     

Total Maximum Daily Load for Toxic Pollutants in Ballona Creek Estuary

Implementation Plan

Photo courtesy of : Jonathan Coffin, Iglewood, CA.

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Executive Summary

ES.1 Introduction

The Ballona Creek Estuary Toxics TMDL Implementation Plan (Implementation Plan) defines the approaches that the cities of Los Angeles (lead agency), Culver City, Beverly Hills, Inglewood, West Hollywood, Santa Monica, and the California Department of Transportation (Caltrans), (the responsible jurisdictions), will take to comply with the requirements of the *Ballona Creek Estuary Toxics TMDL* (Toxics TMDL).

This Implementation Plan was developed along with the Ballona Creek Bacteria and Metals TMDL Implementation Plan. With the exception of institutional BMPs developed specifically to address toxic pollutants, all of the BMPs identified to be implemented under this Implementation Plan serve to reduce both metals, bacteria and toxics in order to meet the numeric limits and waste load allocations (WLAs) of the Metals, Bacteria and Toxics TMDLs, respectively.

The Implementation Plan follows the principles of the Water Quality Compliance Master Plan for Urban Runoff (WQCMPUR) and the Integrated Resources Plan (IRP), and incorporates input from the responsible jurisdictions and stakeholders. The following guidelines were applied in developing this plan:

- ***Integrated Plan***: identify urban runoff management projects that have multiple benefits and treat multiple pollutants. The plan includes pollutant source control and green infrastructure projects that capture stormwater runoff for irrigation, infiltration and other beneficial uses.

- ***Green Solutions***: wherever possible, implement solutions that are "green," sustainable, and compatible with the existing natural environment. Green structural solutions include Best Management Practices (BMPs) that effectively reduce the volume of urban runoff and remove pollutants from urban runoff through natural processes.

- ***Stakeholder Collaboration***: identify projects and concepts through collaboration with the many active organizations and individual stakeholders in the watershed. . In addition to holding several stakeholder workshops, the team worked directly with NGOs and other individual stakeholders to identify specific projects and concepts that they recommend for implementation to assist in complying with TMDL requirements.

- ***Improvements to Existing Programs***: review existing urban runoff programs and identify opportunities to improve current and future water quality plans. —. All of the responsible jurisdictions have existing programs in place that address water quality within their respective areas. One of the goals of the Implementation Plan is to review these programs and identify areas where existing programs can be enhanced.

The implementation of this plan is subject to the availability of the necessary funding. Currently none of the BMPs and projects identified in this plan are funded, except for the institutional measures. The responsible agencies continue to pursue funding alternatives in partnership with the other agencies in the watershed, including the County of Los Angeles.

ES.2 Regulatory and Permitting Requirements

Ballona Creek is on a regulatory list of impaired waterbodies in the Los Angeles region, referred to as the 303(d) list (a reference to the applicable Clean Water Act section). The Los Angeles Regional Water Quality Control Board (LARWQCB) biennially prepares the 303(d) list which identifies the impaired waterbody and the specific pollutant(s) for which it is impaired. All waterbodies on the 303(d) list are subject to the development of a Total Maximum Daily Load (TMDL). A TMDL establishes the maximum amount of a pollutant that a waterbody can receive and still meet the applicable water quality standards for that pollutant. Depending on the nature of the pollutant, TMDL implementation may require a cap on pollutant contributions from point sources (e.g., centralized pipe outfall discharges into the creek from wastewater treatment plants), nonpoint sources (e.g., dispersed urban runoff from the storm drainage system), or both.

Adoption of the Ballona Creek Toxics TMDL required an amendment to the regional water quality regulations (Basin Plan). After the LARWQCB adopted the TMDL as a Basin Plan amendment, it was submitted to the State Board and EPA Region 9 for review and approval. The Ballona Creek Toxics TMDL was approved and became effective on January 11, 2006. This TMDL requires that the responsible jurisdictions submit a TMDL Implementation Plan to the LARWQCB by January 11, 2011, which describes how the TMDL compliance targets will be achieved. Draft Estuary Toxics Implementation Plan was submitted to the LARWQCB on January 11, 2011. Ballona Creek Watershed Agencies received LARWQCB's comments on the Draft Implementation Plan on March 19, 2012. Revised Implementation Plan was then submitted to the LARWQCB on June 19, 2012.

ES.3 Toxics TMDL Numeric Limits

The TMDL includes numeric limits which are based on the sediment quality guidelines compiled by the National Oceanic and Atmospheric Administration. Numeric targets are established for certain sediment bound metals (e.g., cadmium copper, lead, silver and zinc) and organics (chlordane, DDTs, Total PCBs, and total PAHs) as well as toxicity. These numeric targets define allowable concentrations of each constituent expressed in milligrams per kilogram of sediment. The TMDL also defines WLAs of these toxics (in kilograms per year) that prohibit any exceedances of these numeric targets.

ES.4 Estuary Toxics TMDL Compliance Milestones

The Toxics TMDL defines milestones for achieving compliance with TMDL WLAs:

- By **January 11, 2013**, demonstrate that 25 percent of the total drainage area is effectively meeting the waste load allocation for sediment,
- By **January 11, 2015,** demonstrate that 50 percent of the total drainage area is effectively meeting the waste load allocation for sediment,
- By **January 11, 2017,** demonstrate that 75 percent of the total drainage area is effectively meeting the waste load allocation for sediment,
- By **January 11, 2021,** demonstrate that 100 percent of the total drainage area is effectively meeting the waste load allocation for sediment.

ES.4.1 Additional TMDLs and Watershed Impairments

Two additional TMDLs are effective in the Ballona Creek Watershed:

- *Ballona Creek, Estuary, and Sepulveda Channel Bacteria TMDL* - includes numeric limits and wasteload allocations applicable to urban runoff for total coliform, fecal coliform, enterococcus, and *E. coli. (*LARWQCB 2005). The TMDL effective date is April 27, 2007. A Draft TMDL Implementation Plan was submitted to the LARWQCB on November 25, 2009.
- *Ballona Creek Metals TMDL (Metals TMDL)* - includes numeric targets for copper, lead, selenium, and zinc and wasteload allocations for dry and wet weather conditions. The TMDL effective date is October 29, 2008. The Draft TMDL Implementation Plan was submitted to the LARWQCB January 11, 2010.

The technical analyses for this Toxics TMDL Implementation Plan were coordinated with the technical analyses required for development of implementation plans for the Bacteria and Metals pollutant TMDLs.

ES.5 Coordinated Monitoring Plan (CMP) Requirements

The Toxics TMDL required that a CMP be submitted by the responsible jurisdictions (including Los Angeles County) by January 11, 2007. The CMP was submitted for the Ballona Creek Watershed to the LARWQCB on January 10, 2007, and was written to address both the Ballona Creek Metals TMDL and the Ballona Creek Estuary Toxic Pollutants TMDL. The CMP was revised and resubmitted on August 8, 2008 and again on May 4, 2009.

The CMP will characterize existing sediment quality based on applicable sediment quality objectives and assess compliance with the wasteload allocations in the Toxics TMDL. The CMP identified eleven monitoring sites for TMDL effectiveness monitoring. Ten of these sites are applicable to the Metals and Toxics TMDLs, while one is relevant to the Toxics TMDL only.

ES.6 Responsible Agency Planning Process

The jurisdictions named by the TMDL as responsible for meeting the wasteload allocations (except Los Angeles County) have developed a Memorandum of Understanding (MOU) to prepare one integrated Implementation Plan. Approximately 81 percent of the watershed is under the jurisdiction of the City of Los Angeles and the remainder of the watershed consists of the cities of Beverly Hills, West Hollywood, Culver City, Inglewood, Santa Monica, and the County of Los Angeles. Caltrans also has areas within the watershed under its jurisdiction. The City of Los Angeles, as the primary jurisdiction in the watershed, is leading the development of the required TMDL deliverables. The County of Los Angeles is developing its own implementation plan for the portions of Ballona Creek watershed under its jurisdiction.

ES.7 Ballona Creek Watershed Characteristics

The Ballona Creek Watershed is approximately 128 square miles (82,000 acres) in size (Figure ES-1) and is bound by the the Santa Monica Mountains to the north and the Baldwin Hills to the south.

Ballona Creek is predominantly channelized and the watershed is highly developed, with the exception of the headwaters in the northern portions of the watershed in the Santa Monica Mountains. North of Hancock Park, a network of underground storm drains direct flows toward the mainstem Ballona Creek channel.The creek then flows through an open channel for less than 10 miles from Los Angeles (South of Hancock Park) through Culver City, reaching the Pacific Ocean at Playa del Rey.

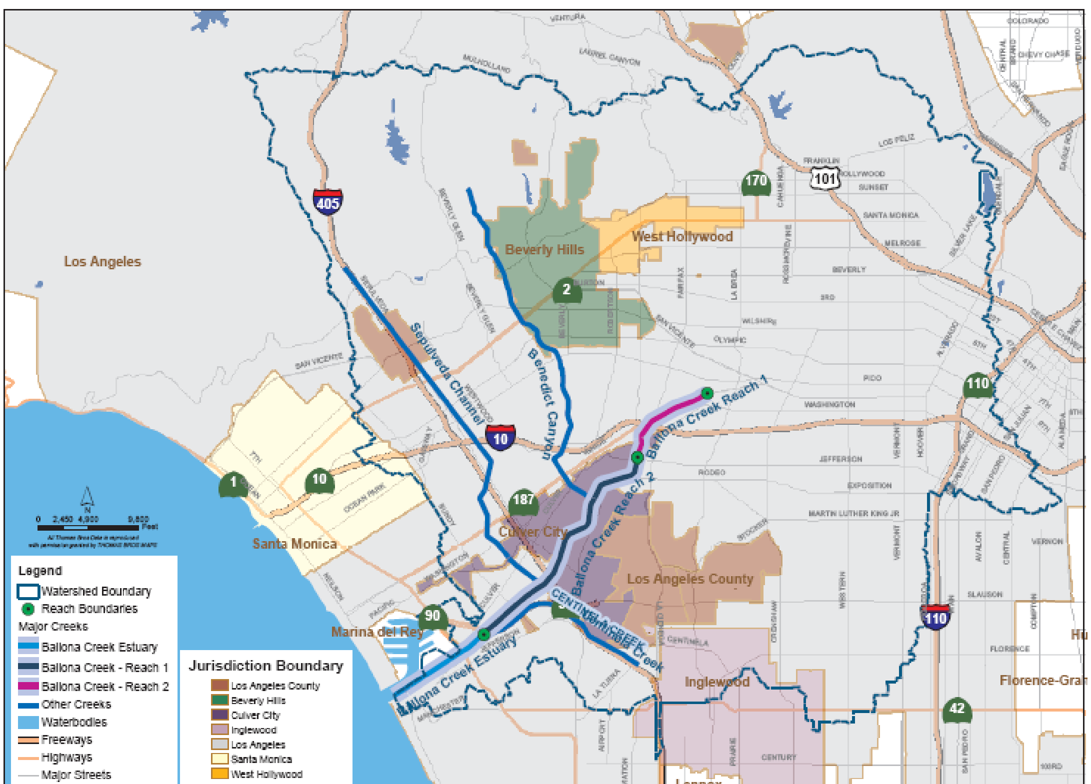


FIGURE ES-1 Ballona Creek Boundary and Jurisdictions

Tributaries of Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, and Benedict Canyon Channel (Figure ES-1). The downstream portions of all of these tributaries are concrete lined channels fed by a network of upstream underground storm drains.

Development of this Implementation Plan required significant data collection to define existing conditions in the watershed and to identify priority locations for potential Best Management Practices (BMPs). The watershed was divided into smaller sub-catchment areas of approximately 40 acres each. These smaller catchment areas allow a more specific analysis of the drainage patterns at the neighborhood or parcel level. Land use coverages were defined for each catchment area. Overall the watershed is 59 percent residential, 14 percent commercial, 4 percent industrial, 17 percent vacant/open space 3 percent education and 2 percent transportation. The high degree of urban development has resulted in the Ballona Creek watershed being covered by approximately 49 percent impervious area consisting of roads, rooftops and other hard surfaces. Additional data compiled to define Ballona Creek watershed characteristics included topography, hydrology and drainage, land use and impervious areas, soils, depth to groundwater, liquefaction and landslide zones.

Precipitation and Hydrology

The Ballona Creek Watershed receives an average annual rainfall of approximately 15 inches per year over most of the developed portions of the watershed. Rainfall volumes and intensity vary throughout the watershed due, in part, to the varied topography in the Ballona Creek Watershed. The rainfall in the northwest and coastal portions of the watershed is typically higher than in the northeast.

Flows in Ballona Creek are monitored by the County of Los Angeles at a site above Sawtelle Boulevard. Lower instream flows occur in June, July and August during low rainfall periods. The primary source of flows during these months is runoff from activities such as landscape irrigation.

Sediment Quality

The responsible agencies are required to collect water, fish tissue and sediment quality data to evaluate the assumptions made in the TMDL by conducting special studies to address the uncertainties in the TMDL and to assist in the design and sizing of BMPs. The responsible agencies initiated the Toxicity Identification Evaluation (TIE) study in 2007. The TIE study is conducted in two phases and determines the potential causes of the sediment toxicity in the Estuary. As described in Section 2, the results of this TIE study find that the main cause of toxicity in the estuary is from the pyrethroid pesticides.

ES.8 Stakeholder-Based Planning

An important step in developing the Implementation Plan included consulting with stakeholders to identify specific BMP implementation opportunities. Identifying these opportunities created the foundation for collaborative implementation of water quality improvement projects. During the development of this Implementation Plan, the responsible jurisdictions conducted community stakeholder workshops, participated in Ballona Creek Watershed Task Force meetings, and held one-on-one discussions with key NGOs. Table ES-1 lists many of the key organizations consulted during the Implementation Plan development process.

The City of Los Angeles Watershed Protection Division staff also met on many occasions with stakeholders on an individual basis to obtain information on specific BMP opportunities in the watershed, both active and proposed. In addition, the former Ballona Creek Watershed Coordinator provided substantive input on potential watershed projects. These consultations with stakeholders resulted in identification of numerous structural and institutional BMP opportunities, many of which are consistent with the WQCMPUR.

