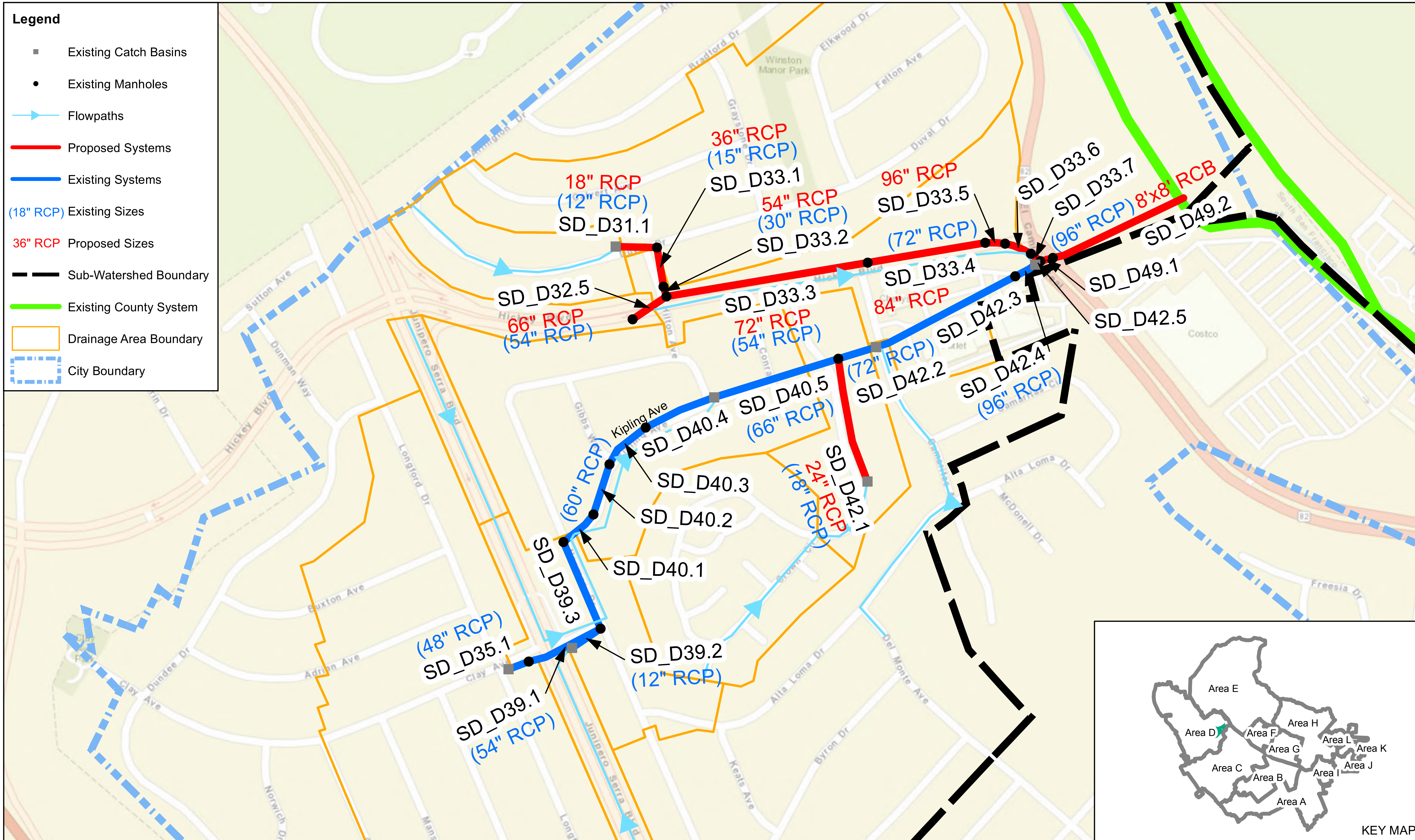
0 75 150 300 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP D18, D24, D28-D30

Figure 5-13



Michael Baker INTERNATIONAL

NORTH

0 187.5 375 750 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP D31-D49

Figure 5-14

5.2.3 Cost Estimates

Table 5-3 provides an estimate of the construction and total project costs of recommended improvements for this drainage area. See Appendix H: Cost Estimations for detailed cost calculations.

Table 5-3: Southern Region Total Cost Estimate

Watershed	Construction Cost	Total Project Cost
B	$14,100,000	$17,919,000
C	$8,728,000	$11,188,000
D	$2,515,000	$3,208,000
Total	**$25,343,000**	**$32,315,000**

This page intentionally left blank.

6 Lower Region

6.1 Watershed Hydrology Analysis

The Lower Region drainage area is part of the Colma Creek watershed, in the lower portion of the City. This drainage area consists of six subwatersheds – Areas A, and H through L (Exhibits 2 and 10-11). Some areas within the watershed fall outside of the City boundary. However, the areas have been incorporated in the hydrologic analysis due to their runoff contribution to the City. The storm drain systems within the subwatersheds discharge either to Colma Creek or directly to San Francisco Bay. There are catch basins on the streets that enter the different storm drain pipeline systems at specific points within the drainage area. The drainage area is mostly compromised of industrial area with some residential land uses. The hydrology results for the 10-and 100-year storm events are provided in Appendix E-1.

6.1.1 Hydrology Results Summary 10- and 100-year storm events

Table 5-1 summarizes the maximum 10- and 100-year storm event flow rates at the major node locations in the Lower Region.

Table 6-1: Hydrology Peak Flow Summaries – Lower Region

Hydrology Node	Subwatershed	Drainage Area acres	10-Year Flow cfs	100-Year Flow cfs
102.5	Area A	162.0	52.0	53.4
104	Area A	78.6	24.2	24.9
110	Area A	210.8	26.3	26.7
131	Area A	710.1	141.6	142.2
112	Area A	70.3	17.8	17.9
124	Area A	102.9	29.5	28.8
918	Area H	229.1	6.0	6.1
928	Area H	409.4	124.0	126.0
913	Area H	159.2	23.2	23.3
908	Area H	655.9	887.8	1058.7
1004	Area I	71.0	88.0	90.4
1008	Area I	81.2	28.7	28.7
1012	Area I	68.4	24.0	24.5
1108	Area J	216.2	145.5	148.8
1203	Area K	54.9	34.6	35.4
1209	Area K	106.0	66.1	67.5
1310	Area L	99.2	25.4	25.5
1306	Area L	120.9	16.4	16.5
1315	Area L	38.2	64.1	72.4

6.2 Hydraulic Analysis

6.2.1 Existing Condition

The Lower Region drainage area consists of several main storm drain systems that outlet to both Colma Creek Channel and San Francisco Bay. A majority of this drainage area consists of industrial areas with very flat terrain. Many of the storm drains that outlet to Colma Creek and the bay experience backwater conditions due to the high tides in the area.

Appendix E-2 provides the existing condition hydraulic analysis for the 10- and 100-year storm events.

6.2.2 Proposed Improvements

The Lower Region consists of many known flooded areas as identified by the City, all of which have been outlined as Priority 1. Due to the amount of flooding caused by recent storm events and tidal conditions in the bay, improvements of systems in the known flooded areas are recommended based on 100-year design levels outlined in Section 3, Table 3-1.

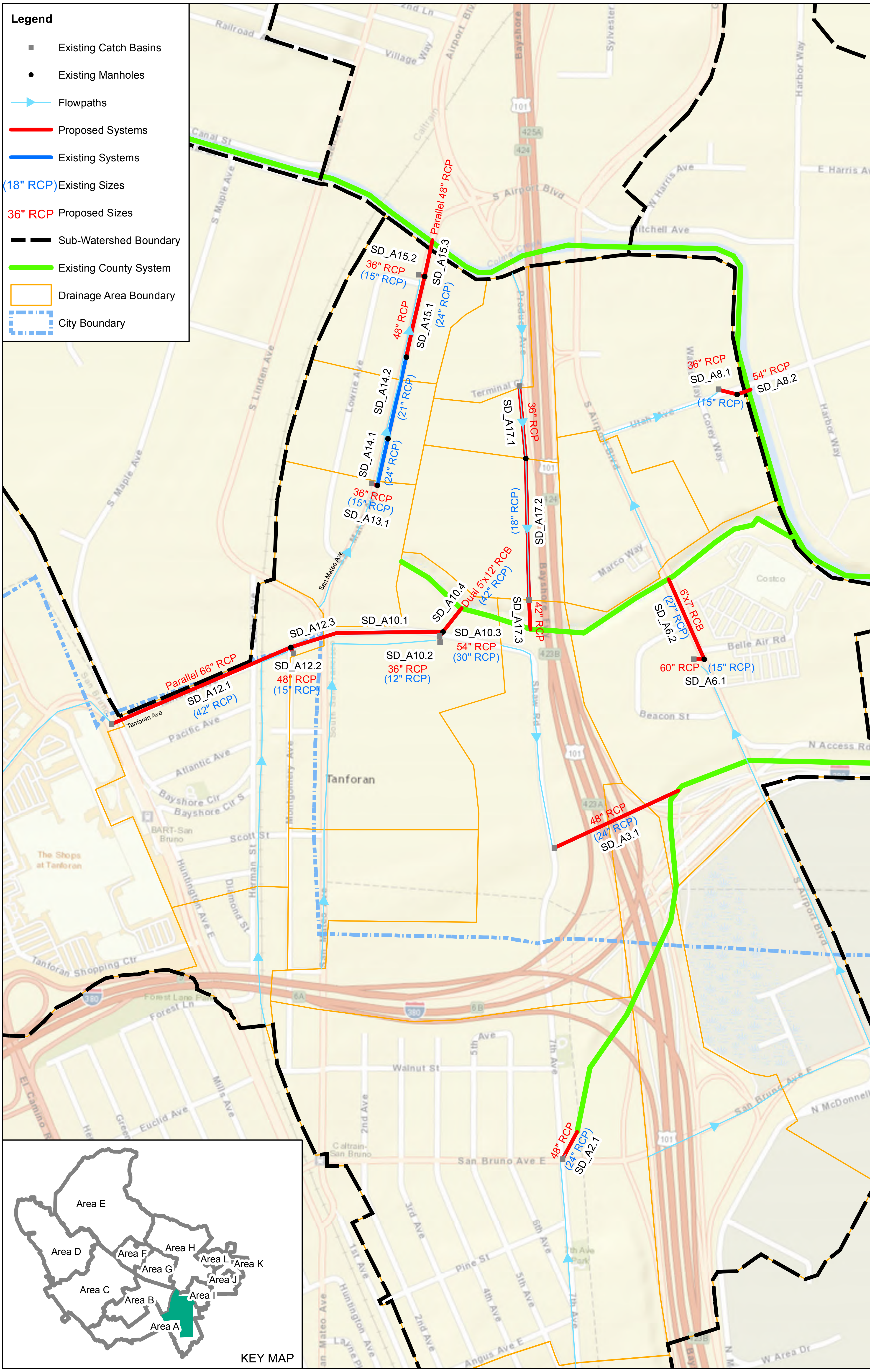
Table 6-2 outlines the proposed improvements in the North region. The figures following this section illustrate these improvements.

Table 6-2: Lower Region Recommended Facility Improvements

Subwatershed	Street	Facility Name	Priority	Existing Size	Proposed Size	Improvement Map
A	7th Ave	SD_A2.1	2	24” RCP	48” RCP	Figure 6-1
	Shaw Rd	SD_A3.1	1	24” RCP	48” RCP	Figure 6-1
	Tanforan Ave	SD_A12.1	1	42” RCP	Parallel 66” RCP	Figure 6-1
	Tanforan Ave	SD_A12.2	1	15” RCP	48” RCP	Figure 6-1
	Tanforan Ave	SD_A12.3	1	42” RCP	Parallel 66” RCP	Figure 6-1
	Shaw Rd	SD_A10.1	1	42” RCP	Parallel 66” RCP	Figure 6-1
	Shaw Rd	SD_A10.2	1	12” RCP	36” RCP	Figure 6-1
	Shaw Rd	SD_A10.3	1	30” RCP	54” RCP	Figure 6-1
	Shaw Rd	SD_A10.4	1	42” RCP	Dual 5’x12’ RCB	Figure 6-1
	S Airport Blvd	SD_A6.1	1	15” RCP	60” RCP	Figure 6-1
	S Airport Blvd	SD_A6.2	1	27” RCP	6’x7’ RCB	Figure 6-1
	Terminal Ct	SD_A17.1	1	18” RCP	36” RCP	Figure 6-1
	Terminal Ct	SD_A17.2	1	18” RCP	42” RCP	Figure 6-1
	Terminal Ct	SD_A17.3	1	18” RCP	42” RCP	Figure 6-1
	San Mateo Ave	SD_A13.1	2	15” RCP	36” RCP	Figure 6-1
	San Mateo Ave	SD_A15.1	2	24” RCP	48” RCP	Figure 6-1
	San Mateo Ave	SD_A15.2	2	15” RCP	36” RCP	Figure 6-1
	San Mateo Ave	SD_A15.3	2	24” RCP	Parallel 48” RCP	Figure 6-1
	Utah Ave	SD_A8.1	2	15” RCP	36” RCP	Figure 6-1
	Utah Ave	SD_A8.2	2	15” RCP	54” RCP	Figure 6-1
H	Hillside Blvd	SD_H11.1	3	18” RCP	36” RCP	Figure 6-2
	Hillside Blvd	SD_H11.2	3	24” RCP	48” RCP	Figure 6-2

Subwatershed	Street	Facility Name	Priority	Existing Size	Proposed Size	Improvement Map
	Hillside Blvd	SD_H11.2.1	3	24” RCP	48” RCP	Figure 6-2
	Airport Blvd	SD_H12.1	2	12” RCP	54” RCP	Figure 6-2
	Airport Blvd	SD_H12.2	2	12” RCP	Parallel 60” RCP	Figure 6-2
	Gateway Blvd	SD_H14.1	3	18” RCP	48” RCP	Figure 6-2
	Grand Ave	SD_H17.1	1	18” RCP	54” RCP	Figure 6-2
	Grand Ave	SD_H18.2	1	63” RCP	72” RCP	Figure 6-2
	Gateway Blvd	SD_H19.1	1	72” RCP	84” RCP	Figure 6-2
	Gateway Blvd	SD_H19.2	1	72” RCP	90” RCP	Figure 6-2
	Gateway Blvd	SD_H19.3	1	72” RCP	90” RCP	Figure 6-2
	Mitchell Ave	SD_H19.4	1	72” RCP	90” RCP	Figure 6-2
	Mitchell Ave	SD_H19.5	2	18” RCP	48” RCP	Figure 6-2
I	Mitchell Ave	SD_I2.5	2	33” RCP	48” RCP	Figure 6-3
	Mitchell Ave	SD_I2.6	2	36” RCP	72” RCP	Figure 6-3
	Utah Ave	SD_I4.1	2	21” RCP	48” RCP	Figure 6-3
	Utah Ave	SD_I4.2	2	21” RCP	54” RCP	Figure 6-3
	Colma Creek Service Rd	SD_I6.1	2	21” RCP	48” RCP	Figure 6-3
	Colma Creek Service Rd	SD_I6.2	2	21” RCP	Dual 3’x6’ RCB	Figure 6-3
J	Haskins Way	SD_J3.5	2	15” RCP	24” RCP	Figure 6-4
	Haskins Way	SD_J4.1	2	36” RCP	60” RCP	Figure 6-4
	Haskins Way	SD_J4.2	2	15” RCP	36” RCP	Figure 6-4
	Haskins Way	SD_J5.1	2	48” RCP	72” RCP	Figure 6-4
	Haskins Way	SD_J5.2	2	48” RCP	72” RCP	Figure 6-4
	Haskins Way	SD_J5.3	2	15” RCP	36” RCP	Figure 6-4
K	DNA Way	SD_K2.1	2	18” RCP	48” RCP	Figure 6-4
	Forbes Blvd	SD_K5.1	2	27” RCP	Parallel 42” RCP	Figure 6-4
	Forbes Blvd	SD_K5.2	2	27” RCP	Parallel 48” RCP	Figure 6-4
	Forbes Blvd	SD_K5.3	2	27” RCP	Parallel 48” RCP	Figure 6-4
	Forbes Blvd	SD_K5.4	2	27” RCP	Parallel 54” RCP	Figure 6-4
	Forbes Blvd	SD_K5.5	2	33” RCP	Triple 3’x6’ RCB	Figure 6-4
	Forbes Blvd	SD_K5.6	2	18” RCP	36” RCP	Figure 6-4
	Forbes Blvd	SD_K5.7	2	33” RCP	Triple 3’x6’ RCB	Figure 6-4
	Forbes Blvd	SD_K5.8	2	33” RCP	Dual 4’x8’ RCB	Figure 6-4
L	Oyster Point Blvd	SD_L3.1	2	18” RCP	36” RCP	Figure 6-4
	Oyster Point Blvd	SD_L3.2	2	18” RCP	48” RCP	Figure 6-4
	Oyster Point Blvd	SD_L3.3	2	18” RCP	48” RCP	Figure 6-4
	Oyster Point Blvd	SD_L3.4	2	18” RCP	60” RCP	Figure 6-4
	Oyster Point Blvd	SD_L3.5	2	18” RCP	60” RCP	Figure 6-4
	Oyster Point Blvd	SD_L3.6	2	18” RCP	60” RCP	Figure 6-4

Subwatershed	Street	Facility Name	Priority	Existing Size	Proposed Size	Improvement Map
	Marina Blvd	SD_L5.1	2	12” RCP	Triple 2’x4’ RCB	Figure 6-4
	Oyster Point Blvd	SD_L6.1	2	12” RCP	24” RCP	Figure 6-4
	Oyster Point Blvd	SD_L7.5	2	12” RCP	24” RCP	Figure 6-4
	Oyster Point Blvd	SD_L7.6	2	30” RCP	48” RCP	Figure 6-4
	Oyster Point Blvd	SD_L7.7	2	30” RCP	48” RCP	Figure 6-4



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

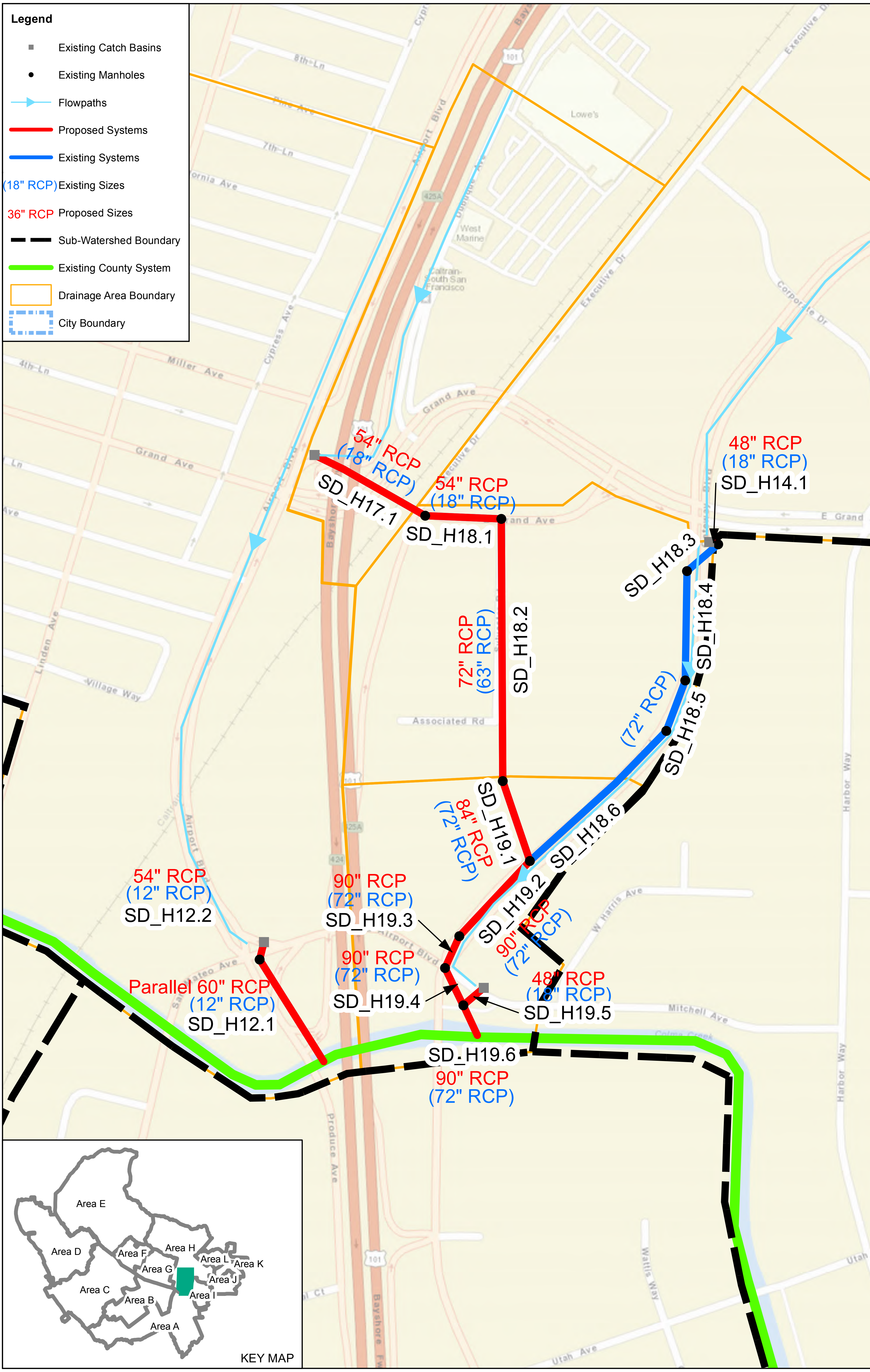
0 155 310 620 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP A1-A26

Figure 6-1



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

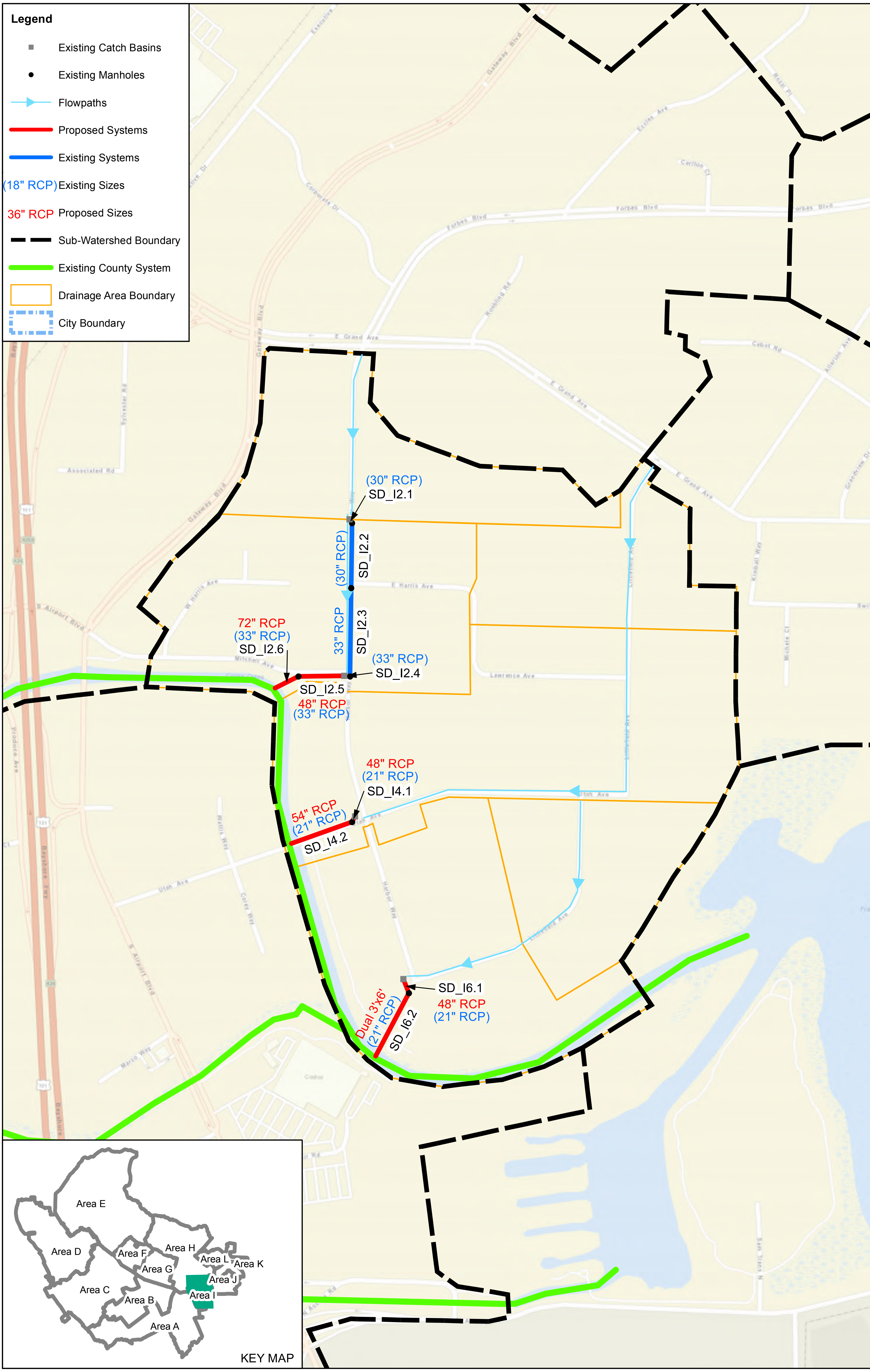
0 85 170 340 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP H10-H19

Figure 6-2



1/7/2016 JN M:\Mdata\143186\GIS\MXD\Hydrology\SSF_Improvements_Portraits.mxd

Michael Baker INTERNATIONAL

NORTH

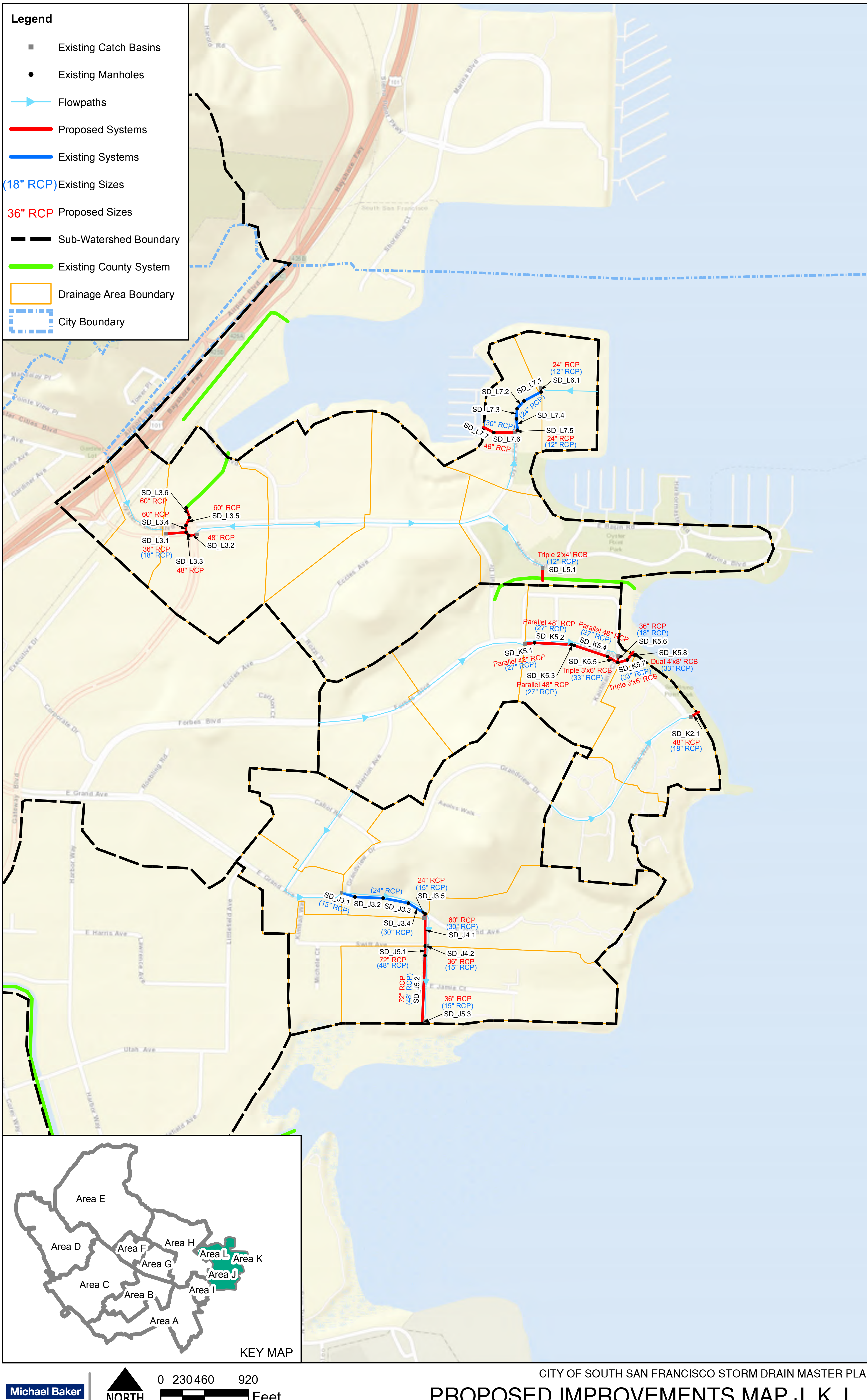
0 130 260 520 Feet

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP I1-I6

Figure 6-3



Michael Baker INTERNATIONAL

Source:

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

PROPOSED IMPROVEMENTS MAP J, K, L

Figure 6-4

6.2.3 Cost Estimates

Table 6-3 provides an estimate of the construction and total project costs of recommended improvements for this drainage area. See Appendix H: Cost Estimations for detailed cost calculations.