Table ES-1
Stakeholder Participants in TMDL Implementation Plan Development

Ballona Creek Renaissance
Santa Monica Bay Restoration Commission (SMBRC)
Mar Vista community groups
Mountains Recreation and Conservation Authority
Surfrider Foundation
Heal the Bay
Santa Monica Baykeeper
Private residents
US Army Corps of Engineers
Baldwin Hills Conservancy
Ballona Wetlands (including: Ballona Institute, Friends of Ballona Wetlands, Ballona Wetlands Land Trust)
Los Angeles Regional Water Quality Control Board
Playa Vista
California State Coastal Conservancy

ES.9 TMDL Technical Analysis

This Implementation Plan relies on both structural and institutional (or non-structural) BMPs that, in combination, work together towards achieving compliance with TMDL targets. Where possible, the selection of BMPs emphasizes an Integrated Water Resources Approach that relies first on the implementation of green solutions. The process for selecting appropriate BMPs varied depending on whether the BMP was structural or institutional. Structural BMPs include one of two types:

- *Regional BMPs*: defined as centralized stormwater facilities and are designed to treat urban runoff from a relatively large drainage area (drainage areas ranging from 20 acres to several hundred acres). These BMPs include infiltration facilities, detention basins, subsurface flow (SSF) wetlands (including detention), surface flow (SF) wetlands, treatment facilities, manufactured separation systems (e.g., hydrodynamic separators and trash nets/screens), and channel naturalization (e.g., storm drain daylighting, revegetation, and wetland channel establishment).

- *Distributed BMPs*: defined as stormwater collection devices and landscaping practices dispersed throughout a catchment and serve relatively small drainage areas (typically 10 acres or less). These BMPs include, for example, cisterns, bioretention, vegetated swales, green roofs, porous/permeable pavements, gross solids removal devices (GSRDs), media filters, and catch basin inserts.

ES.10 Identification of Structural BMPs Locations

The Los Angeles County-wide Structural BMP Prioritization Analysis Tool (SBPAT) provided the means for identifying potential BMP locations and types for implementation. SBPAT uses a GIS-based decision tool that relies on four steps for identifying BMP implementation opportunities (Figure ES-2):

SBPAT screens areas based on *need* (i.e., pollutant load generation and downstream impairments), and then identifies *opportunities* (i.e., appropriateness of the area, adjacent storm drains) for BMP implementation. These opportunities are ranked based on factors such as effectiveness, cost, and maintenance requirements. The BMP rankings were used to assist with the selection of the best regional and distributed BMPs for each potential BMP location. The selection process also considered the opportunity to use an Integrated Water Resources Approach or implement BMPs that provide multiple benefits at a potential BMP location.

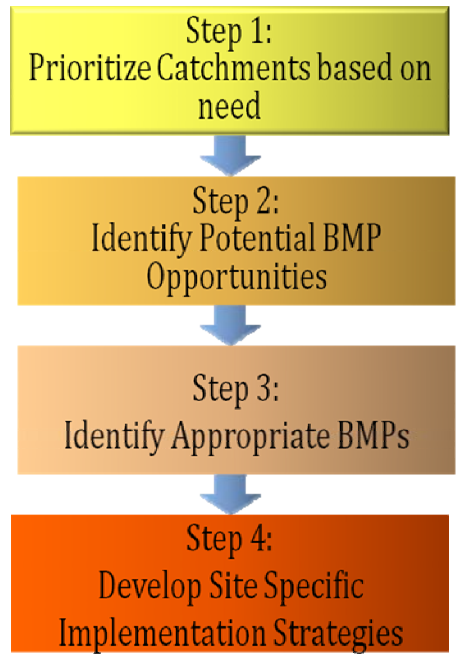


Figure ES-2
Steps for Selection of Structural BMPs

ES.11 Identification of Institutional BMP Programs

Due to the highly developed nature of the Ballona Creek Watershed and limited availability of sites for construction of new urban runoff infrastructure, the responsible jurisdictions will have to rely on an implementation program that includes both structural and institutional elements to achieve compliance. Development of the institutional component of the Toxics TMDL Implementation Plan relied on information gathered from existing programs; information provided by stakeholders; and other regional and national institutional BMPs.

ES.12 Recommended BMP Implementation

The Implementation Plan relies on a combination of measures designed to decrease introduction and transport of sediment bound toxics, as well as other pollutants such as bacteria and organics, by (1) reducing the amount of dry weather and wet weather anthropogenic/urban runoff, (2) providing localized source control to reduce pollutant loads, and (3) incorporating opportunities for beneficial reuse of urban runoff. A phased approach to BMP implementation is recommended. Phase 1 includes the period from 2010 through January 2013, Phase 2 includes the period from 2013 through January 2015, Phase 3 includes the period from 2015 through January 2017, and Phase 4 includes the period from 2017 through January 2021.

Recommended BMPs include three general categories:

- Low Flow Treatment (for initial dry-weather compliance with the Metals and Bacteria TMDLs);
- Regional and distributed structural BMPs; and
- Institutional BMPs.

The recommended BMP implementation approach for each category is summarized below.

ES.12.1 Dry Weather Low Flow Treatment Facilities

The Implementation Plan includes the construction of two low flow treatment facilities in the watershed that divert a portion of the runoff from Ballona Creek and Sepulveda Canyon Channel for treatment prior to a portion of the flow being discharged back into the respective waterbody. The purpose of these low flow treatment facilities is to supplement the watershed BMPs in achieving the necessary metals and bacteria load reductions during dry-weather conditions for the purpose of meeting the interim compliance deadlines for those TMDLs. Continued used of these LFTFs will be evaluated after the other suites of BMPs have been implemented.

ES.12.2 Structural BMPs Implementation

The Implementation Plan includes structural BMPs that will be designed to treat wet weather runoff. Structural BMPs include regional projects serving multiple catchments as well as distributed BMPs that consist of small-scale decentralized structural BMPs.

As a result of the extensive desktop and field analyses conducted in the watershed, 27 sites were selected to be implemented as priority distributed BMPs and eight sites were selected as priority regional BMPs based on opportunity potential, site conditions, ownership, drainage area, and geographic distribution. Preliminary concept drawings are included in Appendix G. Implementation of these projects will be subject to confirmation of engineering feasibility, and where appropriate, the water quality treatment approach may be modified.

Priority distributed and regional projects proposed by this Implementation Plan are the same as proposed by the Implementation Plan for the Ballona Creek Bacteria TMDL and are shown in Table ES-3. Levels of implementation for distributed BMPs by landuse category is listed in Table 5-9 to 5-11.

In addition to these specific projects, it is expected that many additional BMP projects will need to be implemented to meet TMDL compliance requirements. It is estimated that the level of implementation required results in the need for runoff from 11,300 acres, or 13.9 percent of the Ballona Creek watershed, to be treated by distributed BMPs in order to meet the TMDL limits.

ES.12.3 Institutional BMPs

A critical component of institutional BMP implementation is the establishment of a programmatic structure that creates consistency in urban runoff management, encourages application of green solutions, provides adequate legal authority, and includes appropriate levels of coordination, planning, and collaboration. The Implementation Plan includes a number of institutional BMPs directed at improving programmatic issues.

The following institutional BMPs are recommended in Ballona Creek Bacteria TMDL Implementation Plan. These BMPs are designed to address multiple pollutants (bacteria, metals, and toxic pollutants) and can be categorized as follow:

- *Education and Outreach* - Some of these BMPs are already being implemented; but they and must be reevaluated and expanded to address toxic pollutant sources more effectively. This category also includes BMPs that are more programmatic in nature to help ensure that education and outreach activities receive the needed funding, are consistent across the watershed, and are based on current policies and guidance.

- *Program Development* - This category addresses the need for ordinance, policy and guidance development. It includes the need to consider how to persuade private landowners, especially commercial and industrial property owners, to implement BMPs.

- *Planning and Coordination* - Coordination is required among agencies to create opportunities, increase efficiency and effectiveness, and prevent the responsible jurisdictions from working at cross-purposes. For example, new education and outreach materials, green policies, and downspout retrofit specifications need not be developed separately by each jurisdiction. Moreover, opportunities may exist to work collaboratively with NGOs to implement selected elements of the institutional BMPs.

- *Individual Car Washing* - This BMP targets car owners that wash their own cars. This activity increases dry-weather urban runoff and contributes metal concentrations in the watershed. To reduce dry-weather metal loads, educational outreach could be increased to encourage car owners to minimize washing activities that increase runoff to storm drains.

- *Enhanced Street Sweeping* – This BMP focuses on enhancing street sweeping activities to achieve a modest 15% increase in material picked up by 2021. To achieve this goal, the watershed agencies will evaluate opportunities to increase the efficiency of existing street sweeping programs. This evaluation will include a pilot study to evaluate effectiveness of street sweeping by evaluating parameters such as sweeping frequency, sweeper type, location (areas with highest potential pollutant loads), need for parking regulations, material captured (type and quality), etc. Based on the study findings, program features that improve sweeping effectiveness can be developed and implemented.

- *Downspout Retrofits* - This BMP redirects runoff from roofs to pervious areas, resulting in reduced flow to storm drains. Implementation options include redirecting downspouts to lawns, gardens or swales, or installing a rain barrel or cistern to collect roof runoff for later use. Downspout retrofit can be an effective institutional BMP for commercial, industrial, and public buildings as well.

- *Direct Source Control* - BMPs that directly address metals sources are included. The following direct source control BMPs are included in the Metals TMDL Implementation Plan. The product replacement and targeted zinc reduction program were not included in the Bacteria TMDL Implementation Plan as they only apply to metals.

  - *Product Replacement* – The purpose of this BMP is to reduce a significant source of metals in the environment by developing safe alternative products. To implement this BMP, the agencies will continue to support efforts to reduce metals in vehicle brake pads and wheel weights through pending legislation (SB 346 and SB 757, respectively). In addition, if opportunities arise to participate in studies or legislation to reduce the metal content in other products, the agencies will consider its potential roles for participating in those efforts.

  - *Targeted Zinc Reduction Program* - A Targeted Zinc Reduction Program is a proposed institutional BMP comprised of three elements: 1) generally identify potentially significant sources of zinc loading in the watershed, 2) conduct targeted monitoring to specifically identify significant sources of zinc into the storm drain system, and 3) conduct outreach to encourage stakeholders and property owners to reduce zinc loads and concentrations in runoff from their property (with some level of enforcement if necessary).

- *Targeted Pesticide Reduction Program to address the main cause of toxicity, pyrethroids:*

  - Public education and outreach: this will be done to promote use of non-toxic methods of pest-control and educate the public on proper ways to apply pesticides to keep them from running off of the property; and

  - Product replacement: identification of product replacement options will be done as necessary.

Institutional BMP Implementation

Institutional BMPs are anticipated to be implemented under each phase. The responsible jurisdictions have already implemented several of the institutional BMPs that are identified in this Plan. Implementation of these institutional BMPs will generally follow a typical project cycle including planning, preparation of a detailed BMP specific BMP action plan, development of a pilot program, leading into the subsequent implementation phases. Each of these project phases is expected to take approximately one year. Where feasible, the pilot programs will be prioritized to target the higher priority catchments, (i.e., those with a CPI score > 3). A detailed institutional BMP action plan will be developed for each program and will focus on what each specific agency is currently doing, how resources could be shifted to target high priority catchments initially, and what can be done to enhance activities that will be implemented by each jurisdiction within the first three years following approval of this plan, enabling many of these strategies to be fully in effect by the second interim compliance milestone of 2013.

Under the remaining phases, as the institutional BMPs become better defined through the iterative, adaptive approach, specific, quantifiable performance measures will be identified and included in the respective program implementation plans. In addition, as water quality monitoring results are obtained from the CMP, institutional BMPs can be honed to target specific locations where high toxic pollutant contributions are found, and the implementation plan for the affected programs modified accordingly.

Instream Solutions

Several unique projects may be feasible along Ballona Creek. These include various stakeholder identified "stream daylighting" projects which are intended to restore portions of Ballona Creek and major tributaries into 'natural' stream channels. These projects will be evaluated opportunistically and their implementation schedule is to be determined.

The Ballona Creek Wetlands present another unique opportunity to achieve multi-objective watershed project. Several agencies have initiated a project to enhance habitat and public access at the 600-acre property along both sides of Ballona Creek Estuary.

ES.13 Quantification of Water Quality Benefits

Implementation of structural and institutional BMPs is proposed to address toxic pollutant loading in wet and dry weather runoff. Potential pollutant reductions associated with the proposed structural BMPs were quantified using the SBPAT modeling software. Pollutant reductions associated with institutional BMPs were quantified using a spreadsheet model that accounts for specific pollutant sources and the predicted performance of source control measures based on literature values, mass balance accounting, and best professional judgment.

The general approach taken to quantify pollutant reductions is as follows:

- Pollutant reductions are quantified for the implementation of regional BMPs, distributed BMPs, and source controls by the year 2021.
- The results for the regional BMPs, distributed BMPs, and source controls are added together to predict the pollutant load reduction for the entire watershed. The catchment areas tributary to each treatment BMP and the implementation areas for source controls were assumed to not overlap to avoid over-predicting load reductions.
- The predicted BMP pollutant reduction results for the watershed are summarized in terms of average annual load reduction. Ranges of annual load reductions are also estimated for 2021.

ES.13.1 Compliance with Wet Weather TMDL Limits

Compliance with Waste Load Allocation (WLA) for toxic pollutants based on the BMPs described above are shown in Table ES-2.

Table ES-2
Predicted Annual Load Compared to Waste Load Allocation (WLA)

Constituent	Baseline Load[1]	Load Reduction[2]	Post BMP Load[3]	WLA[4] (MS4 Permittees and Caltrans)	Percent Excee-dance[5]
Metals	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**%**
Cadmium	4.53	0.48	4.05	8.11	0%
Copper	243.95	25.75	218.19	230.50	0%
Lead	184.87	19.52	165.35	316.70	0%
Silver	2.96	0.31	2.65	6.78	0%
Zinc	1,012.58	106.90	905.69	1,017.00	0%
Organics	**(g/yr)**	**(g/yr)**	**(g/yr)**	**(g/yr)**	**%**
Chlordane	17.32	1.83	15.50	3.39	357%
DDTs	52.53	5.55	46.99	10.71	339%
PCBs	13.43	1.42	12.01	154.00	0%
PAHs	973.43	102.76	870.67	27,300.00	0%

Notes:
[1]*Baseline load: see Table 5-7 in Section 5 (MS4 Permittees and Caltrans portion of the load).*
[2]*The load reduction is based on the TSS load reduced by the proposed BMPs, which is based on SBPAT modeling results (603 tons/yr, Table 5-8 in Section 5). The percent reduction is based on the baseline TSS load established by SBPAT (5,712 tons/yr, see Table 5-6 in Section 5) for consistent comparison. Therefore a percent reduction of 11 percent was established based on these values.*
[3]*The post BMP load is the baseline load minus the load reduction.*
[4]*The WLA is from the TMDL.*
[5]*The percent exceedance is the percent that the post BMP load exceeds the WLA for the MS4 Permittees and Caltrans.*

There are several unavoidable sources of uncertainty in the pollutant load reduction estimates for structural and institutional BMPs due to data limitations, unknown future conditions, simplifying assumptions, and site-specific factors.

This compliance analysis accounted for a great level of uncertainty in order to ensure that load reductions were not overestimated. At each step in the process, as previously described in this section, factors of safety were applied to the load reduction estimates in order to be conservative in the overall load reduction estimation at final compliance.