Table 6-3: Lower Region Total Cost Estimate

Watershed	Construction Cost	Total Project Cost
A	$6,059,000	$7,711,000
H	$2,676,000	$3,448,000
I	$819,000	$1,074,000
J	$757,000	$962,000
K	$1,319,000	$1,740,000
L	$1,221,000	$1,551,000
Total	**$12,851,000**	**$16,486,000**

This page intentionally left blank.

7 Water Quality Facilities

7.1 Trash Capture Devices

To identify the optimal trash capture devices (TCDs) for the City, a comprehensive watershed assessment process was used. The integrated Watershed Assessment Tool for Restoration (iWATR™) is a spreadsheet tool developed to identify, evaluate, and select appropriate TCD retrofits for watershed restoration. It includes the following components:

a. Geographic information system (GIS) watershed analysis to identify potential TCD retrofit locations;
b. TCD prioritization and assessment to integrate the results of the water quality analysis;
c. Constructability analysis to further prioritize sites; and
d. TCD cost estimation.

A schematic of the iWATR™ process is shown in Figure 7-1

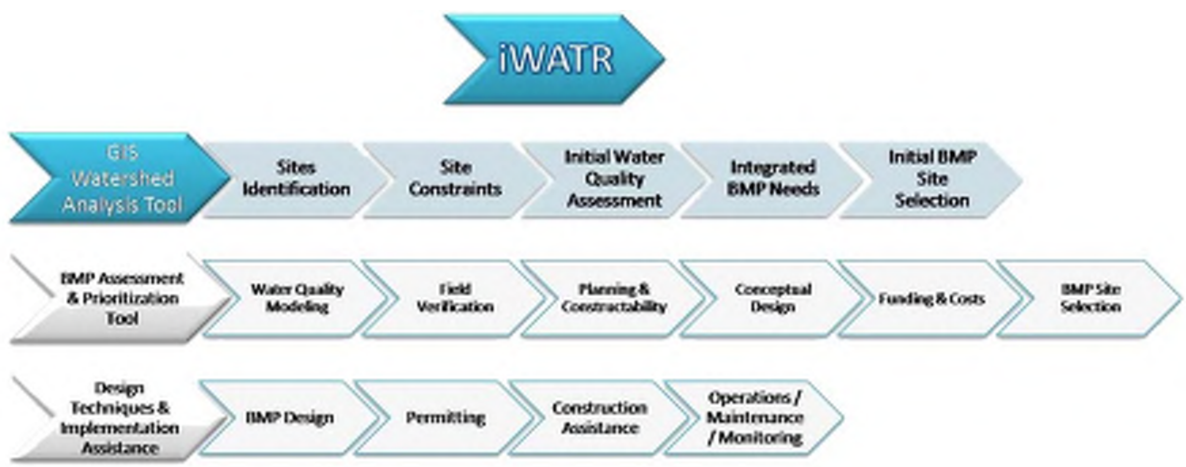


Figure 7-1: iWATR™ Process

The iWATR™ process was used to survey the watershed for opportunities using the following information:

- Aerial Imagery Information – Aerial photography from the United States Geological Survey (USGS) provides an understanding of the local land uses, terrain, and density of vegetation, physical obstructions, and utilities. Specific land uses such as parks, parking lots, and open space that are potentially suitable for the implementation of regional facilities are of particular interest.
- Ownership of parcels – Parcels in GIS format provided by public and private databases typically include information related to the ownership and the assessor's estimate of the parcel. Some of the potential sites identified are owned by government agencies or conservation organizations. Public parcels, including county-owned parcels and municipal parks, were investigated.

- Tributary Area Served – The identification process focuses on sub-regional and regional-scale opportunities to use the maximum drainage area for treatment by a trash capture device. The topography helps delineate the tributary areas.
- Proximity to Existing Drainage Facilities – Cost-effectiveness of the regional opportunities is partly driven by the need for offsite infrastructure improvements, including diversion structures and piping. The investigation focuses on sites adjacent to or near improved channels, and storm drains. Regional BMPs that receive discharges through gravity are preferred in an effort to minimize high operation and maintenance costs associated with the implementation of pumps and lift stations.

7.1.1 Identification of Trash Capture Devices in South San Francisco

The initial phase of the BMP site selection process included using GIS analysis, aerial topography, storm drain information, and geotechnical information to find locations for placement of a regional BMP. The following factors were considered when identifying potential suitable BMP site locations: land availability, topography, hydrology, existing stormwater infrastructure, land ownership, physical site constraints, maintenance access, and areas of high trash generation. Fifteen sites were identified and analyzed. A limited number of potential regional BMP sites were available due to urbanization, topography, tributary drainage areas, available hydraulic head, and land ownership. Most of the locations were found in public parks, vacant land, pump stations, or open space. The following subsections identify the elements of the technical approach used to identify regional and local trash capture devices in the City.

7.1.1.1 TCD Types

Following are brief descriptions of the types of trash capture devices evaluated for integration in the City. Maintenance information for these devices is provided in Table 7-1.

TCDs must be approved by the San Francisco Bay Regional Water Quality Control Board staff. The San Francisco Estuary Partnership maintains an updated list of trash devices that have been approved by the RWQCB. Last updated in May 2014 and included in this report as Appendix G-1, the list includes 42 TCDs from 15 vendors. Following is a brief summary of each type of TCD:

- Pipe Screen: Pipe screens are physical screens that are perforated to catch trash larger than the size of the perforation and allow storm water to pass through to the connecting system. Perforation size can vary, but 5 millimeters is typical. Screen material is typically stainless steel, but HDPE screens also exist. The screen can be removable or non-removable and is to be used in combination with inserts.
- Separators: Various types of separators are available, including oil-debris separators, continuous deflective separators (CDS), and hydrodynamic separators. Separators function by separating sediments through a centrifugal force as stormwater passes downwards through the device. Floatable trash, debris, and oils are retained behind baffle areas. They are typically installed as a manhole vault.
- Filter Insert: Filter inserts are removable curb inserts. Various types of filters are available and vary by the facility in which they are used. Skimmer boxes are designed for grated inlets and can be used for retrofit applications. They can provide multi-stage filtration and are effective at removing trash, as well as other pollutants, including total suspended solids (TSS), phosphorus, and metals. Catch basin inserts can capture sediment, trash, and oil/grease while allowing high flows to bypass, and they are available in various sizes. Filters can be perforated meshes similar to pipe screens or they can be made of fibrous material that replicates a biofiltration process.

- In-Line Netting: In-line netting captures gross pollutants within the pipe and allows flows to continue through the system.
- End-of-Line Netting: End of line netting captures gross pollutants at the pipe's point of discharge into a connecting canal or outfall. They require no structural changes to be made at the discharge point. Solids are captured by the net, and flows continue through the system.

Table 7-1: Maintenance of Trash Capture Devices

BMP or Device Type	Maintenance and Inspection	
	Activity	**Schedule**
Drain insert (catch basin insert)	Remove Trash and Debris	Monthly
	Monitor for sediment accumulation in and upstream of the insert	Annually
	General Inspection for Structural Integrity	Annually
	Replace insert material, dispose of saturated insert properly	Every 3 years
Hydrodynamic separator	Remove Trash and Debris	Annually
	Remove Sediment accumulation in the sump	Annually
	General Inspection for Structural Integrity	Annually
Water quality inlet	Remove Trash and Debris	Monthly
	Monitor for sediment accumulation in and upstream of the inlet	Annually
	General Inspection for Structural Integrity	Annually
	Replace insert material, dispose of saturated insert properly	Bi-Annually
Screen and racks	Remove Trash and Debris	Annually
	Remove Sediment accumulation	Annually
	General Inspection for Structural Integrity	Annually
Netting: in-line and end-of-line	Remove Trash and Debris	Annually
	Remove Sediment accumulation	Annually
	Replace Netting	Bi-Annually
Litter booms	Clear boom of trash and debris	Weekly
	Remove litter from surrounding shoreline	Weekly
	Remove barrier and scrape of biological material (mussels, etc)	Bi-Annually

TCDs can also remove pollutants. Sediments, oil/grease, metals, organics, nutrients, and bacteria can be targeted based on TCD selection. Most devices remove these pollutants at a moderate or low level. Devices that have a high level of pollutant removal are typically more expensive.

A summary of TCD details including descriptions, pollutant removal, benefits, and limitations can be found in Appendix G-2.

7.1.1.2 Desktop Survey

The technical approach for identifying potential structural BMP site locations included the development of site selection criteria. The BMP siting and selection criteria and steps conducted were as follows:

1. Identification of the City boundary in the watershed using GIS –This step allowed the search to be focused on the areas within the City.
2. Use of aerial imagery to identify vacant parcels – Storm drain networks, USGS topography, and aerial photography were used to identify potential BMP locations and the tributary drainage area. These data sets also provided an understanding of the local land uses, terrain, and density of vegetation, physical obstructions, and utilities. The topographical information allowed for a hydrology analysis, including:
    a. confirmation of watershed drainage areas to each potential site;
    b. evaluation of gravity drainage to a potential TCD site from either the site drainage area for local sites or an adjacent receiving water for extraction or diversion of water for regional sites;
    c. evaluation to determine the need for reasonable hydraulic modifications and infrastructure additions/modifications; and
    d. Identification of vacant parcels ownership
3. Selection of potential TCDs for the identified potential sites – A list of potential TCDs for the sites was developed based on the drainage areas and site constraints. For each potential TCD site, specific site information was identified and reviewed, including:
    - area available for the TCD footprint;
    - available hydraulic head; and
    - maintenance access.

7.1.1.3 Initial TCD Prioritization Methodology

Potential locations for the regional TCD are based on the desktop survey results. This initial prioritization provided the baseline for identifying the sites that provide the greatest potential to retain the trash from high trash generating areas for the 1-year, 1-hour storm event. Based on the prioritization, a preliminary list of regional TCD sites was developed.

The initial TCD prioritization allowed the City to have a ranking of potential TCD locations based on their capacity to effectively treat the tributary drainage area. The ranking process (Table 7-2) is based on the development of a benefit score that is obtained through evaluation of independent variables. The overall benefit score considers three independent scores defined by:

- Watershed Trash Generation Rate (30%)
- Acres Captured (40%)
- Constructability (30%)

Watershed Trash Generation Rate

The best available TCD location will be one that treats a high percentage of tributary area that is identified as a high trash generating areas. The high trash generating areas receive a higher weight than the medium or low trash generating areas.

Water Quality Capture

The second factor in scoring regional project sites is the treatment of the TCD in relation to its drainage area. If a TCD has a treatment area of 20 acres compared to another with five acres, then the 20-acre TCD will have a greater weighted score. The score is represented by the treatment of one TCD (Capture Area) divided by the TCD tributary drainage area (TDA).

Constructability Analysis

The constructability analysis has been generated to understand if a BMP is feasible for construction. Characteristics that contribute to the feasibility of a BMP include:

- drainage area greater than one acre;
- potential for maintenance access; and
- sufficient available hydraulic head.

For a TCD to be feasible, at a minimum, the TCD needs to have all these characteristics. Appendix G-3 identifies four parameters that, if present, may make construction of the TCD infeasible or not cost effective. Table 7-2 shows the ranking prioritization process based on the three factors.

Table 7-2: Prioritization Weighting Factors

Key factors	Sub-factors	Variables	Weights	Percent Weight
Water Quality Benefits	Watershed Trash Generation Rate	High	1.00	30%
		Medium / Low	0.500	
	Water Quality Capture %	$\frac{Capture\ Area}{TDA}$	1	40%
	Constructability	High	1	30%
		Medium	0.80	
		Low	0.60	
OVERALL WATER QUALITY SCORE				**100%**

7.1.2 Potential Regional and Neighborhood TCD

The potential list of regional and neighborhood TCD projects for implementation in the City are identified in Table 7-3 and Table 7-4. These BMPs have been identified as potential locations for further evaluation, prioritization, constructability analysis, and costs evaluation.

Table 7-3: List of Regional Trash Capture Devices

Site ID	TCD Recommended	Ownership	Land Use	Comments
TCD-1	CDS Unit w/pump	City of South San Francisco	Freeway Commercial	Requires pipe crossing from west to east. CDS unit will require pump.
TCD-2	CDS Unit w/pump	Fremont Frontier Motel	Freeway Commercial	TCD at proposed South Airport & Mitchell pump station per Long Term Plan.
TCD-3	CDS Unit w/pump	P.G. & E.	Freeway Commercial	TCD at existing South Airport Blvd Pump Station. Potential R/W constraints.

Site ID	TCD Recommended	Ownership	Land Use	Comments
TCD-4	CDS Unit w/pump	County of San Mateo	Mixed Industrial	TCD at existing Produce Avenue Pump Station. Potential R/W constraints.
TCD-5	CDS Unit w/pump	Frykberg Associates	Commercial Mixed-Use	Requires pipe crossing from west to east. Potential land acquisition.
TCD-6	CDS Unit w/pump	City & County of San Francisco Water Dept./City & County of San Francisco		Requires pipe crossing from west to east. Potential land acquisition.
TCD-7	CDS Unit w/pump	City & County of San Francisco Water Dept.	Open Space	Requires pipe diversion. Potential land acquisition.
TCD-8	CDS Unit w/pump	Remolona Jason D & Michelle L	Business Commercial	Potential land acquisition.
TCD-12	Basin w/TCD	City of South San Francisco	Parks and Recreation	
TCD-14	Netting	South San Francisco Redevelopment Agency	ECR/C-RH	
TCD-16	CDS Unit w/pump	State of California (assumed)		
TCD-17	CDS Unit at existing pump station	City of South San Francisco	Business Commercial	TCD at existing San Mateo Avenue Pump Station. Existing partial capture device in place.
TCD-18	CDS Unit at existing pump station	City of South San Francisco	Mixed Industrial	TCD at existing South Linden Pump Station.
TCD-19	CDS Unit w/at existing pump station	City of South San Francisco (assumed)		TCD at existing South Maple Pump Station. Potential R/W constraints.
TCD-20	CDS Unit w/at existing pump station	Demaria M J & A J 2007 Trust/Mausser C & M B 2011 Trust	Mixed Industrial	TCD at existing Shaw Road Pump Station. Potential R/W constraints.