In addition to factors of safety, the method of quantification inherently provided a level of safety in that BMP effluent concentrations were used as opposed to percent removal efficiencies for each structural BMP. In addition, there was no overlap in areas treated with the various BMPs (e.g. for the entire tributary area of a regional BMP, no credit was taken for any institutional BMP or distributed BMP regardless of the likelihood that an institutional or distributed BMP may affect that tributary area). The range of post BMP loads presented also accounts for the variability of these estimates. It is therefore stated that every effort was taken to ensure that no overestimation was made in evaluating final compliance with the TMDL.

Chlordane and DDT Exceedances Based on Above Analysis

As described above, the method for establishing the baseline load used the measured constituent concentrations found in the estuary bottom sediments as determined as part of the TIE study. Since this study represents sediments deposited over multiple years which were included in each sample, it is possible that sediments from previous years are erroneously showing high historical concentrations of some constituents. Specifically, it is expected that this applies to the exceedances shown for chlordane and DDT, since these pesticides are persistent in the environment. Following is a summary of these constituents.

Chlordane

- Chlordane was used as an insecticide until 1983 when it was banned for all uses except termite control. It was further banned from all uses in 1988.
- The soil half-life for chlordane is estimated at 350 days but can range from 37 days to 3,500 days (approximately 10 years) (US EPA, 2001).

DDT

- DDT was used as a pesticide until it was banned in 1972 for all uses except as an emergency vector control.
- The half-life of DDT in soil is from 2 to 15 years.
- The half-life of DDT in an aquatic environment is about 150 years.

Based on this information, it is expected that these two pesticides are showing up in high concentrations in the samples because of their persistence in the environment and their long half-life. It is likely that the estimates presented in Table ES-2 are higher than what would be found in samples taken from discharges from the Ballona Creek Watershed because they have been banned for many years. However, since neither of these constituents are the cause of toxicity in the estuary, as determined by the TIE study, this Implementation Plan will focus additional efforts on reducing the concentration of pyrethroids, the main cause of toxicity in the estuary. The Implementation Plan for pyrethroids is discussed in Section 5.2.4.

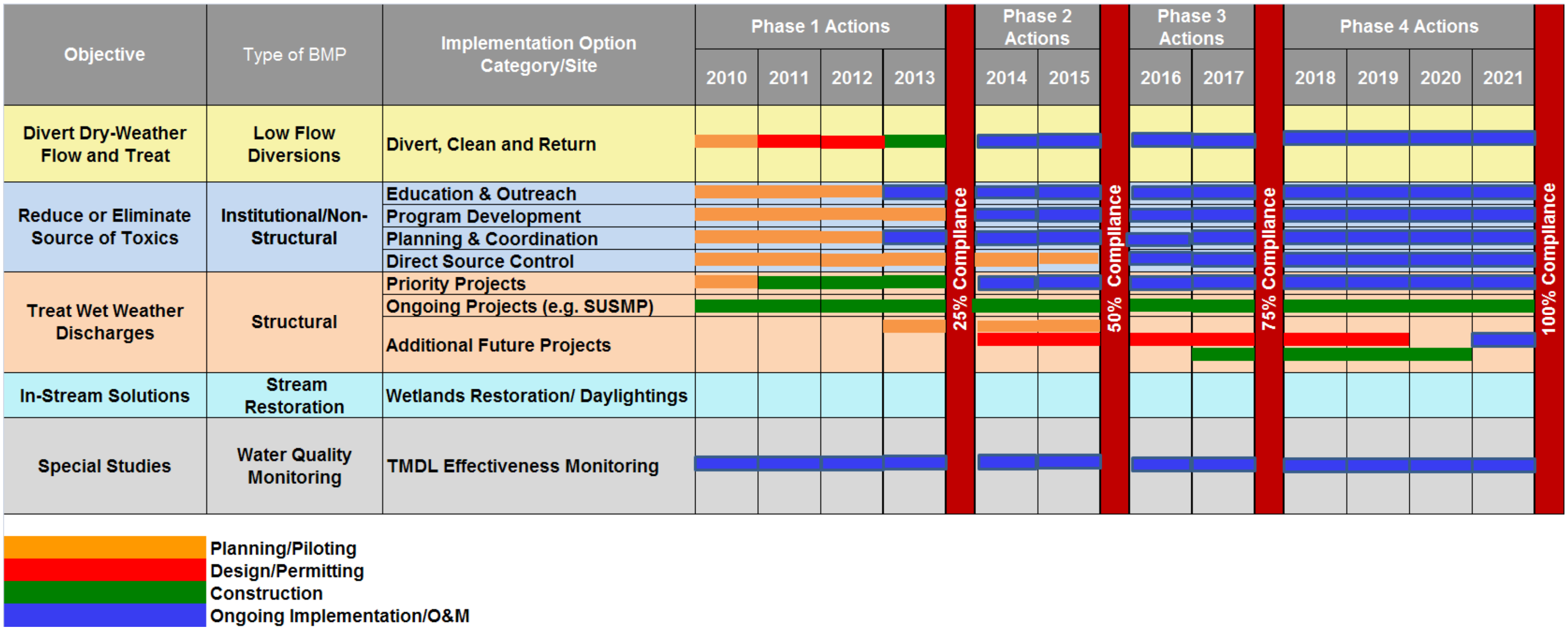
Compliance Analysis Conclusion

As shown in Table 5-9 several of the listed constituents are already in compliance with the TMDL based on the available sampling data. This includes cadmium, lead, silver, zinc, PCBs, and PAHs. Those that are not in compliance currently include copper, chlordane and DDTs. As described above, chlordane and DDT are likely showing exceedance due to the historic use and persistence in the estuary sediment environment. Therefore, only concentrations of sediment bound copper needs to be reduced to meet the TMDL requirements, and based on the data presented in Table 5-9, the current concentration of copper in the sediment must be reduced only by 6 percent to be below the WLA.

ES.14 Implementation Plan Schedule and Milestones

Table ES-3 summarizes the preliminary schedule and milestones for institutional BMPs, structural BMPs including regional and distributed, and low flow treatment projects for achieving compliance with TMDL limits in the Ballona Creek Watershed. The schedule identifies milestones from Phase 1 through 4, however, the schedule of the implementation is identical to the Ballona Creek Bacteria and Metals TMDL Implementation Plans schedule. For each category of BMP, the schedule shows the proposed initiation and duration of: 1) Planning/Piloting activities, 2) Design and Permitting, 3) Construction, and 4) Ongoing Implementation/O&M. It is assumed that the responsible jurisdictions will continue to act collaboratively and continue to coordinate on scheduling the implementation activities. Caltrans, however has reserved the right to proceed independently to address the TMDL goals depending on the specific costs and implementation measures identified during the implementation process.

Table ES-3
Ballona Creek Toxic Pollutants TMDL Implementation Schedule and Milestones



ES.15 Implementation Plan Cost Estimates

The recommended BMPs proposed for the Implementation Plan were analyzed to develop planning level cost estimates including capital and annual operation and maintenance costs. The basis for developing the cost estimates for the structural BMPs was the Water Environment Research Federation (WERF) Whole Life Cycle cost spreadsheets. The Whole Life Cycle costing approach was applied to five selected distributed BMP sites and four selected regional BMP sites. Average "per acre" costs were calculated and applied to estimate the overall costs of the structural BMP program when applied across the Ballona Creek Watershed.

As stated, this Implementation Plan was developed in combination with the Ballona Creek Bacteria and Metals TMDL Implementation Plans. The costs presented in Table ES-4 represent the cost already included in the Bacteria and Metals TMDL Implementation Plans for the distributed BMPs, regional BMP, LFTFs, and institutional BMPs.

The increase in cost for implementation of the Toxics TMDL Implementation Plan is the O&M cost of $1 million per year, as presented in Table ES-5. This represents the cost for the toxic specific BMP, which is the "Target Pesticide Reduction Program."

The total capital cost is estimated to be $1.3 billion, with $38 million in O&M costs.

Implementation of this plan is subject to the availability of the necessary funding. Currently none of the BMPs and projects identified in this plan are funded, except for some of the institutional measures. Responsible jurisdictions continue to pursue funding alternatives in partnership with each other.

Table ES-4
Total Costs from the Ballona Creek Bacteria and Metals TMDL Implementation Plans[1]

Ballona Creek Watershed BMPs	Treated Acres [2]	Capital Cost per Treated Acre	Total Capital Cost	O&M Costs per acre	Annual O&M
Structural BMPs					
Distributed BMPs	*10,100*[3]	$68,000	$686,800,000	*$2,800*	$18,180,000
Regional BMPs	*1,840*	$22,500	$41,400,000	*$600*	$1,100,000
Low Flow Treatment Facility-1 (NOTF)			$10,600,000		$1,060,000
Low Flow Treatment Facility-2 (Oval St)			$14,700,000		$1,470,000
Institutional BMPs					
Enhanced Street Sweeping			$840,000		$600,000
Downspout Disconnection			$88,400,000		$0
Enhance Pet Waste Pickup and Education Program			$2,000,000		$200,000
Target Zinc Reduction Program					$1,000,000
Copper Brake Pad Product Replacement Program					$100,000

Table ES-4 (Continued)
Total Costs from the Ballona Creek Bacteria and Metals TMDL Implementation Plans[1]

Ballona Creek Watershed BMPs	Treated Acres [2]	Capital Cost per Treated Acre	Total Capital Cost	O&M Costs per acre	Annual O&M
Institutional BMPs					
Subtotal			**$840,000,000**		**$23,700,000**
Program Management, Engineering, Administration, and Monitoring (20% of capital cost)[4]			$170,000,000		$4,700,000
Program Contingency (30%)			$250,000,000		$7,100,000
Total Cost			**$1,260,000,000**		**$36,000,000**

[1] Selected BMPs will address multiple pollutants including bacteria, metals and toxicity.
[2] *Treated Acres based on draft Implementation Plan selected scenario assuming distributed BMP deployment as required to meet Bacteria, Metals and Toxics TMDL load reduction target and 8 Regional BMP facilities. See Section 5.*
[3] *Excludes the acres that will be retrofit through the SUSMP program, as these costs would not be the responsibility of the responsible jurisdictions.*
[4]*The responsible agencies will require additional resources in order to manage the BMPs implementation described in this Implementation Plan. The costs associated with this include administration, engineering, and ongoing monitoring of the program. The costs are estimated to be 20% of the total capital costs, or $160,000,000 through 2021. This cost would include increased staff for oversight of the design and implementation of the structural BMPs as well as implementation of the institutional BMPs (reviewing and enhancing existing policies, etc, as listed in Appendix G).*

Table ES-5
Total Costs for Bacteria, and Toxics TMDL Implementation Plans[1]

Ballona Creek Watershed BMPs	Total Capital Cost	Annual O&M
Additional Institutional BMPs for Toxics TMDL Compliance		
Target Toxics Reduction Program		$1,000,000
Subtotal for Additional Institutional BMPs for Toxics TMDL Compliance		**$1,000,000**
Additional Program Management, Engineering, Administration, and Monitoring (20% of capital cost)[2]		$200,000
Additional Program Contingency (30%)		$300,000
Total Increase for Toxics TMDL Compliance		**$1,500,000**
Total Cost from Bacteria and Metals TMDL Implementation Plans	$1,260,000,000	$36,000,000
Total Cost for Implementation of Metals, Bacteria and Toxics TMDL Implementation Plans	**$1,260,000,000**	**$38,000,000**

[1] *Included are the costs estimated to implement the Bacteria, Metals and Toxics TMDL Implementation Plans.*
[2]*The responsible agencies will require additional resources in order to manage the BMPs implementation described in this Implementation Plan. The costs associated with this include administration, engineering, and ongoing monitoring of the program. The costs are estimated to be 20% of the total capital costs. This cost would include increased staff for oversight of the design and implementation of the structural BMPs as well as implementation of the institutional BMPs (reviewing and enhancing existing policies, etc, as listed in Appendix G).*

ES.16 Funding Availability

Currently, except for the institutional measures, none of the projects and BMPs identified in this Implementation Plan are funded. The City of Los Angeles continues to pursue funding alternatives in partnership with the various agencies in the watershed, including the County of Los Angeles.

Section 1
Introduction

The Ballona Creek Estuary Toxic Pollutants TMDL Implementation Plan (Implementation Plan) defines the approaches that the cities of Los Angeles (lead agency), Culver City, Beverly Hills, Inglewood, West Hollywood, Santa Monica, and the California Department of Transportation (Caltrans), (the responsible jurisdictions), will take to comply with the requirements of the *Ballona Creek Estuary Toxic Pollutants TMDL* (Toxics TMDL).

Following the multi-pollutant approach, this Implementation Plan was developed in conjunction with the Ballona Creek Bacteria TMDL Implementation Plan and the Ballona Creek Metals TMDL Implementation Plan. With the exception of institutional BMPs developed specifically to address toxic pollutants, all of the BMPs identified in this Implementation Plan serve to reduce toxics, metals and bacteria in order to meet the numeric limits and waste load allocations of the Toxics, Metals and Bacteria TMDLs, respectively.

1.1 Guiding Principles

A guiding plan in the development of this Implementation Plan is the City of Los Angeles Water Quality Compliance Master Plan for Urban Runoff (WQCMPUR). Although the WQCMPUR is a strategic plan for the City of Los Angeles, its guidelines and directions apply to the entire watershed and were developed in concurrence with all watershed stakeholders, including the responsible jurisdictions. The WQCMPUR includes three initiatives (City of Los Angeles, 2009):

- Water Quality Management Initiative for project identification;
- Citywide Coordination Initiative to develop ordinances and collaborative approaches within and among agencies; and
- Outreach Initiative for pollutant source control.

This Implementation Plan addresses these three initiatives. Further, the WQCMPUR included an Action Plan (Table ES-3 of the WQCMPUR executive summary). The Action Plan identifies high priority items including the development of multiple TMDL Implementation Plans and watershed specific Water Quality Management Plans, which are currently in development.

Following the principles of the WQCMPUR and Integrated Resources Plan (IRP), this Implementation Plan incorporated input from the responsible jurisdictions and stakeholders. This plan uses the following guiding principles:

- ***Watershed Wide Approach***: characterize the watershed as a whole and identify and select projects independently of jurisdictional boundaries in order to develop the most beneficial plan for the watershed.

- ***Integrated Plan***: identify urban runoff management projects that have multiple benefits and treat multiple pollutants.

- ***Green Solutions***: wherever possible, implement solutions that are "green," sustainable, and work with the existing natural environment.

- ***Build on Existing Programs***: review existing urban runoff programs and identify opportunities to improve current water quality programs.

- ***Stakeholder Involvement***: identify the best projects and concepts through collaboration with the many active organizations and individual stakeholders in the watershed.

- ***Adaptive Management***: develop a plan that embraces the need to refine itself based on the information gathered over time through the implementation of both successful and unsuccessful programs and projects.

1.2 Regulatory and Permitting Requirements

1.2.1 Background

The Clean Water Act of 1972 (CWA) provides the basis for the protection of all inland surface waters, estuaries, and coastal waters. The federal Environmental Protection Agency (EPA) is responsible for administering the CWA and developing regulations, but may delegate its authority to the State.

The State of California (State) implements the CWA by establishing water quality protection laws and regulations and issuing discharge permits through State regulatory agencies. At its own discretion, the State has established requirements in many instances that are more stringent than federal requirements for CWA implementation.

California's primary statute governing water quality is the Porter-Cologne Water Quality Control Act of 1970 (Porter-Cologne Act). The Porter-Cologne Act grants the California State Water Resources Control Board (State Board) and nine California Regional Water Quality Control Boards broad powers to protect water quality, and it is the primary vehicle for the administration of California's regulations under the federally delegated responsibilities of the CWA. The governing Regional Board for the Los Angeles area watersheds is the Los Angeles Regional Water Quality Control Board (LARWQCB).

Biennially, the LARWQCB prepares a list of impaired waterbodies in the region, referred to as the 303(d) list (as a reference to the applicable CWA section). The 303(d) list outlines the impaired waterbody and the specific pollutant(s) for which it is impaired. All waterbodies on the 303(d) list are subject to the development of a TMDL. A TMDL establishes the maximum amount of a pollutant that a waterbody can receive and still meet the applicable water quality standard for that pollutant. Depending on the nature of the pollutant, TMDL implementation may require a cap on pollutant contributions from point sources (wasteload allocation), nonpoint sources (load allocation), or both.

The development of TMDLs affecting waters in the Los Angeles area watersheds is the responsibility of the LARWQCB. Adoption of a TMDL requires an amendment to the regional water quality regulations (Basin Plan) and is subject to a substantial public review process. After the LARWQCB adopts the TMDL as a Basin Plan amendment, it is submitted to the State Board for approval. If approved by the State Board, the TMDL is submitted to EPA Region 9 for final review and federal approval. The TMDL does not take effect until the EPA has issued its formal approval.

Once a TMDL becomes effective, the schedule for TMDL implementation by each named responsible jurisdiction becomes active. TMDL-specific implementation requirements vary, but typically include preparation of a Coordinated Monitoring Plan (CMP) for the affected watershed, and development of an Implementation Plan detailing how responsible jurisdictions plan to achieve compliance with the TMDL requirements. This Implementation Plan is written in response to requirements contained in the Toxics TMDL.

1.2.2 Toxics TMDL Development History

To address the Toxics TMDL development requirements, the LARWQCB published for public review draft technical documents, including the Draft Staff Report, a Proposed Basin Plan Amendment, a Tentative Resolution, and the California Environmental Quality Act (CEQA) Requirements checklist. Following comments, these documents were revised and finalized on July 7, 2005.

The LARWQCB adopted the TMDL July 7, 2005 (Appendix A). The State Board Water Resources Control Board approved the TMDL on October 20, 2005, the State Office of Administrative Law approved the TMDL on December 15, 2005, and EPA Region 9 approved the TMDL on December 22, 2005. The TMDL became effective on January 11, 2006.

1.2.3 Toxics TMDL Numeric Limits

Table 1-1 summarizes the Toxics TMDL numeric limits which are based on the sediment quality guidelines compiled by the National Oceanic and Atmospheric Administration and the corresponding waste load allocations (WLA). Throughout this Implementation Plan, the term toxic pollutants refers to these constituents that are listed in the TMDL (both metals and organics).

The numeric target listed in the TMDL is for concentrations of the listed constituents in the Estuary. The WLA are for the maximum amount of each listed constituent that can be transported from the Ballona Creek Watershed to the Estuary. The vast majority of these constituents are bound to sediment and are transported as storm borne sediment during storm events.

Table 1-1
Ballona Creek Estuary Numeric Targets and Waste Load Allocation

Metals	Numeric Target (mg/kg)	WLA (kg/yr)
Cadmium	1.2	8.50
Copper	34.00	241.60
Lead	46.70	332
Silver	1.00	7.1
Zinc	150.00	1,066.00
Organics	**Numeric Target (ug/kg)**	**TMDL (g/yr)**
Chlordane	0.5	3.55
DDTs	1.58	11.2
Total PCBs	22.7	161
Total PAHs	4,022	28,580

Source: Table 5-2, TMDL Final Staff Report, July 7, 2005.

1.2.4 Additional TMDLs and Watershed Impairments

Water quality concerns in the Ballona Creek Watershed extend beyond elevated estuary toxic pollutant concentrations. These concerns have resulted in the adoption of additional TMDLs and 303(d) listed impairments.

Adopted TMDLs

Two additional TMDLs are effective in the Ballona Creek Watershed:

- *Ballona Creek Metals TMDL (Metals TMDL)* - includes numeric targets for copper, lead, selenium, and zinc and wasteload allocations for dry and wet weather conditions. The TMDL effective date is October 29, 2008. The Draft TMDL Implementation Plan was submitted to the LARWQCB January 11, 2010.

- *Ballona Creek, Estuary, and Sepulveda Channel Bacteria TMDL (Bacteria TMDL)* - includes numeric limits and wasteload allocations applicable to urban runoff for total coliform, fecal coliform, enterococcus, and *E. coli. (*LARWQCB 2005). The TMDL effective date is April 27, 2007. The Draft TMDL Implementation Plan was submitted to the LARWQCB on November 25, 2009.

Many of the technical analyses for this Toxics TMDL Implementation Plan were coordinated with the technical analyses required for development of implementation plans for the bacteria and metals TMDLs. This approach supports the development and implementation of an Integrated Water Resource Approach (IWRA) for improving urban runoff quality.

303(d) List of Impaired Waters

Pollutants that are listed on the 303(d) list as the cause of water body impairments must be addressed through the TMDL process. The EPA-approved 303(d) list for

California was most recently updated in 2008. Within the Ballona Creek Watershed, the 2008 303(d) list identifies the following additional impairments:

- Ballona Creek is listed for cyanide with a proposed TMDL completion date of 2019.
- The Ballona Creek Estuary is listed for Shellfish Harvesting Advisory with a proposed TMDL completion date of 2006.
- Ballona Creek Wetlands is listed for Exotic Vegetation, Habitat Alterations, Hydromodification, and reduced tidal flushing with a proposed TMDL completion date of 2019.
- Sepulveda Canyon is listed for ammonia with a proposed TMDL completion date of 2019.

In anticipation of the promulgation of TMDL requirements for these waterbodies in the near future, the Implementation Plan recommends, where possible, Best Management Practices (BMPs) that have the potential to address multiple pollutants.

1.2.5 Coordinated Monitoring Plan (CMP) Requirements

The Toxics TMDL required that a CMP be submitted by the responsible jurisdictions (including Los Angeles County) by January 11, 2007. The CMP was submitted for the Ballona Creek Watershed to the LARWQCB on January 10, 2007, and was written to address both the Ballona Creek Metals TMDL and the Ballona Creek Estuary Toxic Pollutants TMDL. The CMP was revised and resubmitted on August 8, 2008 and again on May 4, 2009.

Based on these requirements, the Ballona Creek Watershed Agencies developed the CMP and identified ambient monitoring points (Table 1-2) for dry-weather water quality, wet-weather water quality, storm-borne sediment and bioaccumulation monitoring. The locations of the monitoring sites are illustrated in Figure 1-1 and Figure 1-2.

The dry-weather monitoring location at the Pacific Avenue Bridge (BCE-1A), was selected to meet the TMDL ambient monitoring requirement. This site was chosen based on its historical precedence along with its location in the estuary. Monitoring at this site will only be done during the ambient monitoring period. To monitor wet-weather conditions and estimate loading, two locations have been selected (BC-1 and BC-5) for water quality monitoring. Five autosamplers located in Ballona Creek (BC-1 to BC-5) which will measure storm-borne sediment loading to the estuary during wet-weather (Table 1-3) (Figure 1-1).

Six sediment quality monitoring locations were selected to measure sediment quality in the estuary (BCE-1 to BCE-6) (Table 1-4) (Figure 1-2).

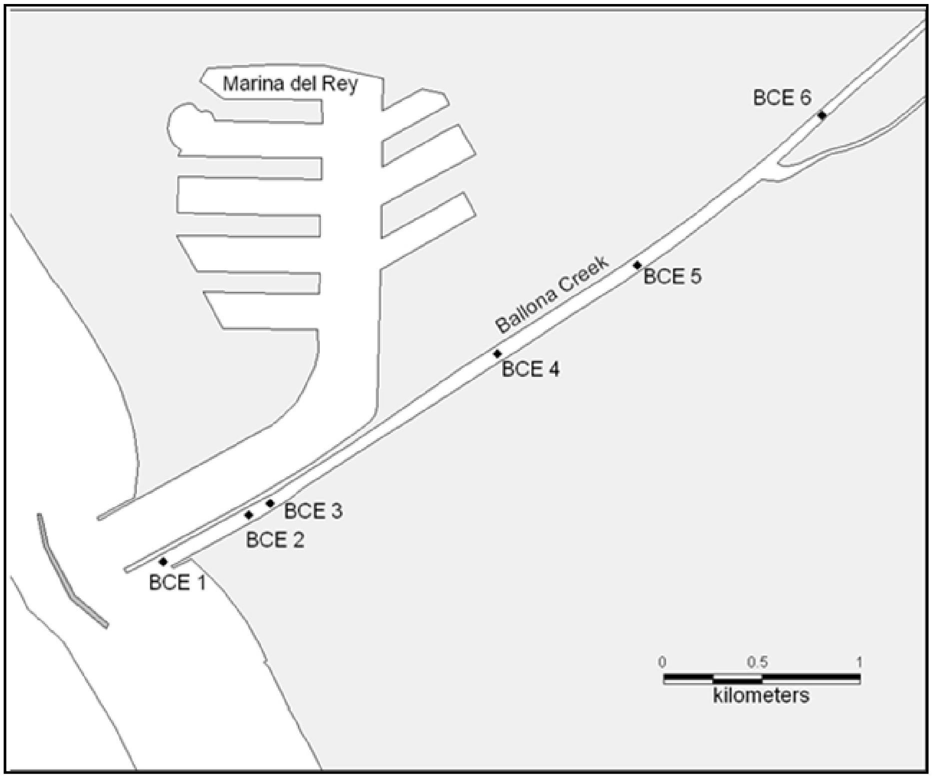


Figure 1-2
Ballona Creek CMP Estuary Monitoring Locations

Two bioaccumulation monitoring locations were selected to collect sport fish and mussels. Both fish and mussels will be collected at stations BCE-2 and BCE-4.

Table 1-2
TMDL Ambient Dry-weather Monitoring Site

Station ID	BCE-1A
Location (just above confluence)	At the Pacific Avenue Bridge
Historical ID & Agency	Pacific (Status & Trends)
Subwatershed	Lower Ballona Estuary
Sampling Frequency	Monthly

Table 1-3
TMDL Effectiveness Wet-weather Monitoring Sites

Station ID	BC-1	BC-2	BC-3	BC-4	BC-5
Location	Centinela Ave. (at Creek)	Between Sawtelle Blvd and Sepulveda Blvd. (at Creek)	National Blvd (at creek)	Sepulveda Channel (just above confluence)	Centinela Creek (just above confluence)
Historical ID & Agency	Cent	S01	Nat	TS08	TS07
Creek Section	Reach 2	Reach 2	Reach 1	Sepulveda Channel	Centinela Creek
Percent of Watershed Tributary	100%	78%	42%	20%	7.6%
Sampling Frequency	Annual or Accelerated[1] Plus Composite[2]	Annual or Accelerated[1]	Annual or Accelerated[1]	Annual or Accelerated[1]	Annual or Accelerated[1] Plus Composite[2]

Notes:
1-accelerated monitoring will be conducted if exceedances occur. Accelerated monitoring will consist of six additional tests conducted approximately two weeks between the termination of one test and the initiation of the next. If no exceedances occur during the six accelerated test samples then regular monitoring will resume. If any two of the accelerated tests have less than an average of 90% survival then an investigation into the cause of the toxicity shall be implemented (i.e. TIE, Toxicity Identification Evaluation).
2-composite samples will occur for selected storm events.

Table 1-4
TMDL Effectiveness Sediment Quality Monitoring Sites

Station ID	BCE-1	BCE-2	BCE-3	BCE-4	BCE-5	BCE-6
Location	Mouth of Ballona Creek	At the Pacific Avenue Bridge	Between Pacific Ave Bridge and tide gate.	Between Ballona wetlands tide gate and Culver Blvd.	Between Centinela Creek and Culver Blvd.	Between Centinela Creek and Centinela Blvd.
Historical ID & Agency	BPTCP 44014.0	N/A	N/A	N/A	N/A	N/A
Sampling Frequency	Semiannually for 1st year and annually after	Semiannually for 1st year and annually thereafter Plus bioaccumulation annually	Semiannually for 1st year and annually thereafter	Semiannually for 1st year and annually thereafter Plus bioaccumulation annually	Semiannually for 1st year and annually thereafter	Semiannually for 1st year and annually thereafter

1.2.6 Toxics TMDL Compliance Requirements

The Toxics TMDL defines milestones for achieving compliance:

- By **January 11, 2011**, MS4 and Caltrans stormwater NPDES permittees shall provide a written draft report to the Regional Board outlining how they will achieve the waste load allocations for sediment in the Ballona Creek Estuary

- By **July 11, 2011**, MS4 and Caltrans stormwater NPDES permittees shall provide a written final report to the Regional Board outlining how they will achieve the waste load allocations for sediment in the Ballona Creek Estuary.

- By **January 11, 2012**, the Regional Board shall reconsider this TMDL to re-evaluate the waste load allocations and the implementation schedule.

- By **January 11, 2013**, demonstrate that 25 percent of the total drainage area is effectively meeting the waste load allocation for sediment (Table 1-1).

- By **January 11, 2015,** demonstrate that 50 percent of the total drainage area is effectively meeting the waste load allocation for sediment (Table 1-1).

- By **January 11, 2017,** demonstrate that 75 percent of the total drainage area is effectively meeting the waste load allocation for sediment(Table 1-1),

- By **January 11, 2021,** demonstrate that 100 percent of the total drainage area is effectively meeting the waste load allocation for sediment (Table 1-1).

1.3 Compliance Components

Adaptive Management

Re-evaluation of the Toxics TMDL noted in the previous section is in line with the adaptive management approach of the Implementation Plan. Adaptive management recognizes that there is uncertainty associated with the development of the numeric targets and waste load allocations of the Toxics TMDL.