Table 7-4: List of Neighborhood Trash Capture Devices

Site Id	Trash Level	Location
1	High	470 Noor Ave
2	High	470 Noor Ave
3	High	470 Noor Ave

Site Id	Trash Level	Location
4	High	470 Noor Ave
5	High	171 State Highway 82
6	High	410 Noor Ave
7	High	171 State Highway 82
8	High	1405 Huntington Ave
9	High	209 El Camino Real
10	High	1405 Huntington Ave
11	High	1405 Huntington Ave
12	High	180 El Camino Real
13	High	1487 Huntington Ave
14	High	120 S Linden Ave
15	Very High	120 Terminal Ct
16	Very High	120 Terminal Ct
17	Very High	264 S Airport Blvd
18	High	133 Southwood Center
19	High	Southwood Center
20	High	609 Orange Ave
21	High	609 Orange Ave
22	High	176 E Grand Ave
23	High	115 Harbor Wy
24	High	115 Harbor Wy
25	High	180 E Grand Ave
26	High	190 E Grand Ave
27	High	74 Camaritas Ave
28	High	405 Grand Ave
29	High	405 Grand Ave
30	Very High	899 Airport Blvd
31	High	899 Airport Blvd
32	High	975 Linden Ave
33	High	967 Airport Blvd
34	High	967 Airport Blvd
35	High	967 Airport Blvd
36	High	1001 Airport Blvd
37	High	1001 Airport Blvd
38	Very High	1165 Airport Blvd
39	Very High	1201 Airport Blvd
40	Very High	101 Oyster Point Blvd
41	Very High	101 Oyster Point Blvd
42	High	ECR and Mclellan
43	High	101 Mclellan

Site Id	Trash Level	Location
44	High	101 Mclellan
45	High	El Camino Real
46	Very High	1289 Mission Rd
47	High	El Camino Real
48	High	
49	Very High	Evergreen and Mission Rd
50	Very High	1296 Mission Rd
51	High	1600 State Highway 82
52	High	1600 State Highway 82
53	High	1600 State Highway 82
54	Very High	Mission Rd
55	High	1600 State Highway 82
56	High	1600 State Highway 82
57	High	861 Camaritas Cir
58	High	1600 State Highway 82
59	High	1600 State Highway 82
60	High	Costco Parking Lot
61	High	1600 State Highway 82
62	High	El Camino Real
63	High	113 Hickey Blvd
64	High	
65	High	El Camino Real
66	High	1600 State Highway 82
67	High	
68	High	1600 State Highway 82
69	High	

7.2 Alternatives Analysis of Trash Capture Devices

7.2.1 Evaluation of Alternatives

Cost Analysis

Costs of each device are determined from various sources, including:

- manufacturer brochures;
- October 25, 2012 update to the approved list of trash control devices as provided in Appendix I of the Bay Area-wide Trash Capture Demonstration Project (November 2013);
- Appendix A: BMP Fact Sheets from the June 2010 San Francisco Stormwater Design Guidelines;
- Trash BMP Tool Box from the September 2007 Santa Clara Valley Urban Runoff Pollution Prevention Program; and
- communication with venders.

Costs can vary based on the quantity of the device ordered from the manufacturer, the size of the device, and the volume or flow capacity of the device. Devices can range from as low as $200 to as high as over $300,000. Generally, screens, racks, and inserts that can be fitted onto existing catch basins are less costly than alternatives that require right of way, such as media filters and basins, and are less costly than alternatives that require extensive retrofitting, such as hydrodynamic separators. A summary of capital costs for each device is provided in Table 7-5 and Table 7-6.

Maintenance Requirements

Maintenance of all TCDs requires the removal and disposal of collected trash and debris to ensure continued performance of the device. Maintenance activities can include street sweeping, vacuum trucks, visual inspection, and other device specific instructions. A summary of maintenance requirements, frequency, and cost estimates are provided in Appendix G-4.

7.2.1.1 Regional TCD

The desktop survey, described in Section 7.1.2, identified 15 potential locations for regional projects in the watershed. Based on initial assessment the majority of these potential locations have the ability to capture trash for the 1-year, 1-hour storm event for the drainage area tributary to the potential project. The proposed list of regional TCD identified in Table 7-5 includes the following information:

- Site ID
- Recommended TCD for implementation at the site
- Land ownership
- Drainage area to the TCD within SSF
- TCD Treatment flow
- TCD costs (capital, land acquisition, operation and maintenance)
- Water Quality Ranking

Table 7-5: Prioritized Regional Projects

Site ID	TCD Recommended	Land Ownership	Drainage Area Within SSF	1-year, 1-hour flow	Cost			Water Quality Ranking
					Construction	Land Acquisition	O&M	
TCD-14	Netting	SO SAN FRANCISCO REDEVELPMNT AGENCY	217 ac	240 cfs	$ 120,000	-	$ 1,200	73
TCD-18	CDS Unit or Hydrodynamic Separator at existing pump station	CITY OF SOUTH SAN FRANCISCO	95 ac	162 cfs	$ 832,000	-	$ 1,900	62
TCD-7	CDS Unit or Hydrodynamic Separator w/pump	CITY & CO OF S F WATER DEPT	950 ac	1,130 cfs	$ 416,000	-	$ 950	56
TCD-12	Basin w/TCD	CITY OF SOUTH SAN FRANCISCO	254 ac	144 cfs	$ 500,000	-	$ 2,000	54

Site ID	TCD Recommended	Land Ownership	Drainage Area Within SSF	1-year, 1-hour flow	Cost			Water Quality Ranking
					Construction	Land Acquisition	O&M	
TCD-6	CDS Unit or Hydrodynamic Separator w/pump	CITY & CO OF S F WATER DEPT/CITY & CO OF SAN FRANCISCO	290 ac	67 cfs	$ 416,000	-	$ 950	46
TCD-5	CDS Unit or Hydrodynamic Separator w/pump	FRYKBERG ASSOCIATES	385 ac	58 cfs	$ 416,000	$ 110,200	$ 950	45
TCD-1	CDS Unit or Hydrodynamic Separator w/pump	CITY OF SOUTH SAN FRANCISCO	118 ac	275 cfs	$ 768,000	-	$ 2,850	35
TCD-3	CDS Unit or Hydrodynamic Separator w/pump	P.G. & E.	45 ac	38 cfs	$ 184,000	$ 27,500	$ 950	32
TCD-19	CDS Unit or Hydrodynamic Separator at existing pump station	Assumed City of South San Francisco	33 ac	40 cfs	$ 32,416	-	$ 950	31
TCD-16	CDS Unit or Hydrodynamic Separator w/pump	Assumed State of California	69 ac	88 cfs	$ 184,000	-	$ 950	31
TCD-4	CDS Unit or Hydrodynamic Separator w/pump	COUNTY OF SAN MATEO	27 ac	35 cfs	$ 184,000	-	$ 950	31
TCD-17	CDS Unit or Hydrodynamic Separator at existing pump station	CITY OF SOUTH SAN FRANCISCO	05 ac	06 cfs	$ 78,400	-	$ 950	30
TCD-2	CDS Unit or Hydrodynamic Separator w/pump	FREMONT FRONTIER MOTEL	201 ac	420 cfs	$ 1,664,000	$ 385,700	$ 3,800	28
TCD-8	CDS Unit or Hydrodynamic Separator at existing pump station	REMOLONA JASON D & MICHELLE L	71 ac	22 cfs	$ 184,000	$ 27,500	$ 950	25
TCD-20	CDS Unit or Hydrodynamic Separator w/pump	DEMARIA M J & A J 2007 TRUST/ MAUSSER C & M B 2011 TRUST	26 ac	91 cfs	$ 78,400	$ 110,200	$ 950	24

7.2.1.2 Neighborhood TCD

In total, 40 existing catch basins or at-grade drain inlets were determined to be potential locations where TCDs can be installed. They are connected to storm drain networks that are not impacted by the 10-year flood event and are located within areas determined to be High or Very High for trash generation. The locations of these catch basins are identified in Exhibits 17-21.

The City currently has 97 connector pipe screens manufactured by West Coast Storm, Inc., installed throughout the City. Seven of these screens were installed on catch basins in areas of High trash generation and are connected to storm drains not impacted by a 10-year flood event. Of the original 69 neighborhood TCDs, 29 could not be verified with online mapping tools, because either the catch basins did not exist, or they were obstructed from view. The total number of potential TCD locations categorized by trash generation is shown in Table 7-6.

Table 7-6: Trash Generation Areas of Potential Trash Capture Device Locations

Site ID	TCD Recommended	Location	Trash Level	Cost		Water Quality Ranking
				Construction	O&M	
CB-39	Skimmer Box	1289 MISSION RD	Very High	$ 938	$ 450	100
CB-42	Skimmer Box	EVERGREEN AND MISSION RD	Very High	$ 1,876	$ 450	100
CB-43	Skimmer Box	1296 MISSION RD	Very High	$ 1,876	$ 450	100
CB-47	Skimmer Box	MISSION RD	Very High	$ 938	$ 450	100
CB-10	Screen Insert	1405 HUNTINGTON AVE	High	$ 550	$ 430	88
CB-11	Screen Insert	1405 HUNTINGTON AVE	High	$ 550	$ 430	88
CB-12	Screen Insert	180 EL CAMINO REAL	High	$ 550	$ 430	88
CB-13	Screen Insert	1487 HUNTINGTON AVE	High	$ 550	$ 430	88
CB-18	Screen Insert	609 ORANGE AVE	High	$ 550	$ 430	88
CB-2	Screen Insert	470 NOOR AVE	High	$ 550	$ 430	88
CB-20	Screen Insert	115 HARBOR WY	High	$ 550	$ 430	88
CB-20a	Screen Insert	115 HARBOR WY	High	$ 550	$ 430	88
CB-20b	Screen Insert	115 HARBOR WY	High	$ 550	$ 430	88
CB-21	Screen Insert	115 HARBOR WY	High	$ 1,650	$ 430	88
CB-25	Screen Insert	405 GRAND AVE	High	$ 550	$ 430	88
CB-26	Screen Insert	405 GRAND AVE	High	$ 550	$ 430	88
CB-27	Screen Insert	394 GRAND AVE	High	$ 550	$ 430	88
CB-31	Skimmer Box	967 AIRPORT BLVD	High	$ 938	$ 450	88
CB-35	Screen Insert	ECR AND MCLELLAN	High	$ 550	$ 430	88
CB-36	Screen Insert	101 MCLELLAN	High	$ 550	$ 430	88
CB-37	Screen Insert	101 MCLELLAN	High	$ 550	$ 430	88
CB-38	Skimmer Box	EL CAMINO REAL	High	$ 938	$ 450	88
CB-4	Screen Insert	470 NOOR AVE	High	$ 550	$ 430	88
CB-40	Skimmer Box	EL CAMINO REAL	High	$ 938	$ 450	88
CB-50	Skimmer Box	861 CAMARITAS CIR	High	$ 938	$ 450	88
CB-56	Screen Insert	113 HICKEY BLVD	High	$ 550	$ 430	88
CB-6	Screen Insert	410 NOOR AVE	High	$ 550	$ 430	88
CB-8	Screen Insert	1405 HUNTINGTON AVE	High	$ 550	$ 430	88
CB-9	Screen Insert	209 EL CAMINO REAL	High	$ 1,100	$ 430	88
CB-19	Skimmer Box	176 E GRAND AVE	High	$ 813	$ 450	75
CB-29	Screen Insert	975 LINDEN AVE	High	$ 1,100	$ 430	71
CB-22	Screen Insert	180 E GRAND AVE	High	$ 550	$ 430	63
CB-24	Screen Insert	74 CAMARITAS AVE	High	$ 550	$ 430	58
CB-28	Screen Insert	899 AIRPORT BLVD	High	$ 550	$ 430	58
CB-3	Screen Insert	470 NOOR AVE	High	$ 550	$ 430	58
CB-32	Screen Insert	967 AIRPORT BLVD	High	$ 550	$ 430	58

Site ID	TCD Recommended	Location	Trash Level	Cost		Water Quality Ranking
				Construction	O&M	
CB-5	Screen Insert	171 STATE HIGHWAY 82	High	$ 550	$ 430	58
CB-55	Screen Insert	EL CAMINO REAL	High	$ 550	$ 430	58
CB-58	Screen Insert	EL CAMINO REAL	High	$ 550	$ 430	58
CB-7	Screen Insert	171 STATE HIGHWAY 82	High	$ 550	$ 430	58

7.2.2 Cooperative Implementation

There may be opportunity to partner with Caltrans on implementation of trash capture devices at locations treating both the City and Highway 101 and Highway 280 (Exhibit 1). Caltrans has set aside funds for cooperative implementation projects within TMDL watersheds, which would fund the capital improvements, including design and construction of treatment control measures. Candidate projects qualifying for these funds will need to build full/partial trash capture devices and treatment controls that remove one or more of the pollutants for which TMDLs have been adopted within the San Francisco Bay Region.

7.2.3 Trash Capture Device Implementation Recommendations

The MRP NPDES Permit requires a 70% reduction in trash by 2017 and 100% reduction in trash by 2022. These requirements necessitate the implementation of TCD in strategic locations. Initial TCD installations are recommended at the locations identified in Table 7-5 with the highest priority. These locations were prioritized according to three criteria: acres of High trash generation (30%), total area treated (40%), constructability (30%). Constructability was evaluated based on right-of-way purchase, available hydraulic head, maintenance access, and the length of new storm drain pipe construction required to divert flows to a recommended TCD location.

The top six TCD locations have the ability to treat approximately 2,100 to 2,200 acres. The drainage area for TCD-6 is located within the drainage area of TCD-5. The TCD-5 drainage area captures all the tributary area to TCD-6 plus an additional 95 acres; however, the property required for a BMP to treat the TCD-5 drainage area is not currently owned by the City and the constructability is more complex. Installation of the recommended TCD at TCD-5 and TCD-6 will require that approximately 100’ to 200’ of pipe be constructed from the existing storm drain network to the locations where the TCDs are proposed.

Several medium priority locations have been identified as feasible locations for TCDs; however, these locations are less favored due to the fewer acres of High trash generation area treated and the smaller amount of overall treated area.

A major challenge encountered in the identification of suitable locations for TCDs, was footprint availability for large TCDs due to the sizable amount of tributary area and high flow rates needing treatment. Right-of-way purchase is required for eight of the fifteen recommended TCD locations. For additional flow to be treated, additional right-of-way is required to accommodate larger custom TCD devices or treatment in series through moderately sized TCD devices. Additionally, the high flow rates often could not be accommodated by manufactured devices. Many manufactured devices have an upper limit in treatment capacity. In such cases, several units will need to be installed in series to maximize treatment. Appendix G-5 contains the final prioritization matrix for the recommended TCDs.

Numerous neighborhood TCDs are also recommended to capture trash in the high and very high trash generating areas. The locations identified in Table 7-6 are not tributary to identified Regional TCD locations. These account for 40 locations, treating approximately 25 acres.

8 Capital Improvement Plan

8.1 Implementation

A priority ranking was developed for all proposed facilities within their corresponding regions and subwatersheds. The improvements broken down by priority can be found in Appendix F: Cost Estimations. The goal of the priority ranking system is to determine the projects of greatest importance and determine which projects should be constructed first when funding becomes available. The three priorities are summarized as follows:

- **Priority 1**
    - **Known Flooded Areas:** Existing storm drain systems classified as being in severe defect condition as stated by the City. Systems where calculated flooding depth or velocity will inundate structures or create a threat to human life.
    - **Other:** Systems downstream of area above that are in need to be improved to prevent flooding upstream
- **Priority 2**
    - **Arterial Streets**: Existing storm drain systems for which a size increase is recommended.
- **Priority 3**
    - **Local Streets:** Existing storm drain systems for which a size increase is recommended

Tables 8-1 through 8-3 break down the cost per drainage area for each priority.