Adaptive management, or in this case, "adaptive implementation" is an iterative process whereby the responsible jurisdictions will commit to implementing an initial suite of priority BMPs both structural and institutional, meanwhile continuing with monitoring under the CMP to quantify progress towards meeting the numeric limits. Refinements or improvements to BMPs or the analytical tools such as water quality models will also be undertaken after initiation of the Implementation Plan. Under the adaptive management process, the responsible jurisdictions, in coordination with the LARWQCB, would identify and implement improved BMPs and apply the refined analytical tools using current water quality monitoring data. The process would involve future periodic revisions to the Implementation Plan. The adaptive management approach can enable implementation of new BMPs with reduced uncertainty of their performance, and potentially improved cost-effectiveness. Adaptive management only addresses uncertainty regarding the efficacy of BMPs and the monitoring data used to characterize the impacted waterbodies.

FIGURE 1-1 Ballona Creek CMP Monitoring Locations

Section 2
Watershed Background

This section provides an overview of physical conditions (e.g., land use, topography and soils types), hydrologic conditions (e.g., precipitation, flow, and storm drain connectivity), and historic water quality in the Ballona Creek Watershed.

2.1 Ballona Creek Watershed

The Ballona Creek Watershed is approximately 128 square miles (approximately 82,000 acres) in size (Figure 2-1). Located on the coastal plain of the Los Angeles basin, it is bounded by the the Santa Monica Mountains to the north and the Baldwin Hills to the south. Draining to Santa Monica Bay, the watershed collects runoff from the southern part of the Santa Monica Mountains (south of Mulholland Drive) and the western part of the City of Los Angeles. Approximately 80 percent of the watershed is under the jurisdiction of the City of Los Angeles. The remainder of the watershed consists of the cities of Beverly Hills, West Hollywood, Culver City, Inglewood, Santa Monica, and the County of Los Angeles. Caltrans also has areas within the watershed under its jurisdiction.

The Basin Plan describes three main sections of Ballona Creek (Figure 2-1); Reach 1, the uppermost section; Reach 2, the middle portion; and the Estuary, the lower section that flows into the Pacific Ocean. Ballona Creek is predominantly channelized and with the exception of the headwaters within the northern portion of the watershed in the Santa Monica Mountains, the watershed is highly developed.

2.2 Watershed Characteristics

2.2.1 Topography

Figure 2-2 illustrates the topography of the Ballona Creek Watershed. The northern area in the Santa Monica Mountains has the highest elevations. The Baldwin Hills area in the southern part of the watershed is also elevated. The topography of the watershed is an important factor in understanding rainfall variation, subwatershed and catchment development, landslide potential, and potential BMP siting.

2.2.2 Hydrologic Connectivity and Storm Drain Network

Hydrologic connectivity refers to the physical connections between a river or channel and its tributaries, between surface water and groundwater, and between wetlands and waterbodies. The Basin Plan defines three sections of the creek based on hydrologic units (Figure 2-3):

- *Ballona Creek, Reach 1* – Reach 1 begins at the point where the creek emerges from the underground network of drains at Cochran Avenue in the City of Los Angeles and extends about 2 miles to National Boulevard in Culver City. This Reach is characterized as concrete lined box channel.

- *Ballona Creek to Estuary, Reach 2* - The longest segment of the creek (approximately 4 miles). This reach begins at the lower end of Reach 1 (National Boulevard) and ends at Centinela Avenue, where the Ballona Creek Estuary begins.

- *Ballona Creek Estuary* - The estuary reach, which is 3.5 miles in length, begins at Centinela Avenue and ends at the Pacific Ocean. Its lower portion flows parallel to the main channel of Marina del Rey Harbor.

The estuarine section of the creek is composed of grouted rip-rap sloped sides and an earthen bottom.The other reaches of Ballona Creek are entirely lined in concrete and extend into a complex underground network of storm drains, which extend north beyond Beverly Hills and West Hollywood into the Hollywood Hills.

Tributaries of Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, and Benedict Canyon Channel (see Figure 2-1). All these tributaries are concrete lined channels and are fed by a network of upstream underground storm drains. Benedict Canyon discharges into Ballona Creek in Reach 2 at Madison Avenue. Downstream of the Benedict Canyon confluence, Sepulveda Canyon Channel also discharges into Ballona Creek Reach 2. Centinela Creek drains directly to Ballona Creek Estuary just below its boundary with Reach 2.

Storm drainage throughout most of Ballona Creek Watershed is provided through a vast network of underground pipelines (Figure 2-3). The upper watershed drains the Los Angeles neighborhoods of Hollywood Hills, Silver Lake, Hollywood, South Park, mid-Wilshire, Koreatown, Crenshaw, Lemmert Park, Jefferson Park, the northeast drainage of the Baldwin Hills, and the cities of West Hollywood and Beverly Hills.

BMPs were sited based on their location relative to storm drains and storm drain size. For example, the potential benefits to be obtained from a regional BMP depend on the location of storm drains. In addition, understanding the drainage area of a storm drain network is critical to BMP sizing considerations.

2.2.3 City-Defined Catchment Areas

In order to effectively develop a TMDL implementation plan for the watershed, the watershed was divided into smaller sub-catchment areas. Existing Geographical Information Systems (GIS) data developed by the the City and County of Los Angeles divide the watershed into catchments of approximately 40 acres each (Figure 2-4). These smaller catchment areas allow for a more detailed analysis of the drainage patterns at the neighborhood or parcel level. The catchments are delineated by topography and the drainage patterns within each area.

2.2.4 Land Use and Impervious Area

Watershed land use and its relationship to imperviousness were used to estimate runoff generated at the catchment, watershed, or subwatershed level.

Land Use

The Ballona Creek Watershed encompasses approximately 82,000 acres. Figure 2-5 illustrates the land use distribution in the watershed (LACDPW, 2005). For this illustration, related land use classes were combined into larger categories based on the nature of the land use and how land use data are used in selected watershed modeling tools (Section 4). For example, "residential" land use represents a combination of high-density single-family residential, low-density single-family residential, multi-family residential, and mixed residential. These residential land use classes were aggregated into two categories: single family and multi-family. The Implementation Plan analysis incorporated seven major land use categories. These categories and their relative land use coverage include:

- Multi-family Residentail 22%
- Single-family Residential 37%
- Vacant/Open Space 17%
- Commercial 14%
- Education 3%
- Transportation 2%
- Industrial 5%

Impervious Areas

Imperviousness is a measure of the fraction of the total area covered in impervious surfaces, such as roads, rooftops, sidewalks, patios, parking areas, and highly compacted soil. Rainfall and dry weather water sources (e.g., irrigation, car washing, etc.) that fall on pervious surfaces have the best opportunity to infiltrate into the ground and reduce the total amount of runoff generated from an area. The degree to which infiltration is expected to occur in pervious areas is related to soil types and associated infiltration rates (Section 2.2.5).

The Los Angeles County Department of Public Works (LACDPW) Hydrology Manual assigns an imperviousness factor to a number of land use types (LACDPW, 2006) (Table 2-1). Higher numbers indicate greater imperviousness. With a potential range of 0 to 1, the weighted average imperviousness factor for the entire Ballona Creek Watershed is estimated to be 0.49.

2.2.5 Soil Types

Soil types are an integral factor in determining how much runoff can infiltrate into the ground. This is an important component in evaluating the feasibility of siting an infiltration BMP, along with depth to groundwater, and geotechnical considerations. Figure 2-6 identifies the primary soil types and presents their geographic distribution in the watershed (LACDPW Hydrology GIS Database). Note that soil type is only one factor in identifying ideal sites for infiltration BMPs. Other factors, such as depth to groundwater and geotechnical issues, are also important.

2.2.6 Parcel Ownership Data

Figure 2-7 illustrates parcel ownership in the Ballona Creek Watershed. One important consideration for BMP project selection includes determining whether a potential BMP site is publicly or privately owned. It is assumed that implementation can occur in a timelier and less costly manner on publicly owned parcels. These publicly owned sites are primarily considered for regional BMPs. However, BMPs on privately owned parcels are included in the Implementation Plan, assuming a selection of both distributed and institutional BMPs will be implemented.

2.2.7 Groundwater Depth

Depth to groundwater is important when selecting infiltration BMPs, since high groundwater conditions will prohibit infiltration. Figure 2-8 illustrates the depth to groundwater (less than or greater than 30 feet below ground surface) throughout the Ballona Creek Watershed. The northern portion of the watershed and the area adjacent to the downstream portion of Ballona Creek contain groundwater that is less than 30 feet below the surface of the ground. The remainder of the area has a groundwater depth of greater than 30 feet.

2.2.8 Liquefaction and Landslide Zones

Liquefaction refers to the behavior of soils (e.g. loose sand) that, under conditions such as an earthquake, shift from a solid state to a liquefied state with a consistency similar to that of a heavy liquid. This occurs in saturated soils where the water pressure increases with the earthquake event and changes the behavior of the soil. Soil liquefaction can cause tremendous damage during earthquakes. Liquefaction zone areas in the watershed are located along the mainstem of Ballona Creek (Figure 2-9). Liquefaction potential may preclude siting of typical structural infiltration BMPs in these areas.

Landslides occur when a slope's stability changes from stable to unstable, causing the ground to move. Landslides can be caused by many natural factors, including earthquakes, increased groundwater pressure, heavy rains, and human factors, including the use of heavy machinery, blasting, and earthwork. Areas susceptible to landslides in the watershed are primarily in the north and the Baldwin Hills area (Figure 2-9).

2.3 Hydrology

The following two sections present a summary of precipitation and flow in the Ballona Creek Watershed.

2.3.1 Rainfall Data Summaries

The Ballona Creek Watershed climate can be characterized as Mediterranean with average annual rainfall of approximately 15 inches per year over most of the developed portions of the watershed. Table 2-2 summarizes rainfall data from 1998 to

2008 from Los Angeles County Gauge 634C in the Santa Monica area (monthly totals, max/min rainfall data, and yearly summaries).

Rainfall volumes and intensity vary throughout the watershed due, in part, to the varied topography in the Ballona Creek Watershed. Figure 2-10 provides a plot of 85th percentile, 24-hour rainfall isohyets (i.e., lines of equal rainfall depth) throughout the watershed (based on Los Angeles County data). The isohyets represent the depth of rainfall for the 85th percentile design frequency over a 24-hour period. Figure 2-11 illustrates the distribution of rainfall in the area, showing that the rainfall in the northwest and coastal portions of the watershed is higher than in the northeast.

2.3.2 Flow Data

Flow in Ballona Creek is monitored by the County of Los Angeles at a site above Sawtelle Boulevard at meter F38CB (Figure 2-12). Tables 2-3 and 2-4 present flow data from 1998 to 2008 for dry and wet weather, respectively. The tables also provide monthly mean stream flows by year, as well as summary data each year. The summary data include the mean flow, maximum flow, and minimum flow, and a count of the number of days flow is above or below 40 cfs—the definition for the distinction between dry and wet weather flows contained in the Metals TMDL.

Figures 2-13 and 2-14 present the flow in Ballona Creek at Sawetelle Boulevard for the periods of 1987 to 1998 and 1987 to 2008, respectively. The graphs show that the average flow in Ballona Creek from the period of 1987 to 1998 was 61.76 cfs, while for the period of 1987 to 2008 the average flow was 70.10 cfs. This indicates that the average flow in the creek has been increasing over time.

Lower instream flows occur in June, July and August during low rainfall periods (Tables 2-3 and 2-4). Generally, the primary source of flows during these months is likely runoff from activities such as landscape irrigation. During the period from December 16, 1999 to April 1, 2008, the County recorded 3,471 flow and rainfall measurements. Observations included:

- Rainfall occurred on 316 days. On these days:
  - Instream flow exceeded 40 cfs on 229 days, resulting in a classification of the flow as a wet weather flow.
  - Instream flow was less than 40 cfs on 87 days, resulting in a classification of the flow as a dry weather flow.
- Overall, flow exceeded 40 cfs on 975 days. On these days:
  - No rainfall occurred on 746 days even though, by definition, they would be considered wet weather days.
  - Rainfall did occur on 229 of the days.

2.4 Sediment Quality

The responsible agencies are required to collect water, fish tissue and sediment quality data to evaluate the assumptions made in the TMDL by conducting special studies to address the uncertainties in the TMDL and to assist in the design and sizing of BMPs. The responsible agencies initiated the Toxicity Identification Evaluation (TIE) study in 2007. The TIE study is conducted in two phases and determines the potential causes of the sediment toxicity in the Estuary.

At the time of the preparation of this TMDL Implementation Plan, sediment quality data from the TIE study was drafted and available for the period of September 2007 to December 2009 (Appendix B). Sediment samples were taken from the bottom of the estuary at the locations shown in Figure 1-1, and analyzed to determine the concentration of each of the various constituents listed in the TMDL. Figure 2.15 provides the overall summary of the TIE study with the median and average concentrations, standard deviations, and the number of samples. The results show that the sediment in Ballona Estuary meet the numeric limits for all the contaminants except Chlordane and DDTs.

In addition to collecting and analyzing sediment concentrations for each constituent, the toxicity evaluation was performed to determine the causes of toxicity in the estuary.

General findings of the TIE study are as follow:

- Estuary sediment characteristics have high seasonal and spatial variability;
- Pyrethroid pesticides are the principal cause of observed sediment toxicity;
- Most contaminants included in the Toxics TMDL likely have low influence on sediment toxicity and related impacts; and
- Current TMDL target concentrations are very conservative and have little relationship to demonstrated effects of the contaminants.

TIE Study was concluded in 2011 and study results were submitted to the Regional Board on September 22, 2011. Based on the findings, the Implementation Plan presented in Section 5 serves to meet the Toxics TMDL WLAs as well as addresses the cause of toxicity, namely pyrethroids.

Table 2-1
Land Use in Ballona Creek Watershed with Associated Imperviousness Factor

Land Use	Imperviousness Factor[1]	Acres[2]	Percent Cover
Vacant	0.01	11,198	13.7%
Golf Courses	0.03	1,092	1.3%
Under Construction	0.15	367	0.5%
Low Density Single Family / Rural Residential	0.21	2,688	3.3%
High Density Single Family	0.42	27,039	33.1%
Agriculture / Orchards / Horse Ranch	0.47	21	0.0%
Education	0.47	2,518	3.1%
Natural Resources Extraction	0.47	870	1.1%
Multiple Family Residential / Trailer parks	0.55	11,219	13.7%
Mixed Residential	0.59	7,404	9.1%
Military	0.65	21	0.0%
Heavy Industrial	0.66	32	0.0%
Open Space / Recreation	0.74	1,640	2.0%
Mixed Urban	0.89	184	0.2%
Commercial / Industrial	0.91	74	0.1%
General Office	0.91	1,324	1.6%
Institutional	0.91	1,739	2.1%
Light Industrial	0.91	2,369	2.9%
Maintenance Yards Communications Facilities	0.91	178	0.2%
Other Commercial	0.91	435	0.5%
Other Facilities	0.91	139	0.2%
Regular / Mixed Transportation	0.91	1,673	2.0%
Retail / Commercial	0.97	6,874	8.4%
Floodways and Structures	1.00	216	0.3%
Receiving / Marina Waters	1.00	326	0.4%
Weighted Average	0.49	NA	NA
Total	NA	81,644	100%

[1] Source: LA County Hydrology Manual, Appendix D.
http://dpw.lacounty.gov/wrd/publication/engineering/2006_Hydrology_Manual/Appendix-D.pdf
[2] Source: Southern California Association of Governments (SCAG) Land Use Data (2005),
http://www.scag.ca.gov/

Table 2-2
Precipitation Summary (inches) based on Daily Precipitation Records in the Santa Monica Area, November 1998 to May 2008, Los Angeles County Gauge 634C

Year		Statistic	Month												Year Total
From	To		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
1998	1999	Monthly Total		1.09	0.64	1.00	0.82	1.99	1.74		0.37				7.65
		Mean		*0.36*	*0.21*	*0.25*	*0.21*	*0.33*	*0.44*		*0.12*				
		Max Day		*0.86*	*0.45*	*0.38*	*0.58*	*1.15*	*0.82*		*0.28*				
		Min Day		*0.06*	*0.05*	*0.12*	*0.04*	*0.02*	*0.13*		*0.02*				
		# Rain Days		*3*	*3*	*4*	*4*	*6*	*4*		*3*				*27*
1999	2000	Monthly Total				1.41	5.48	2.13	1.47	0.05				0.02	10.56
		Mean				*0.20*	*0.55*	*0.36*	*0.74*	*0.05*				*0.02*	
		Max Day				*0.69*	*1.65*	*1.27*	*1.02*	*0.05*				*0.02*	
		Min Day				*0.02*	*0.10*	*0.01*	*0.45*	*0.05*				*0.02*	
		# Rain Days				*7*	*10*	*6*	*2*	*1*				*1*	*27*
2000	2001	Monthly Total	0.01		0.02	6.05	7.29	1.66	0.73						15.76
		Mean	*0.01*		*0.02*	*0.76*	*0.52*	*0.55*	*0.37*						
		Max Day	*0.01*		*0.02*	*3.25*	*2.03*	*0.80*	*0.40*						
		Min Day	*0.01*		*0.02*	*0.01*	*0.02*	*0.10*	*0.33*						
		# Rain Days	*1*		*1*	*8*	*14*	*3*	*2*						*29*
2001	2002	Monthly Total	0.09	2.00	0.95	0.40	0.30	0.32	0.05						4.11
		Mean	*0.05*	*0.40*	*0.16*	*0.13*	*0.30*	*0.08*	*0.05*						
		Max Day	*0.07*	*0.91*	*0.30*	*0.25*	*0.30*	*0.17*	*0.05*						
		Min Day	*0.02*	*0.03*	*0.02*	*0.03*	*0.30*	*0.01*	*0.05*						
		# Rain Days	*2*	*5*	*6*	*3*	*1*	*4*	*1*						*22*
2002	2003	Monthly Total		2.04	2.44		4.49	2.52	1.31	1.54	0.04	0.06			14.44
		Mean		*0.41*	*0.35*		*0.75*	*0.84*	*0.17*	*0.39*	*0.02*	*0.03*			
		Max Day		*1.53*	*1.00*		*3.08*	*2.00*	*0.46*	*1.15*	*0.03*	*0.05*			
		Min Day		*0.01*	*0.03*		*0.05*	*0.07*	*0.01*	*0.03*	*0.01*	*0.01*			
		# Rain Days		*5*	*7*		*6*	*3*	*5*	*4*	*2*	*2*			*34*

Table 2-2 (Continued)
Precipitation Summary (inches) based on Daily Precipitation Records in the Santa Monica Area, November 1998 to May 2008, Los Angeles County Gauge 634C

Year		Statistic	Month												Year Total
From	To		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
2003	2004	Monthly Total	0.04	1.29	0.91	1.04	4.20	0.84	0.01					0.01	8.34
		Mean	*0.02*	*0.26*	*0.13*	*0.09*	*0.47*	*0.21*	*0.01*					*0.01*	
		Max Day	*0.03*	*0.95*	*0.57*	*0.42*	*2.50*	*0.79*	*0.01*					*0.01*	
		Min Day	*0.01*	*0.02*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*					*0.01*	
		# Rain Days	*2*	*5*	*7*	*5*	*9*	*4*	*1*					*1*	*34*
2004	2005	Monthly Total	3.13	0.50	6.03	8.50	11.68	1.56	0.87	0.15				0.20	32.62
		Mean	*0.52*	*0.13*	*0.67*	*0.85*	*1.06*	*0.20*	*0.44*	*0.05*				*0.20*	
		Max Day	*1.26*	*0.30*	*2.25*	*1.87*	*3.88*	*1.10*	*0.85*	*0.09*				*0.20*	
		Min Day	*0.05*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.02*	*0.01*				*0.20*	
		# Rain Days	*6*	*4*	*9*	*10*	*11*	*8*	*2*	*3*				*1*	*54*
2005	2006	Monthly Total	1.16	0.38	1.50	2.40	1.30	2.54	2.05	0.68	0.01				12.02
		Mean	*0.39*	*0.19*	*0.38*	*0.60*	*0.33*	*0.32*	*0.26*	*0.68*	*0.01*				
		Max Day	*0.57*	*0.32*	*1.18*	*1.38*	*0.67*	*0.92*	*1.10*	*0.68*	*0.01*				
		Min Day	*0.03*	*0.06*	*0.01*	*0.12*	*0.10*	*0.01*	*0.01*	*0.68*	*0.01*				
		# Rain Days	*3*	*2*	*4*	*4*	*4*	*8*	*8*	*1*	*1*				*35*
2006	2007	Monthly Total	0.01	0.13	0.51	0.53	0.67	0.02	0.44			0.01		0.95	3.27
		Mean	*0.01*	*0.13*	*0.17*	*0.08*	*0.13*	*0.01*	*0.22*			*0.01*		*0.95*	
		Max Day	*0.01*	*0.13*	*0.30*	*0.36*	*0.23*	*0.01*	*0.36*			*0.01*		*0.95*	
		Min Day	*0.01*	*0.13*	*0.09*	*0.01*	*0.04*	*0.01*	*0.08*			*0.01*		*0.01*	
		# Rain Days	*1*	*1*	*3*	*7*	*5*	*2*	*2*			*1*		*1*	*23*
2007	2008	Monthly Total	1.12	0.61	1.98	4.39	1.58		0.05	0.06					9.79
		Mean	*0.56*	*0.31*	*0.28*	*0.40*	*0.40*		*0.05*	*0.06*					
		Max Day	*1.11*	*0.60*	*1.08*	*1.03*	*0.77*		*0.05*	*0.06*					
		Min Day	*0.01*	*0.01*	*0.01*	*0.02*	*0.01*		*0.05*	*0.06*					

Table 2-2 (Continued)
Precipitation Summary (inches) based on Daily Precipitation Records in the Santa Monica Area, November 1998 to May 2008, Los Angeles County Gauge 634C

Year		Statistic	Month												Year Total
From	From		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
2007	2008	Monthly Total	1.12	0.61	1.98	4.39	1.58		0.05	0.06					9.79
		# Rain Days	*2*	*2*	*7*	*11*	*4*		*1*	*1*					*28*
Average by month of each parameter for the total period from Nov 1998 to May 2008 (based on daily precipitation):															
Average Monthly Total			0.62	0.80	1.50	2.57	3.78	1.36	0.87	0.28	0.05	0.01	0	0.13	11.96
Average of each Mean			0.17	0.22	0.24	0.34	0.47	0.29	0.27	0.14	0.02	0.00	0	0.13	
Average Max Day			0.34	0.56	0.72	0.96	1.57	0.82	0.51	0.23	0.04	0.01	0	0.13	
Average Min Day			0.02	0.03	0.03	0.04	0.07	0.03	0.11	0.09	0.00	0.00	0	0.03	
Average # rain of days			1.9	2.7	4.7	5.9	6.8	4.4	2.8	1.1	0.7	0.3	0	0.4	31.7

Notes:
"Monthly Total" is the sum of all rainfall that month
"Mean" is the average of each daily rain event by month, for days that it rained
"Max Day" is the maximum rainfall observed for the days that had rain that month
"Min Day" is the minimum rainfall observed for the days that had rain that month
"# of Rain Days" is a count of the total number of days that it rained that month
"Average by month of each parameter for the total period from Nov 1998 to May 2008 (based on daily precipitation)" is the average by month over the entire period based on daily rainfall. The averages include zeros for months that had no rainfall
Source: Los Angeles County Gauge 634C, Santa Monica area

Table 2-3
Monthly Mean Dry Stream Flow (cfs) (Less than 40 cfs)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1998										28.1	15.2	17.3	
1999	17.9	13.2	13.4	17.3	27.5	18.9	16.9	16.3	14.6	15.0	20.0	19.8	17.6
2000	17.9	26.5	23.8	25.9	35.4	22.3	14.9	18.5	25.1	25.5	16.1	26.7	23.2
2001	19.1	15.7	26.2	25.4	21.3	25.8	21.8	25.2	18.1	25.7	23.2	27.9	22.9
2002	13.6	25.8	16.7	19.0	24.0	23.0	12.5	17.9	24.1	22.7	25.9	26.8	21.0
2003	25.8	28.9	34.7	18.6	16.8	18.9	18.7	28.4	15.8	13.3	12.6	15.0	20.6
2004	26.3	18.0	22.9	17.4	22.8	25.9	23.6	24.0	20.6	19.0	18.1	28.9	22.3
2005	14.4	39.9		37.5	34.7	39.7	38.5	37.8	35.3	34.9	33.6		34.6
2006	32.5			38.0	36.9	38.6	27.5	27.7	32.4	27.0	37.2	29.3	32.7
2007	34.7	30.9	30.9	31.7	31.3	30.2	29.9	30.0	30.2	26.7	34.1	33.5	31.2
2008	36.3	36.8											
Summary													
Mean	23.9	26.2	24.1	25.6	27.9	27.0	22.7	25.1	24.0	23.8	23.6	25.0	25.1
Minimum	10	10	10	8	8	12	8	9	10	8	9	11	8
Maximum	39	40	40	40	40	40	40	39	40	39	40	39	40
Number of Days Flow is below 40 cfs:													
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANNUAL**
1998										28	28	29	
1999	27	26	28	24	17	28	31	31	29	31	29	30	331
2000	27	19	26	27	9	30	31	30	28	10	30	17	284
2001	28	16	27	25	26	26	23	15	5	30	9	25	255
2002	18	26	29	29	30	22	23	30	29	31	22	16	305
2003	28	17	27	25	26	30	27	21	23	30	28	27	309
2004	25	21	29	25	31	30	31	31	30	25	28	11	317
2005	30	1	=	2	25	2	4	6	13	25	21		129
2006	1			6	10	8	19	31	23	27	14	27	166
2007	25	13	22	22	26	30	31	25	28	29	24	24	299
2008	4	12											

Based on Average Daily Flow, Los Angeles County Dept of Public Works, Meter:F38CB http://dpw.lacounty.gov/wrd/report/0607/runoff/discharge.cfm, Site: Above Sawtelle Blvd.

Table 2-4
Monthly Mean Wet Stream Flow (cfs) (Greater than 40 cfs)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1998										43	624	194	
1999	421	206	522	421	49	352			95		382	392	315
2000	421	718	566	646	78			74	93	128		57	309
2001	336	774	335	302	48	47	64	63	85	42	126	192	201
2002	507	172	151	59	77	62	53	41	43		371	267	164
2003	332	550	1132	195	251		43	43	55	399	243	416	333
2004	47	879	449	49						845	128	542	420
2005	497	651	138	129	60	56	51	50	53	296	74	96	179
2006	539	192	164	169	115	46	55		51	42	59	249	153
2007	482	148	48	106	49			46	595	487	143	346	245
2008	67	208	102	80									
Summary													
Mean	365	450	361	215	91	113	53	53	134	285	239	275	258
Minimum	40	40	40	40	40	40	40	40	40	40	40	40	40
Maximum	4,390	3,370	4,060	1,590	1,080	571	86	100	919	1,810	2,020	5,230	5,230
Number of Days Flow Exceeds 40 cfs:													
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANNUAL**
1998										3	2	2	
1999	4	2	3	6	14	2			1		1	1	34
2000	4	10	5	3	22			1	2	21		14	82
2001	3	12	4	5	5	4	8	16	25	1	21	6	110
2002	13	2	2	1	1	8	8	1	1		8	15	60
2003	3	11	4	5	5		4	10	7	1	2	4	56
2004	6	8	2	5						6	2	20	49
2005	1	27	31	28	6	28	27	25	17	6	9	31	236
2006	30	28	31	24	21	22	12		7	4	16	4	199
2007	6	15	9	8	5			6	2	2	6	7	66
2008	27	17	31	1									
Average	10	13	12	9	10	13	12	10	8	6	7	10	99

Based on Daily Flow from Los Angeles County Dept of Public Works, Meter: F38CB; http://dpw.lacounty.gov/wrd/report/0607/runoff/discharge.cfm, Site: Above Sawtelle Blvd.