Table 8-1: Priority 1 Cost Estimate Summary

Watershed	Proposed Construction Cost	Proposed Total Project Cost
Northern Region	$0	$ 0
Southern Region	$11,573,000	$14,701,000
Lower Region	$6,792,000	$8,673,000
Total Priority 1 System Cost	**$18,365,000**	**$23,377,000**

Table 8-2: Priority 2 Cost Estimate Summary

Watershed	Proposed Construction Cost	Proposed Total Project Cost
Northern Region	$3,255,000	$4,153,000
Southern Region	$12,047,000	$ 15,401,000
Lower Region	$5,728,000	$7,391,000
Total Priority 2 System Cost	**$21,030,000**	**$26,945,000**

Table 8-3: Priority 3 Cost Estimate Summary

Watershed	Proposed Construction Cost	Proposed Total Project Cost
Northern Region	$1,020,000	$1,335,000
Southern Region	$1,722,000	$2,213,000
Lower Region	$331,000	$420,000
Total Priority 3 System Cost	**$3,073,000**	**$3,968,000**

This page intentionally left blank.

9 Final Considerations and Recommendations

Storm Drain master planning studies are planning-level documents focused on identifying a citywide storm drainage system to reduce flooding risk and improve water quality. Implementation of any facility identified in this document as deficient should be supplemented with detailed focused hydrology and hydraulic calculations during the final design process. Additional studies that should be performed during final design include detailed geotechnical investigations, utility mapping, surveying, catch basin design, and utility relocation.

In this SDMP, the entire storm drain system located within the City's jurisdiction was analyzed. The most updated storm drain information was used in conjunction with a coupled hydrology and hydraulics model in XPSWMM. The comprehensive model's basis of GIS data makes the XPSWMM model a valuable tool for future design projects. The City would have to purchase an XPSWMM license and have staff trained in the use of the program to maintain the model in house. The model will require knowledge of the County of San Mateo hydrology and hydraulic methods to efficiently model future improvements.

One of the main goals of this comprehensive model was to provide the City with a living document and model that could be revised as significant changes in the storm drain system are completed. These changes include but are not limited to roadway improvements, new development and redevelopment projects, and storm drain improvements. Generally, the SDMP for any city should be updated every ten years, and Michael Baker recommends that the City review this SDMP in ten years. However, the approach used in this SDMP allows the City to continuously revise the models, which could result in lower overall costs to produce future master plans. Future revisions to consider include addition of currently missing or incomplete storm drain infrastructure data, analysis of current recommended capital improvement projects as they are designed and constructed, storm drain improvements constructed by others, updates to rainfall data by the County of San Mateo, and changes in the County of San Mateo hydrology and hydraulics methods.

This page intentionally left blank.

10 References

Alameda County Hydrology Manual, 2003

California Regional Water Quality Control Board, San Francisco Region. (2009). *San Francisco Bay Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit*, Order R2-2009-0074, NPDES Permit No. CAS612008 (As amended on November 28, 2011 by Order No. R2-2011-0083)

California State Water Resources Control Board. (1969). *Porter-Cologne Water Quality Control Act*. (With additions and amendments effective January 1, 2015)

City of South San Francisco Public Works. (1997). *Drainage Index Map*.

County of Los Angeles Department of Public Works. (2006). *The County of Los Angeles Department of Public Works Hydrology Manual*. Alhambra: Water Resources Division.

Department of Transportation, State of California. (2010). *Standard Plans*

NOAA Atlas 14, Volume 6, Version 2. Point Precipitation Frequency Estimates.

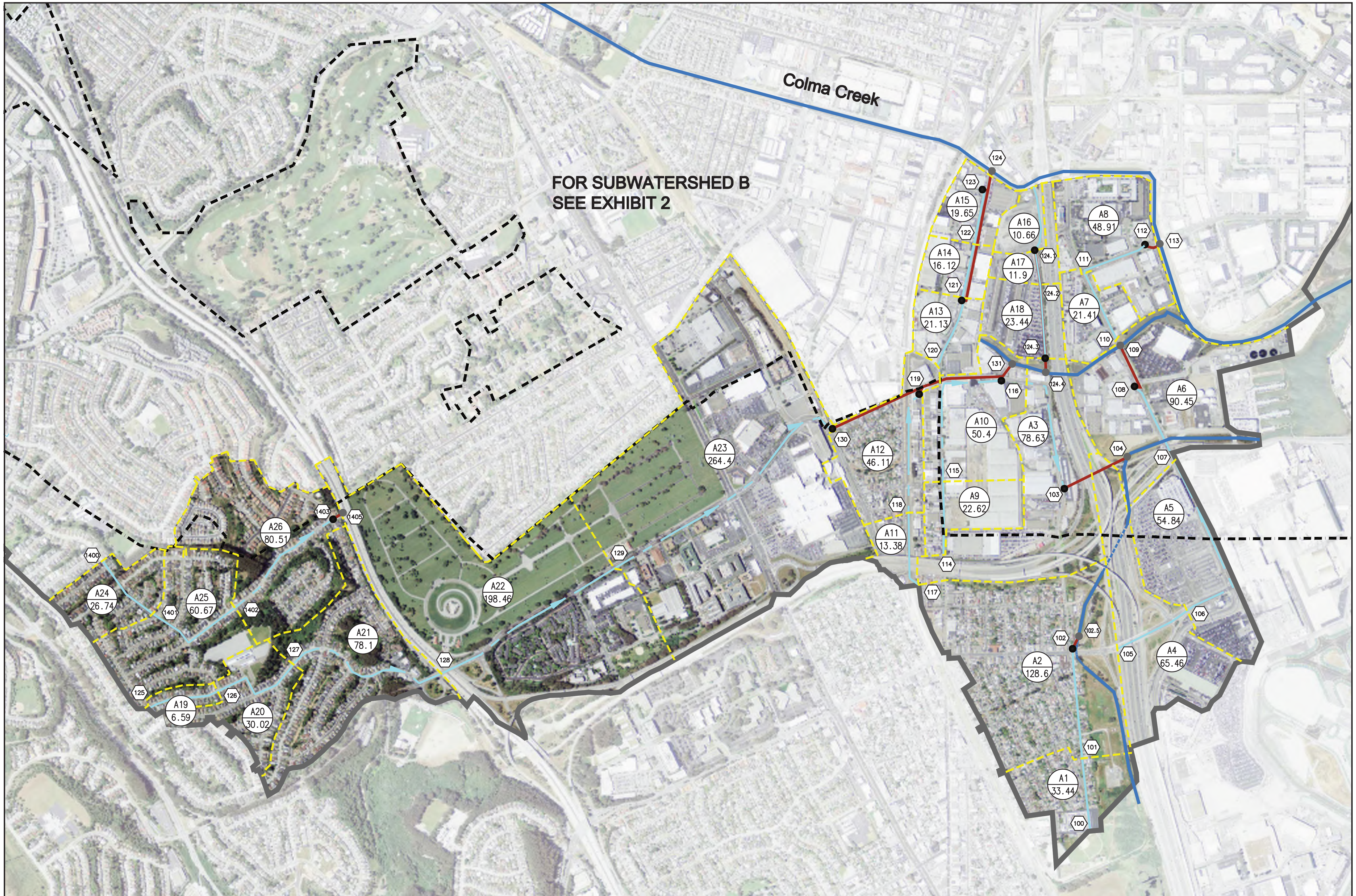
RSMeans. *Heavy Construction Cost Data 2016*.

San Mateo County. *Guidelines for Drainage Review*

United States Environmental Protection Agency (U.S. EPA). (1972). *Clean Water Act*.

US Geological Survey and San Francisco State University. (2010). *Golden Gate Lidar Project*

This page intentionally left blank.



LEGEND

- HYDROLOGY NODE
- A1 2.22 SUBAREA DESIGNATION AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed A Hydrology Map

Exhibit 1

LEGEND

- 1000 HYDROLOGY NODE
- A1 2.22 SUBAREA DESIGNATION AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed B Hydrology Map

Exhibit 2

LEGEND

- 1000 HYDROLOGY NODE
- A1 / 2.22 SUBAREA DESIGNATION / AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

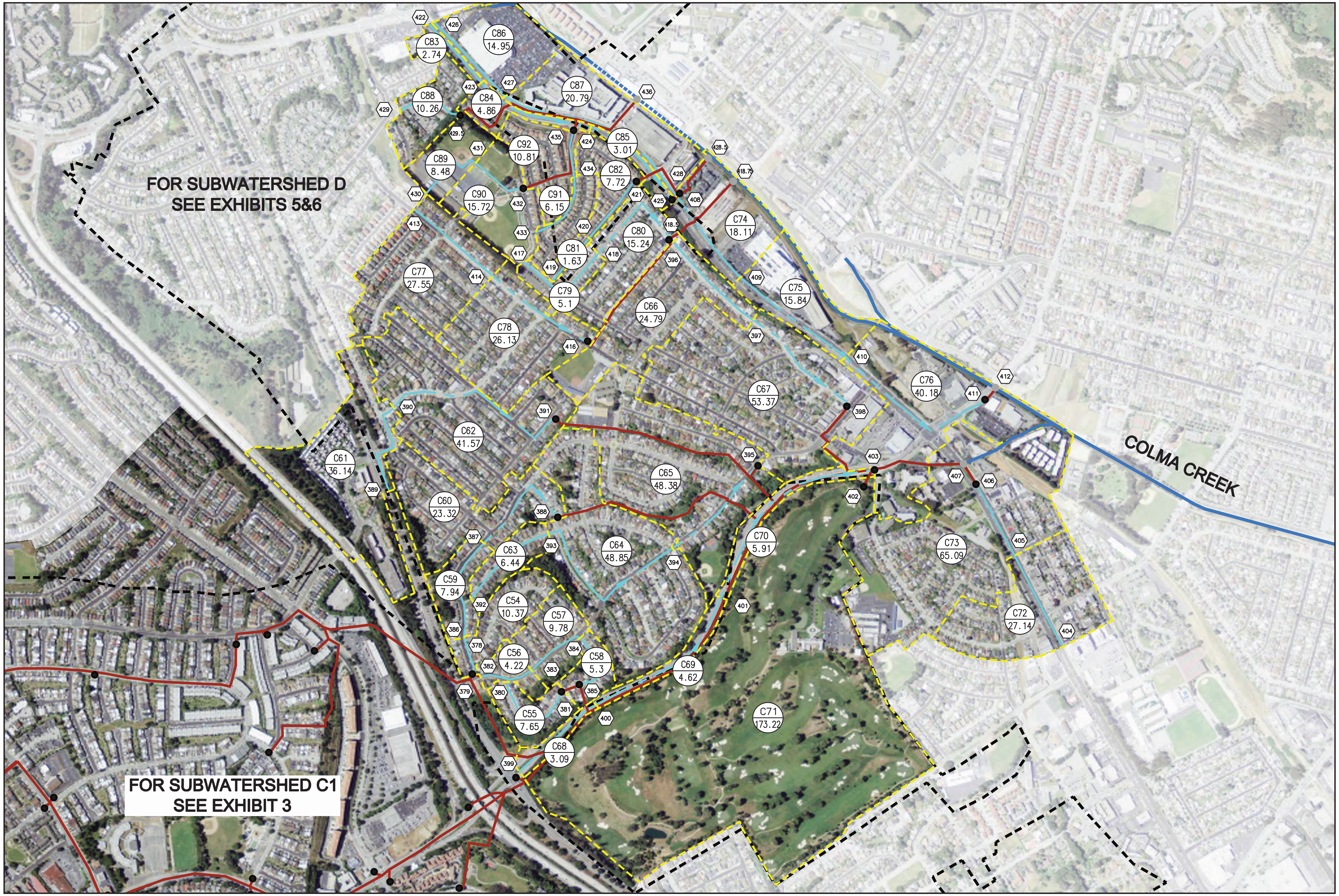
NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed C1 Hydrology Map

Exhibit 3



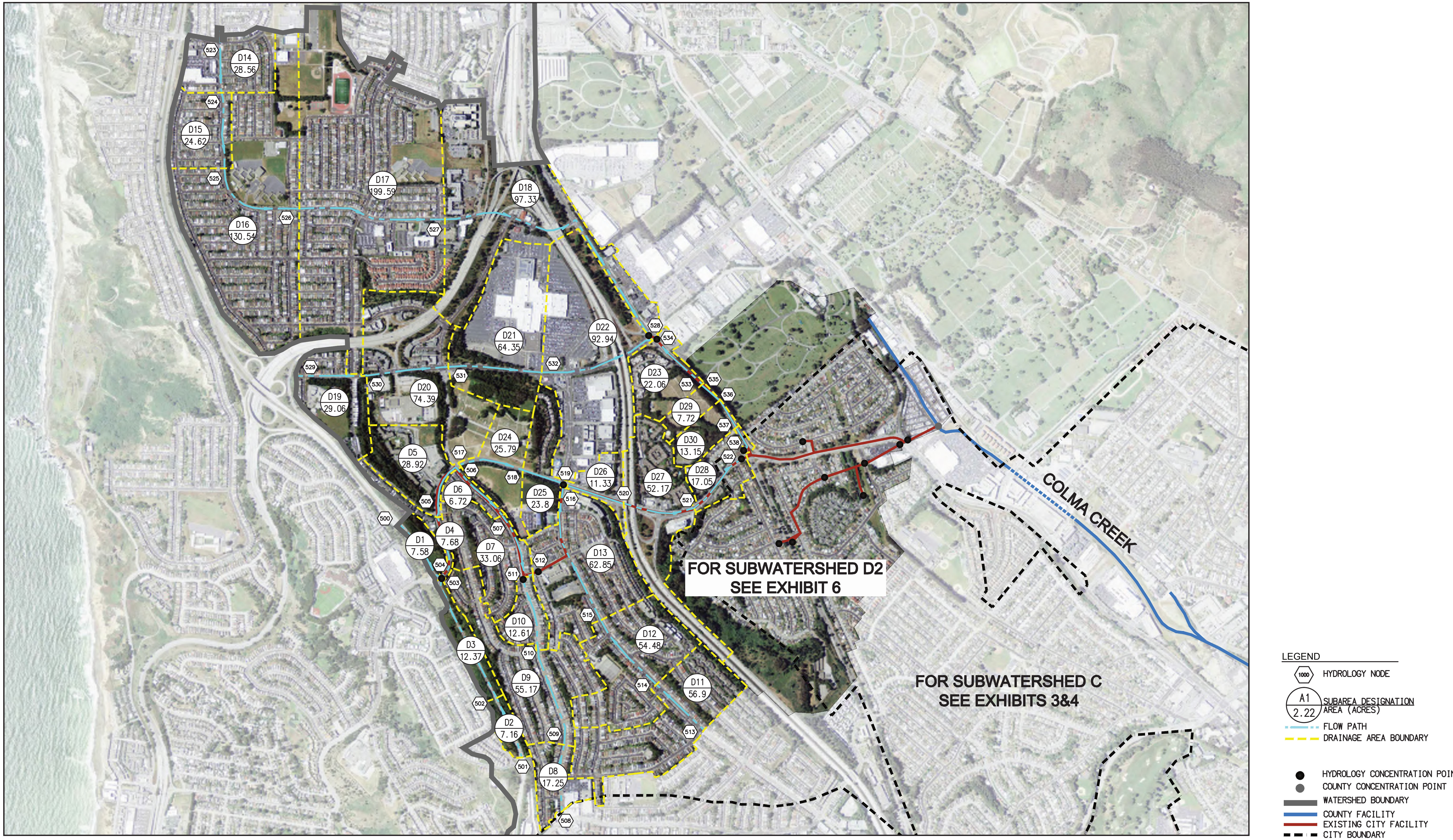
Michael Baker INTERNATIONAL

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed C2 Hydrology Map

Exhibit 4



Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed D1 Hydrology Map

Exhibit 5

LEGEND
- HYDROLOGY NODE (1000)
- A1 / 2.22 — SUBAREA DESIGNATION / AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed D2 Hydrology Map