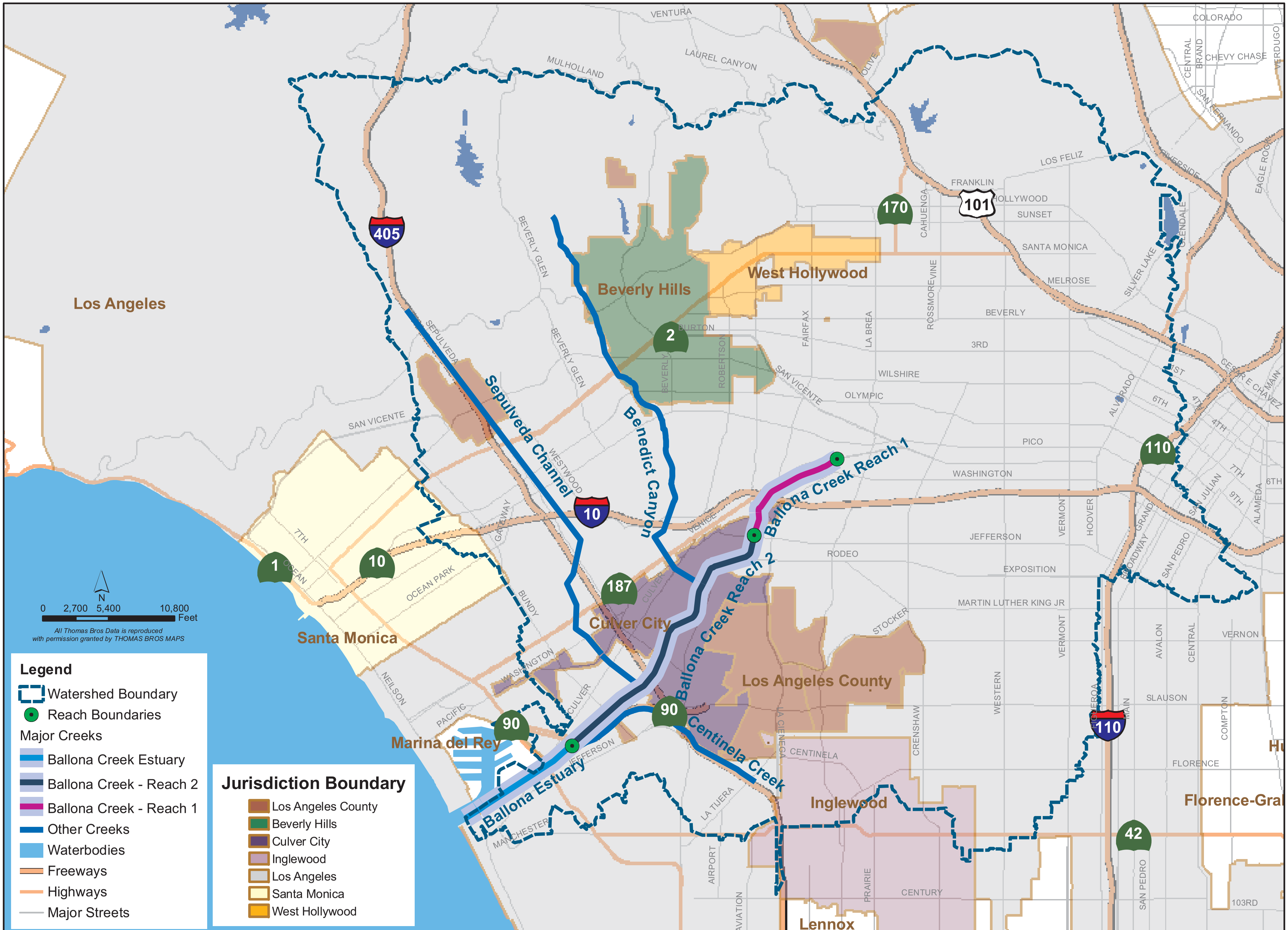


Figure 2-1 Ballona Creek Boundary and Jurisdictions

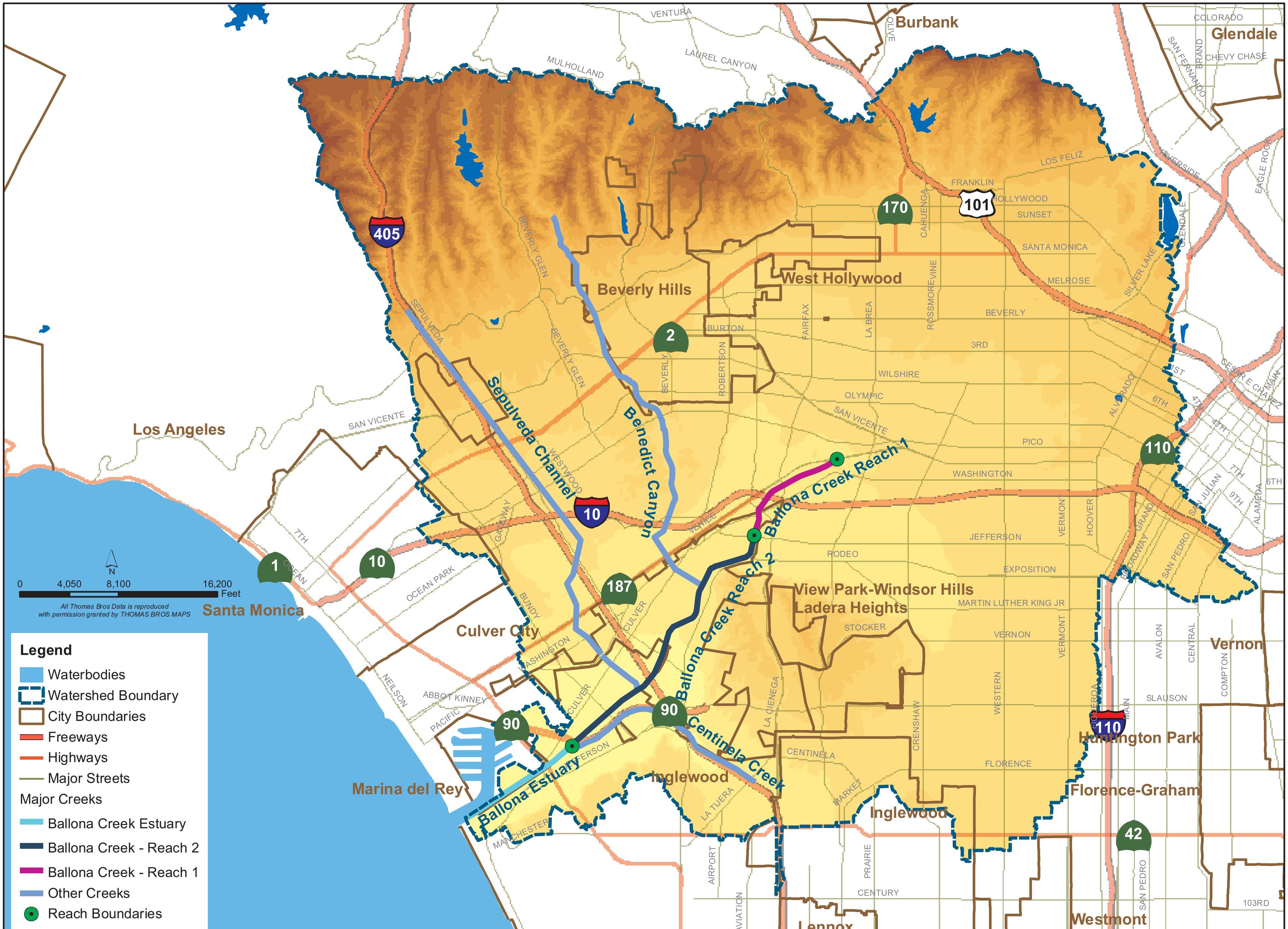


Figure 2-2 Ballona Creek Watershed - Topography

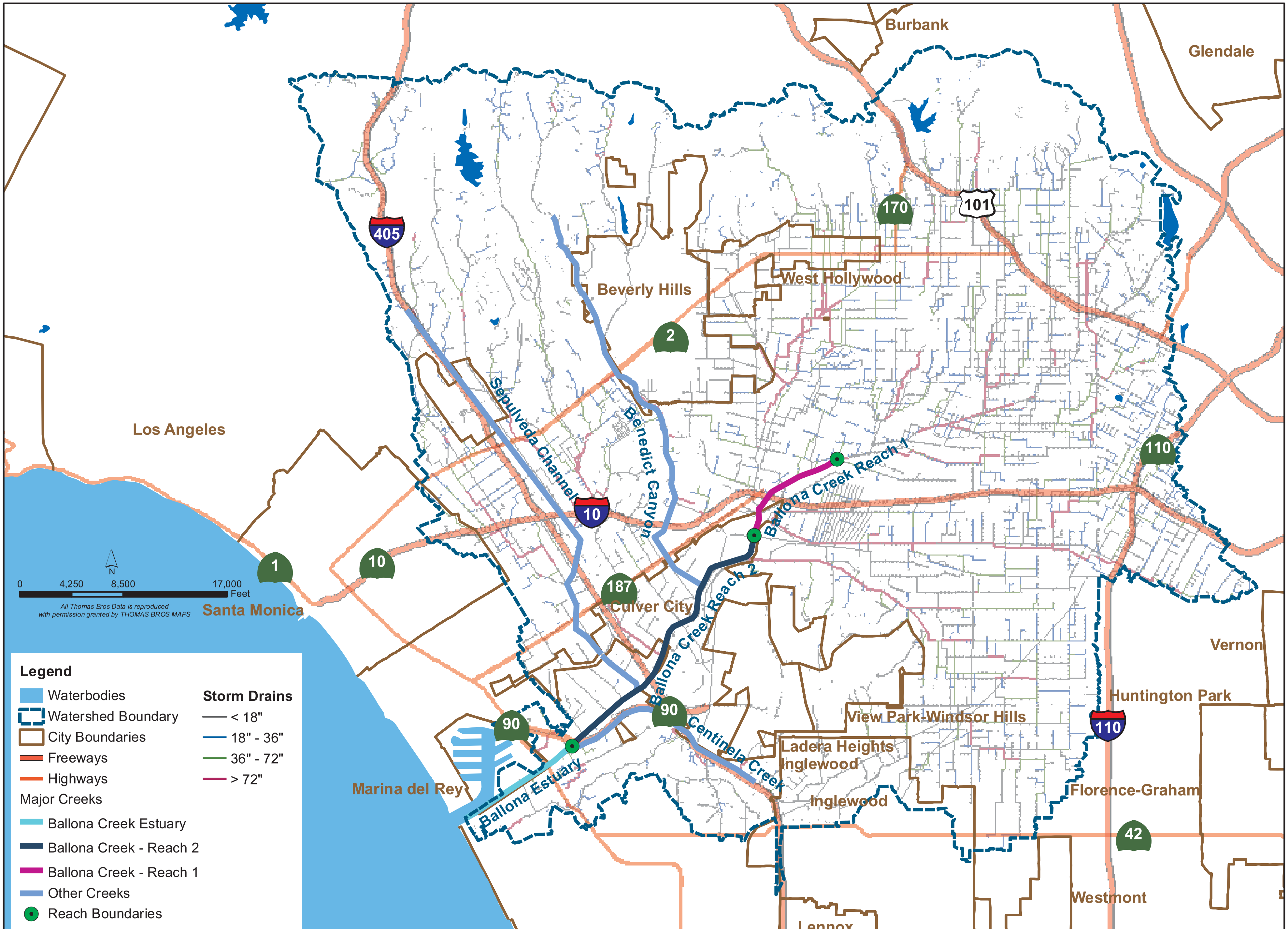


Figure 2-3 Ballona Creek Watershed - Storm Drains

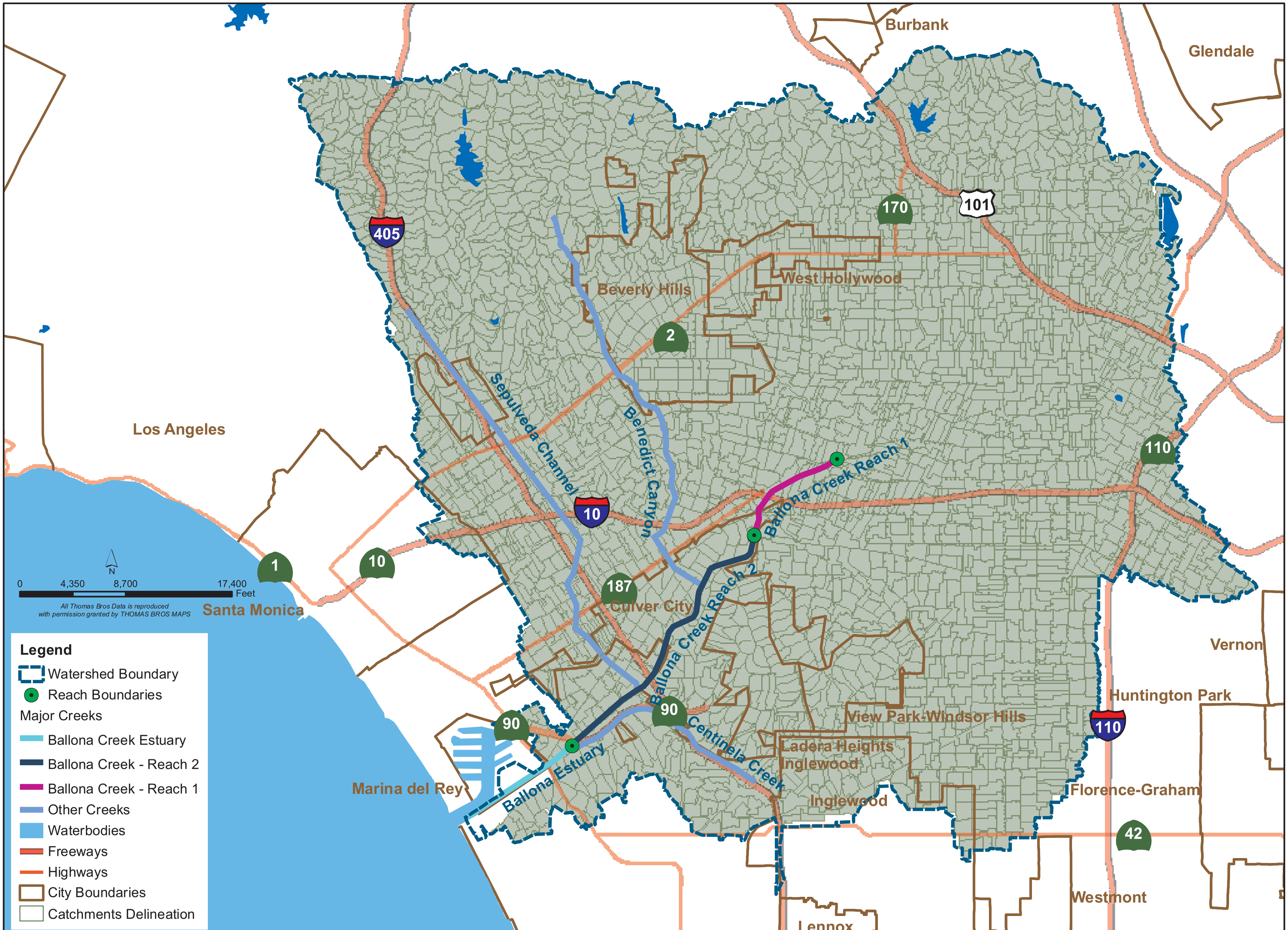


Figure 2-4 Ballona Creek Watershed Catchments

Figure 2-5 Ballona Creek Watershed - Land Use

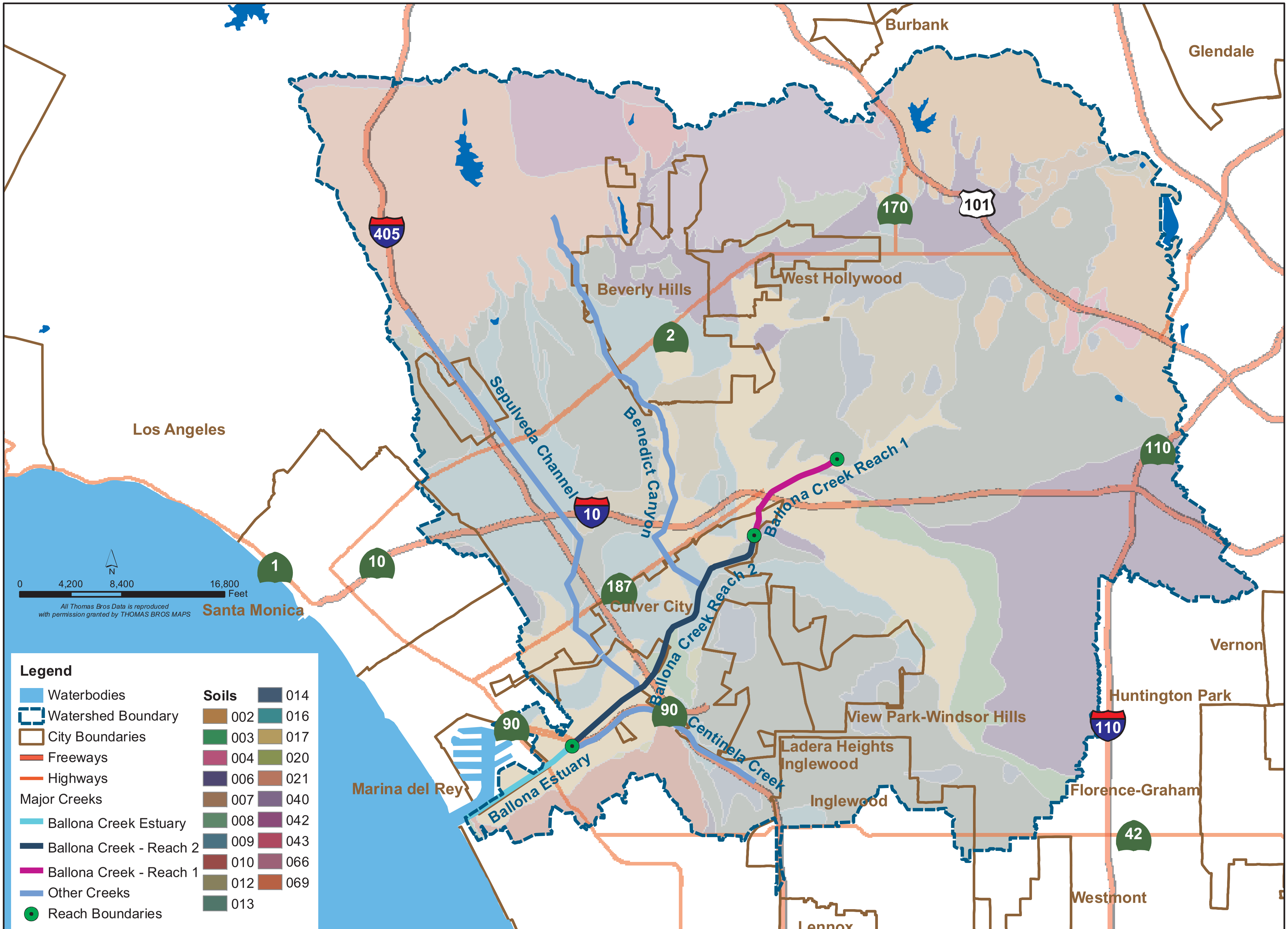