Exhibit 6

LEGEND

- HYDROLOGY NODE
- A1 / 2.22 — SUBAREA DESIGNATION / AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed E Hydrology Map

Exhibit 7

LEGEND

- 1000 HYDROLOGY NODE
- A1 2.22 SUBAREA DESIGNATION AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed F Hydrology Map

Exhibit 8

LEGEND

- 1000 HYDROLOGY NODE
- A1 / 2.22 SUBAREA DESIGNATION / AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed G&H Hydrology Map

Exhibit 9

LEGEND

- HYDROLOGY NODE
- SUBAREA DESIGNATION / AREA (ACRES)
- FLOW PATH
- DRAINAGE AREA BOUNDARY
- HYDROLOGY CONCENTRATION POINT
- COUNTY CONCENTRATION POINT
- WATERSHED BOUNDARY
- COUNTY FACILITY
- EXISTING CITY FACILITY
- CITY BOUNDARY

Michael Baker INTERNATIONAL

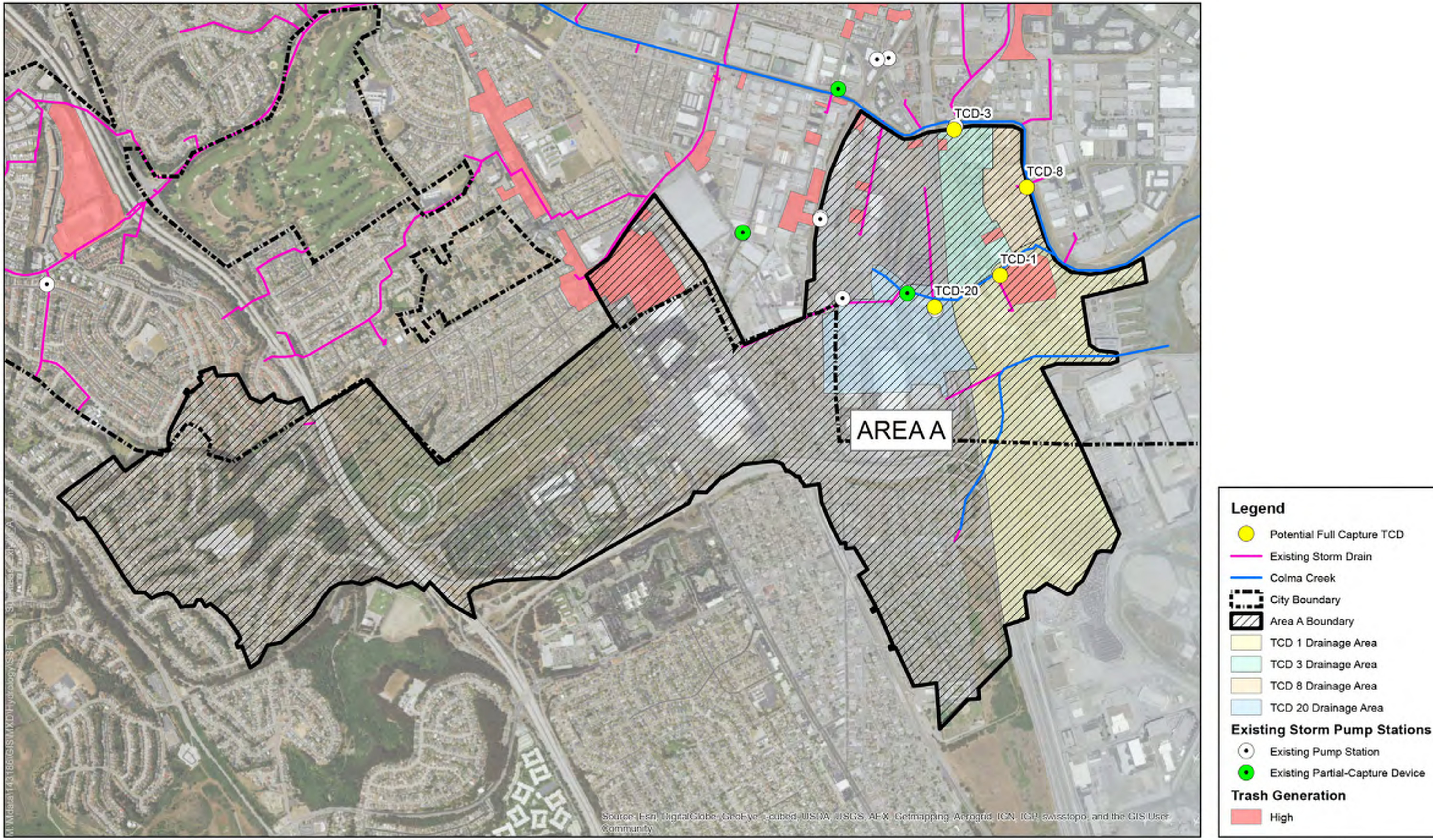
NORTH 0 300' APPROXIMATE

11/2/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Subwatershed I,J,K&L Hydrology Map

Exhibit 10



Michael Baker INTERNATIONAL

NORTH

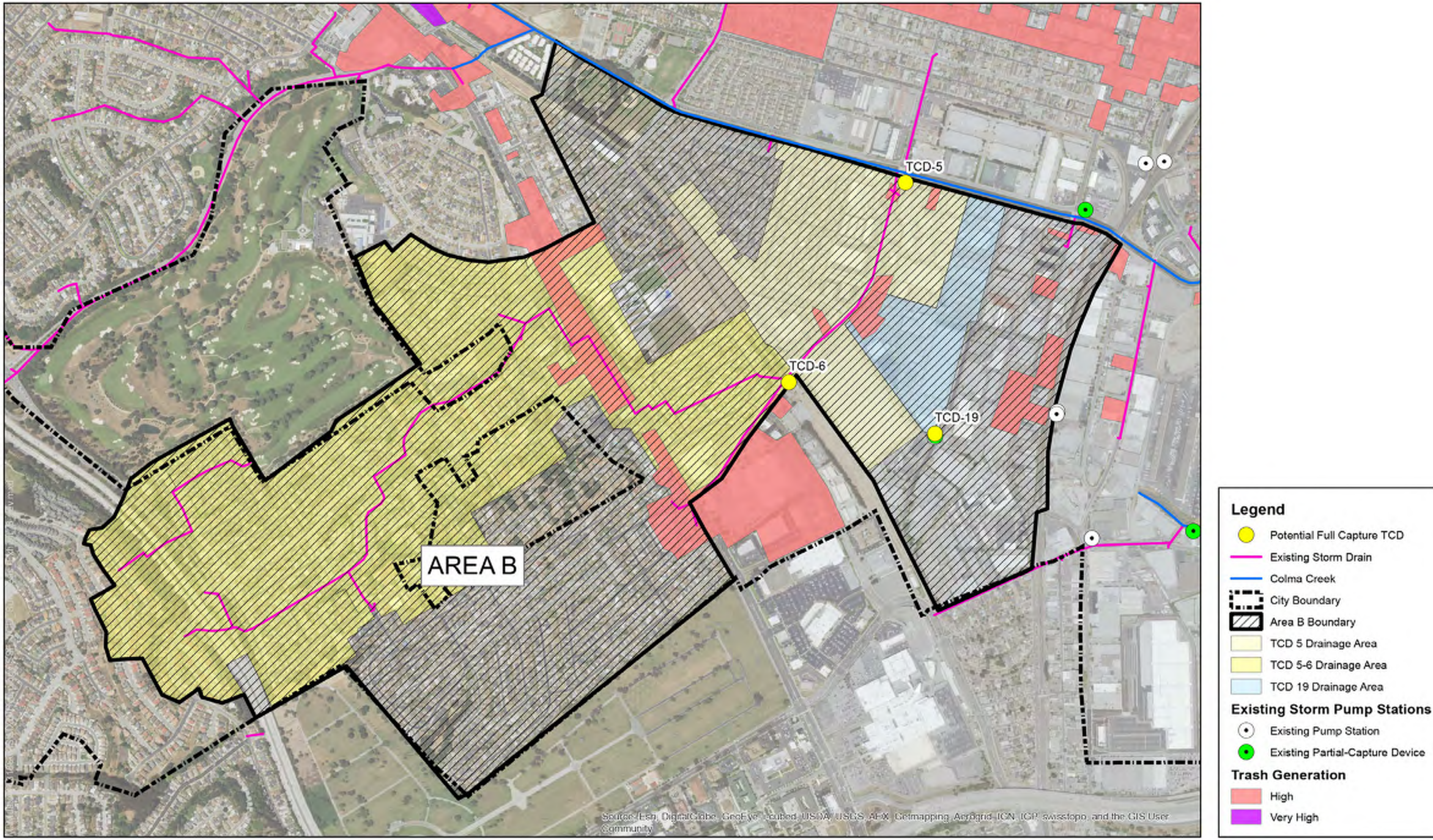
0 750' 1500' 3000'
APPROXIMATE

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area A - Trash Capture Devices

Exhibit 11



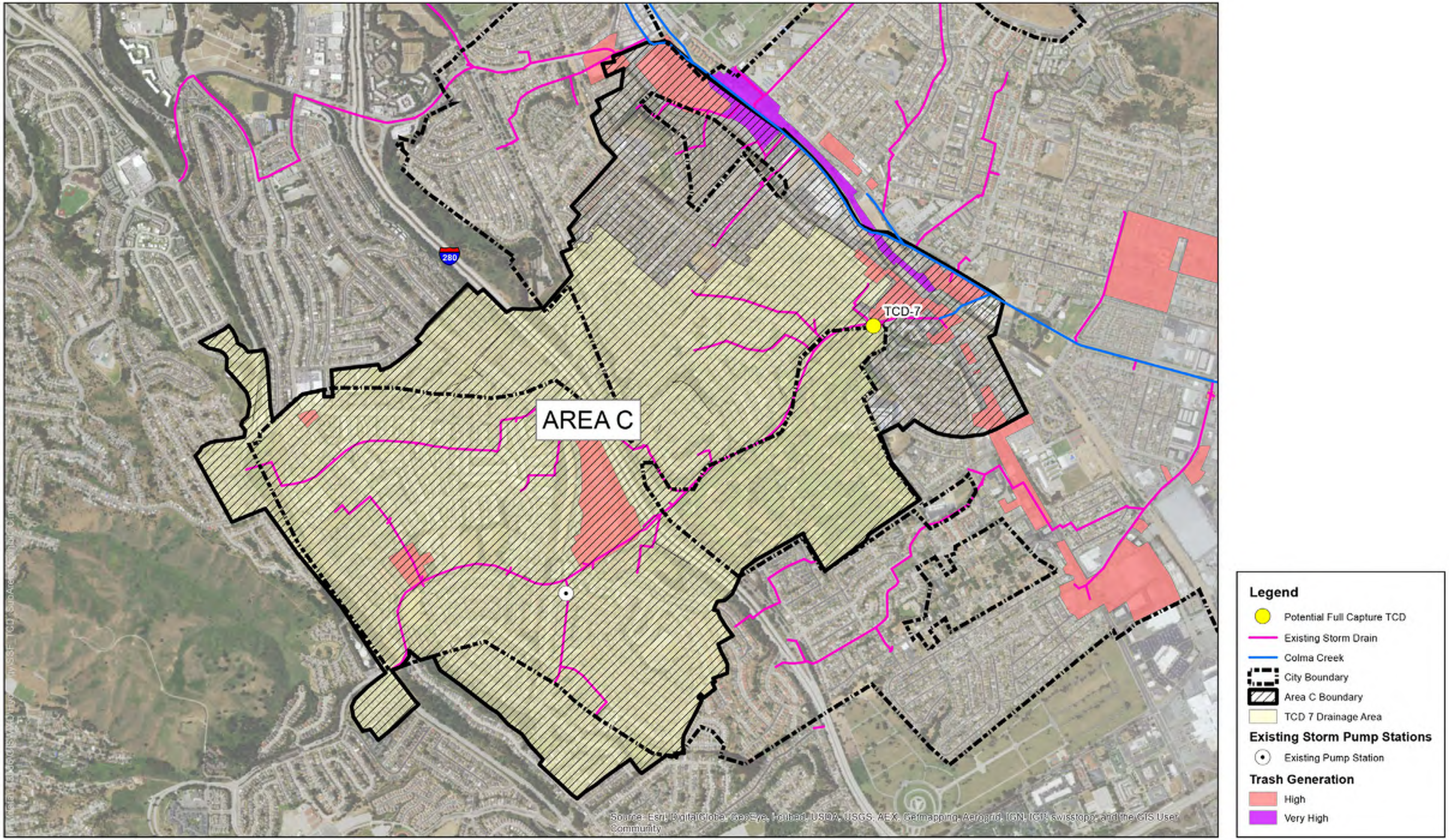
Michael Baker INTERNATIONAL

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area B - Trash Capture Devices

Exhibit 12



Michael Baker INTERNATIONAL

NORTH

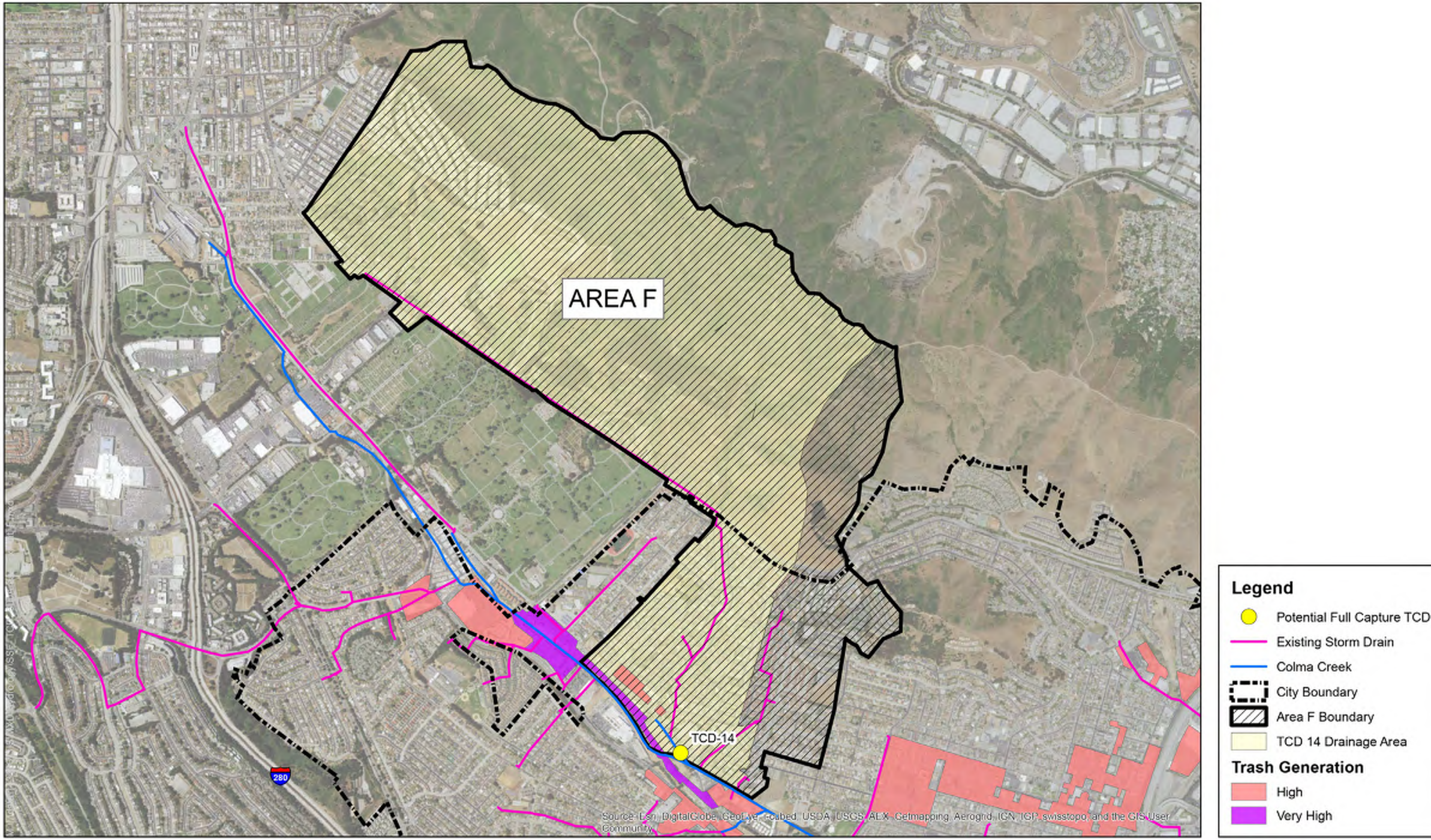
0 750' 1500' 3000'
APPROXIMATE

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area C - Trash Capture Devices

Exhibit 13



Michael Baker
INTERNATIONAL

NORTH

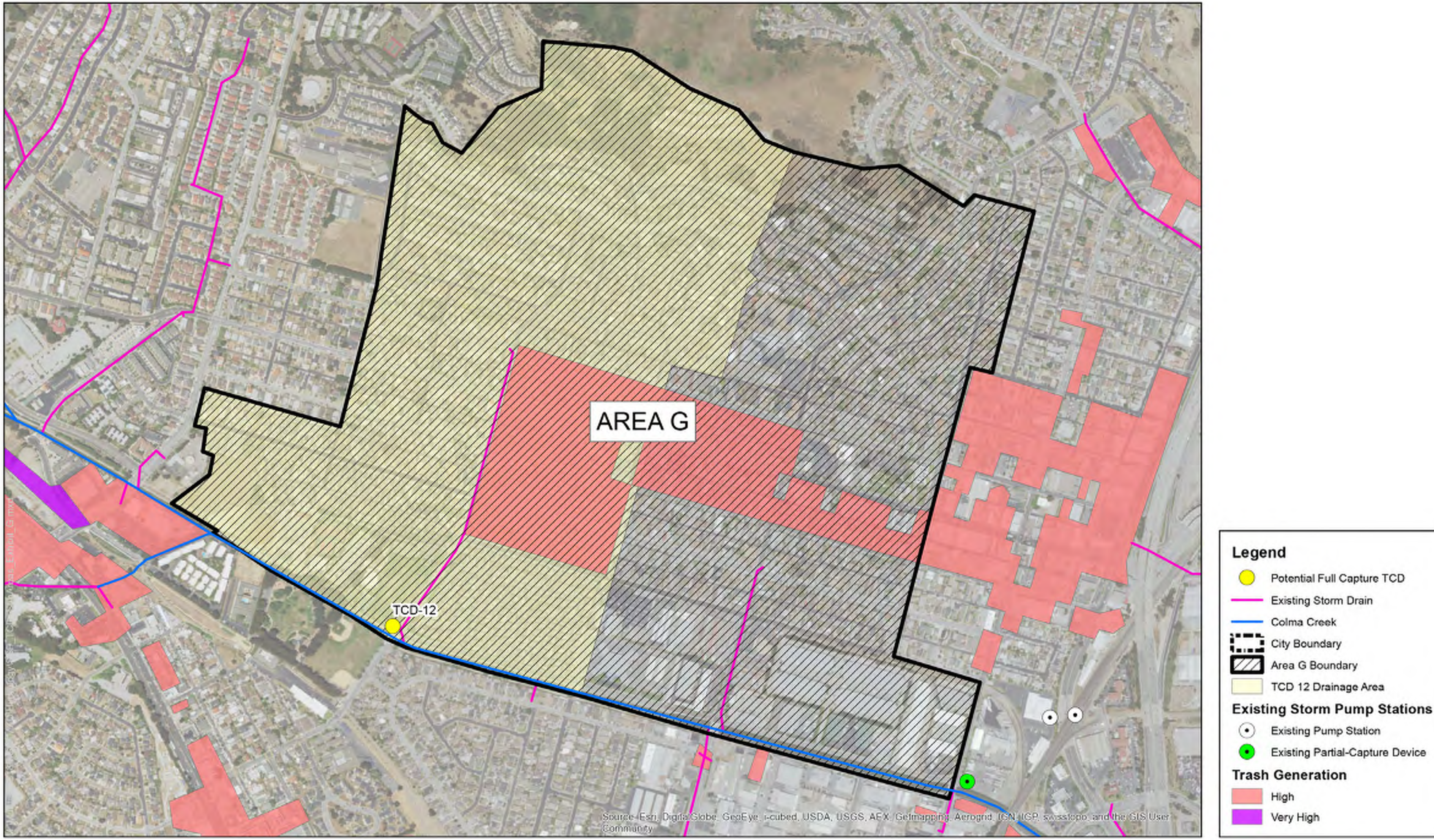
0 750' 1500' 3000'
APPROXIMATE

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area F - Trash Capture Devices

Exhibit 14



Michael Baker INTERNATIONAL

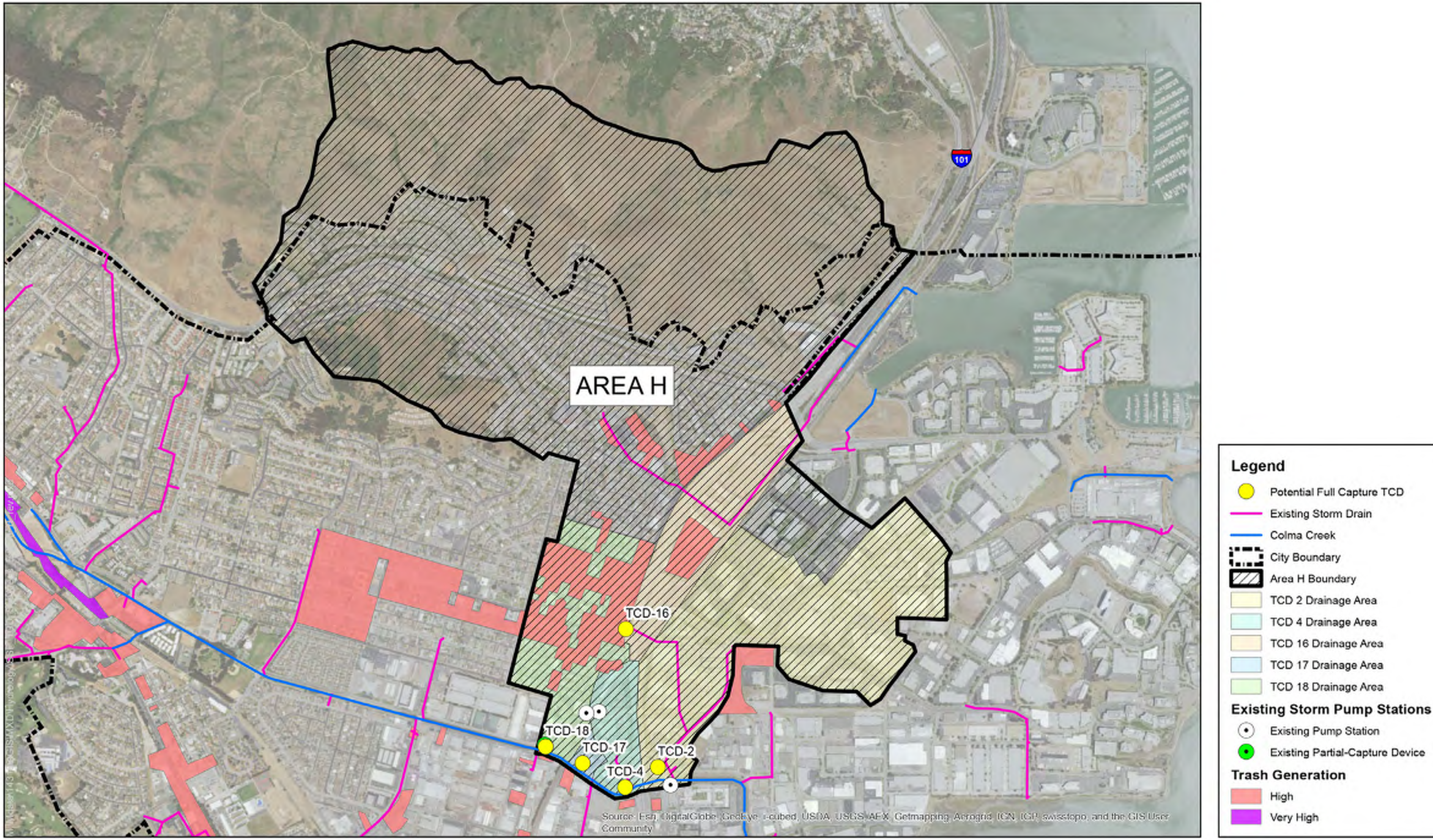
NORTH 0 500' 1,00' 2000' APPROXIMATE

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area G - Trash Capture Devices

Exhibit 15



Michael Baker INTERNATIONAL

NORTH

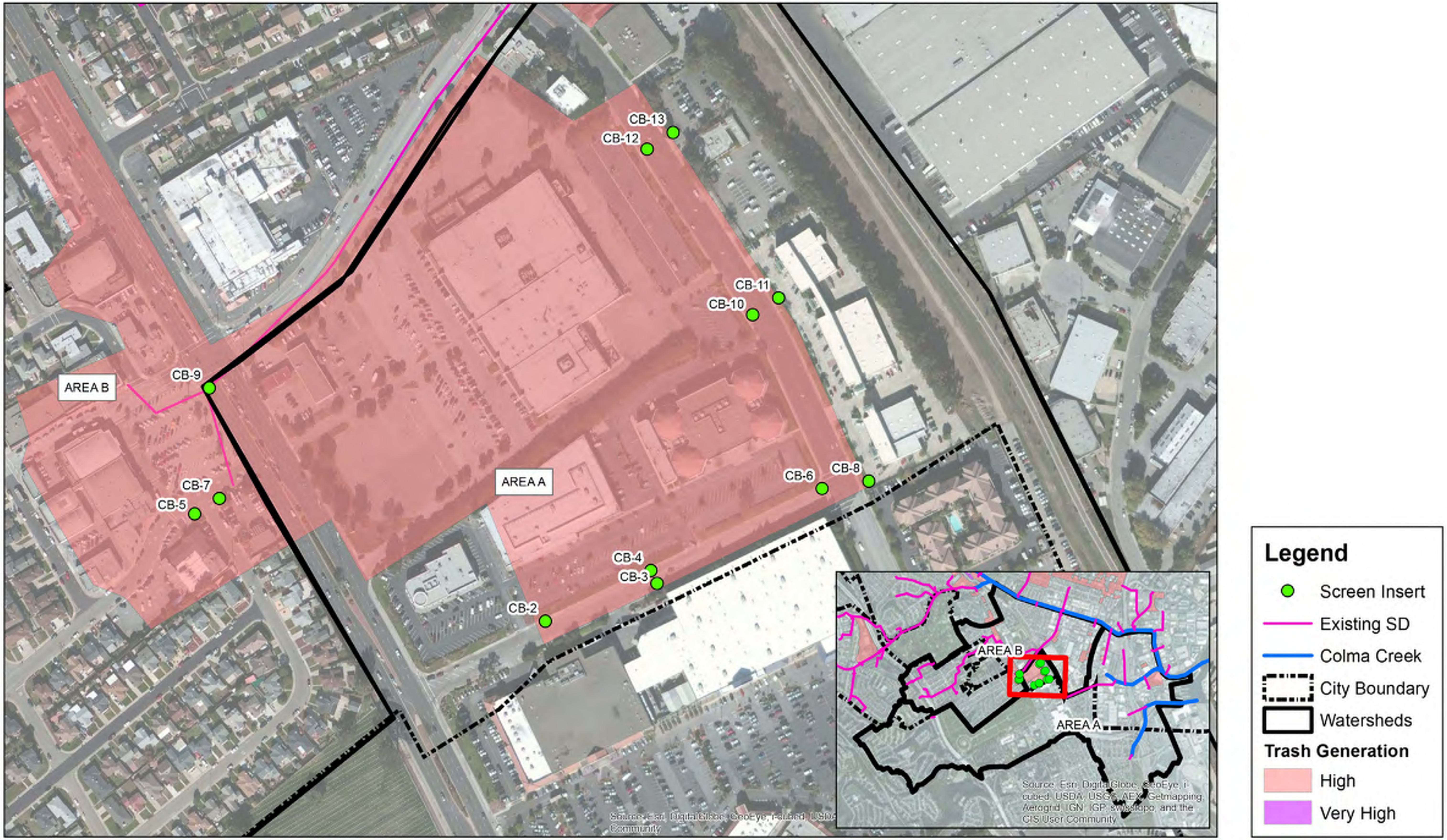
0 750' 1500' 3000' APPROXIMATE

10/20/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area H - Trash Capture Devices

Exhibit 16



Michael Baker INTERNATIONAL

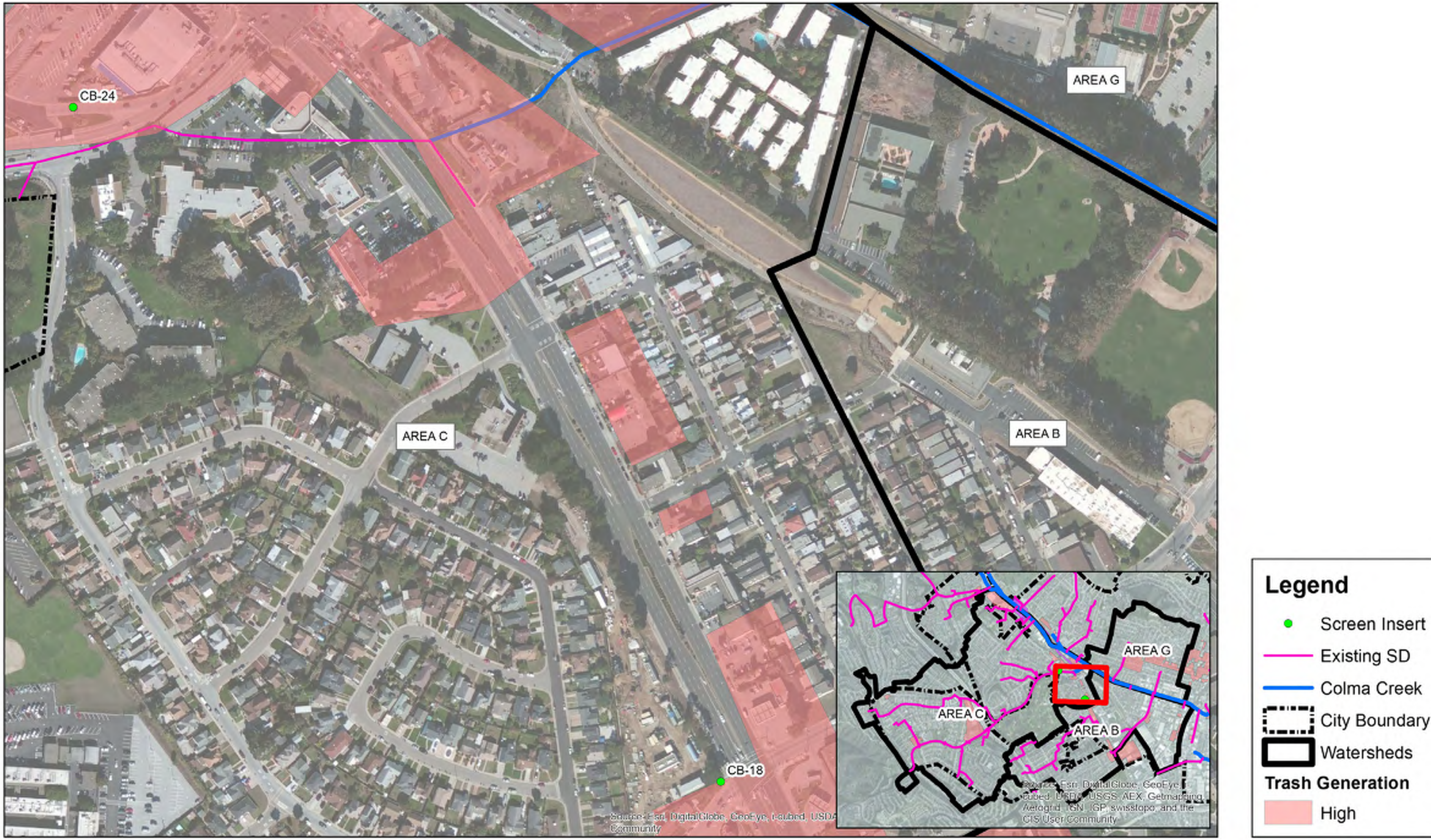
NORTH 0 125' 250' 500 FEET APPROXIMATE

10/30/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area A, B - Neighborhood BMP Locations

Exhibit 17



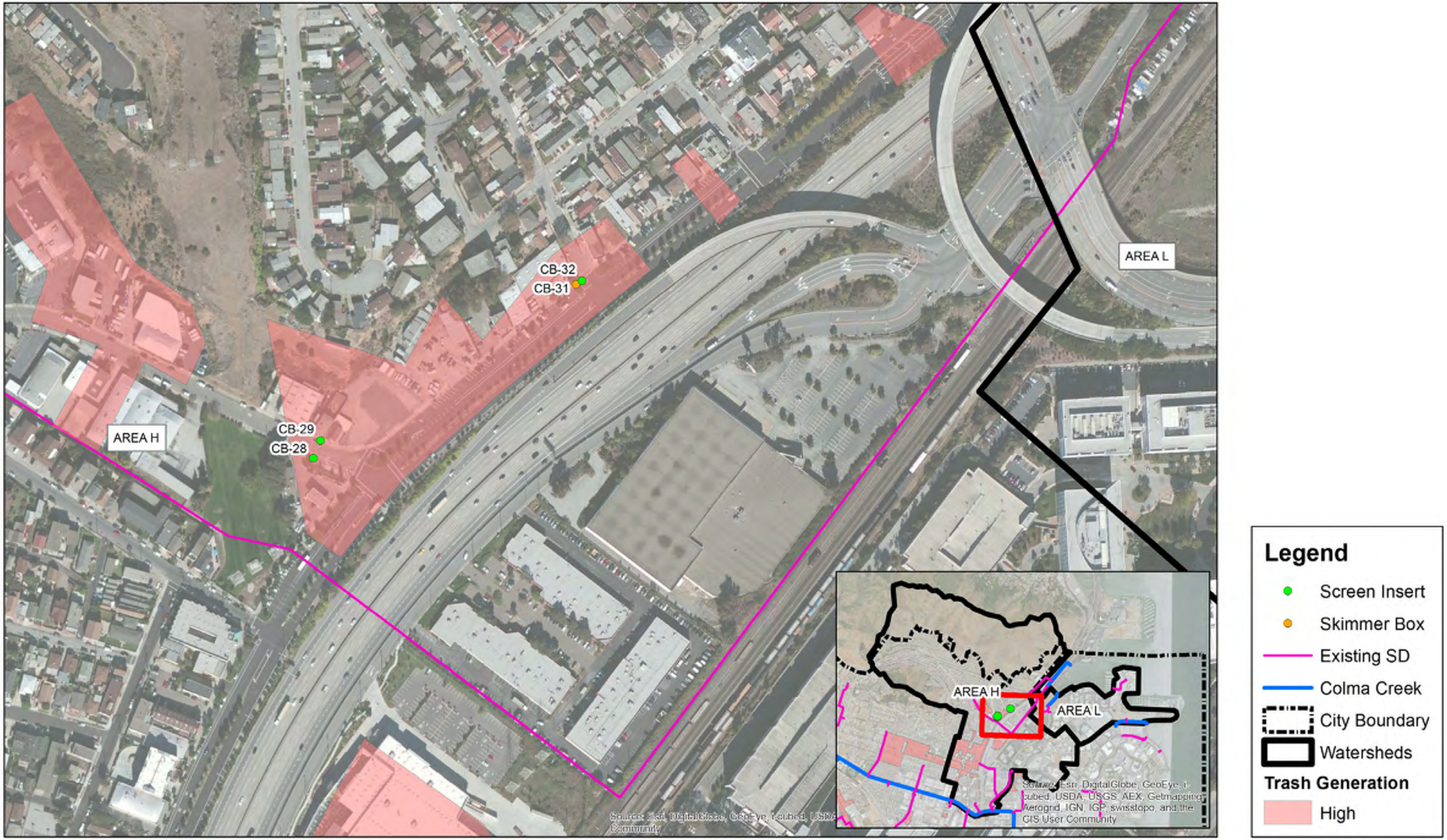
Michael Baker INTERNATIONAL

10/30/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area C - Neighborhood BMP Locations

Exhibit 18



Michael Baker INTERNATIONAL

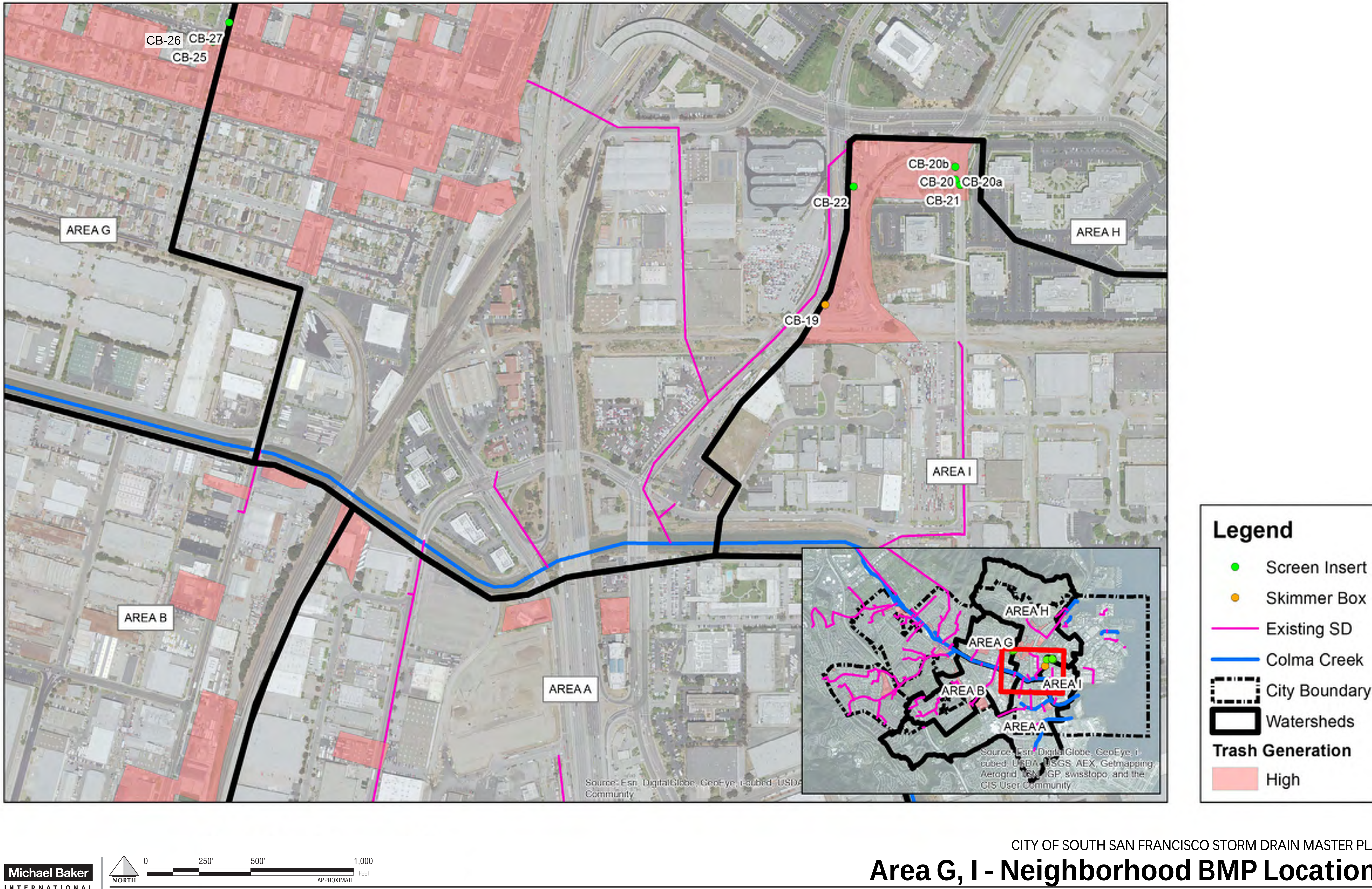
NORTH 0 125' 250' 500 FEET APPROXIMATE

10/30/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area H - Neighborhood BMP Locations

Exhibit 19



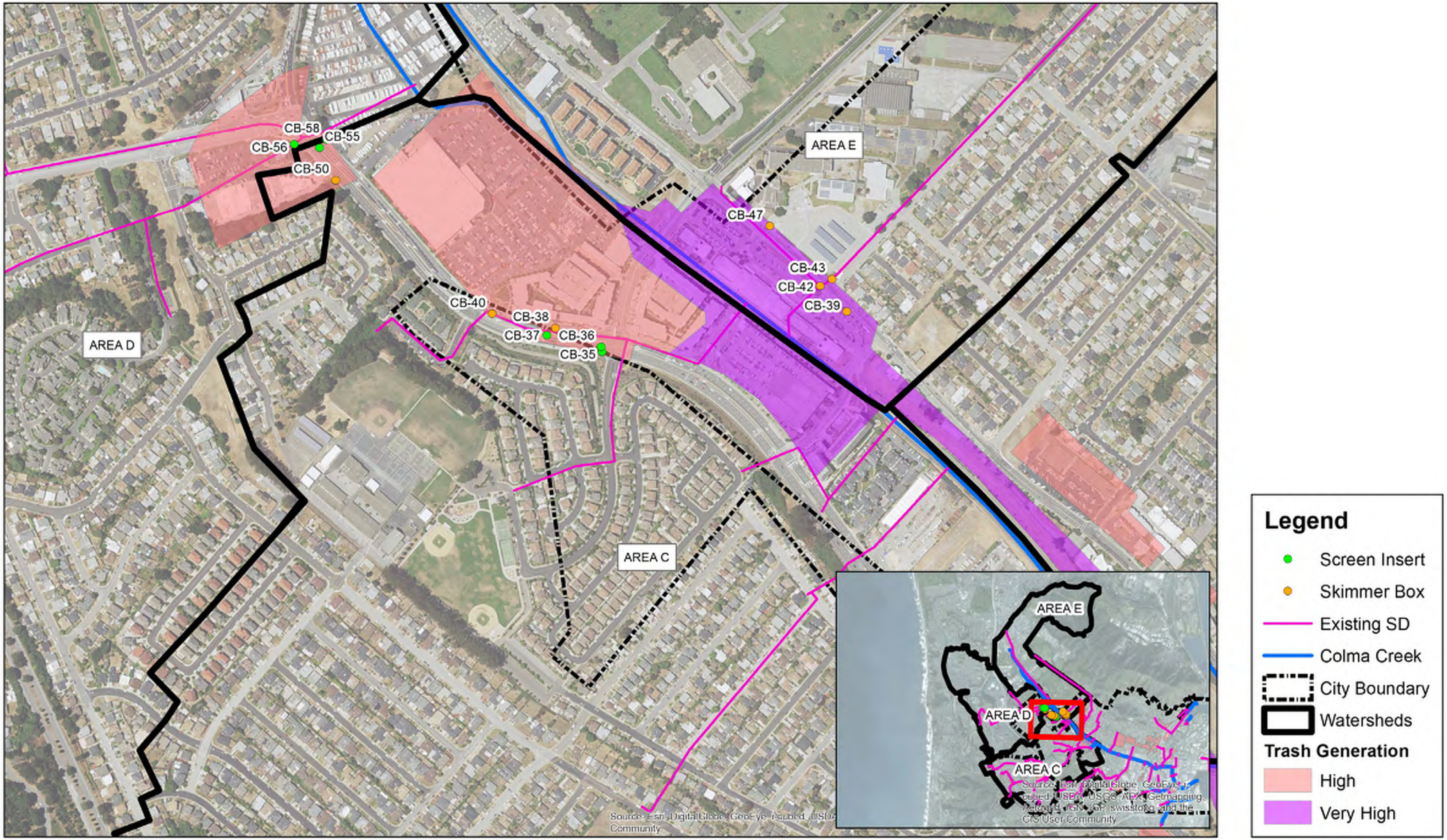
Michael Baker INTERNATIONAL

10/30/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area G, I - Neighborhood BMP Locations

Exhibit 20



Michael Baker INTERNATIONAL

NORTH 0 250' 500' 1,000 FEET APPROXIMATE

10/30/15 JN 143186-21097 MAS

CITY OF SOUTH SAN FRANCISCO STORM DRAIN MASTER PLAN

Area C, D, E - Neighborhood BMP Locations

Exhibit 21