Figure 2-6 Ballona Creek Watershed - Soils

Figure 2-7 Ballona Creek Watershed - Parcels

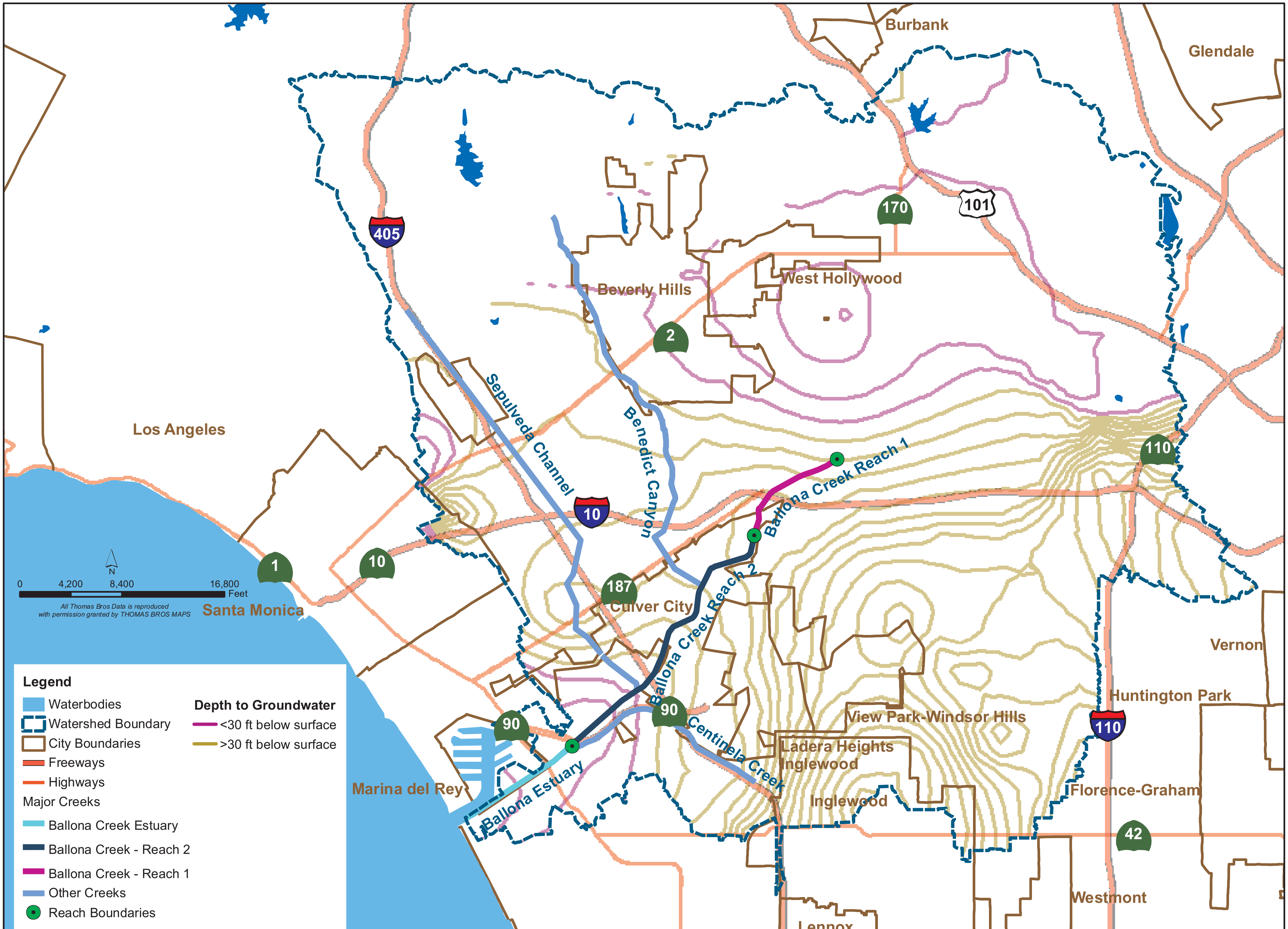


Figure 2-8 Ballona Creek Watershed - Depth to GroundWater

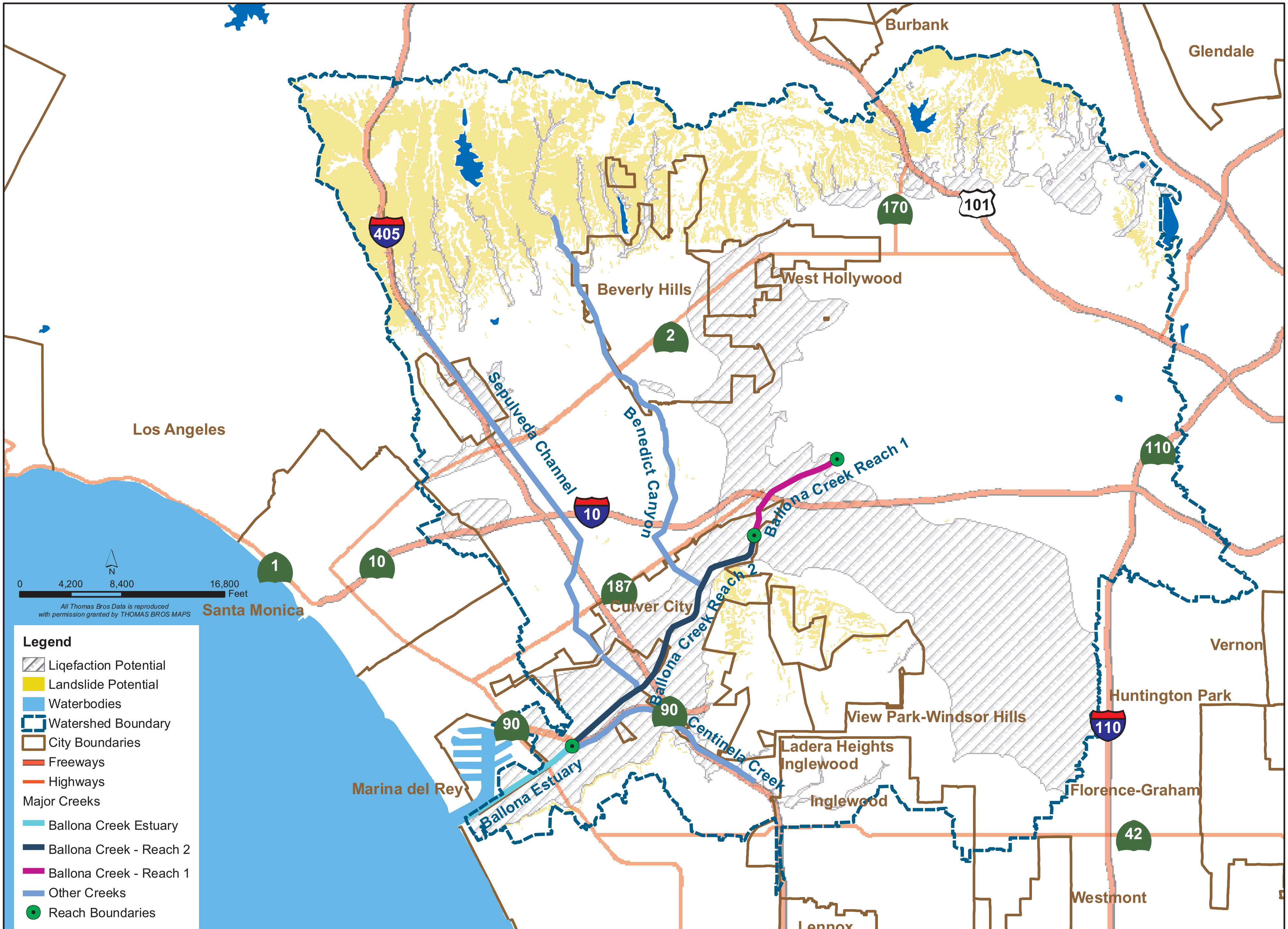


Figure 2-9 Ballona Creek Watershed - Areas of Landslide and Liquefaction Potential

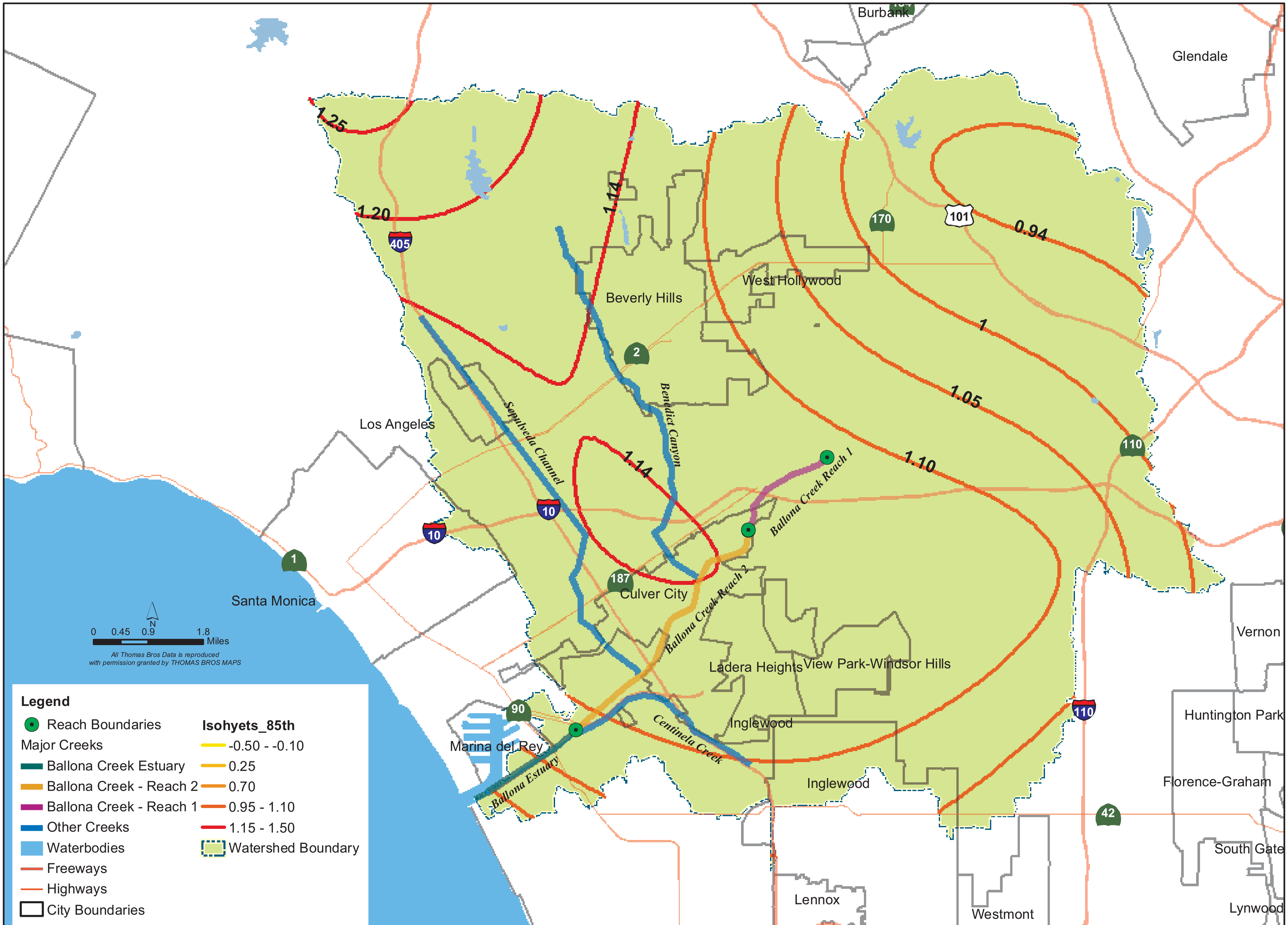


Figure 2-10 Ballona Creek Watershed - Rainfall (85th-percentile 24-hour rainfall depths)

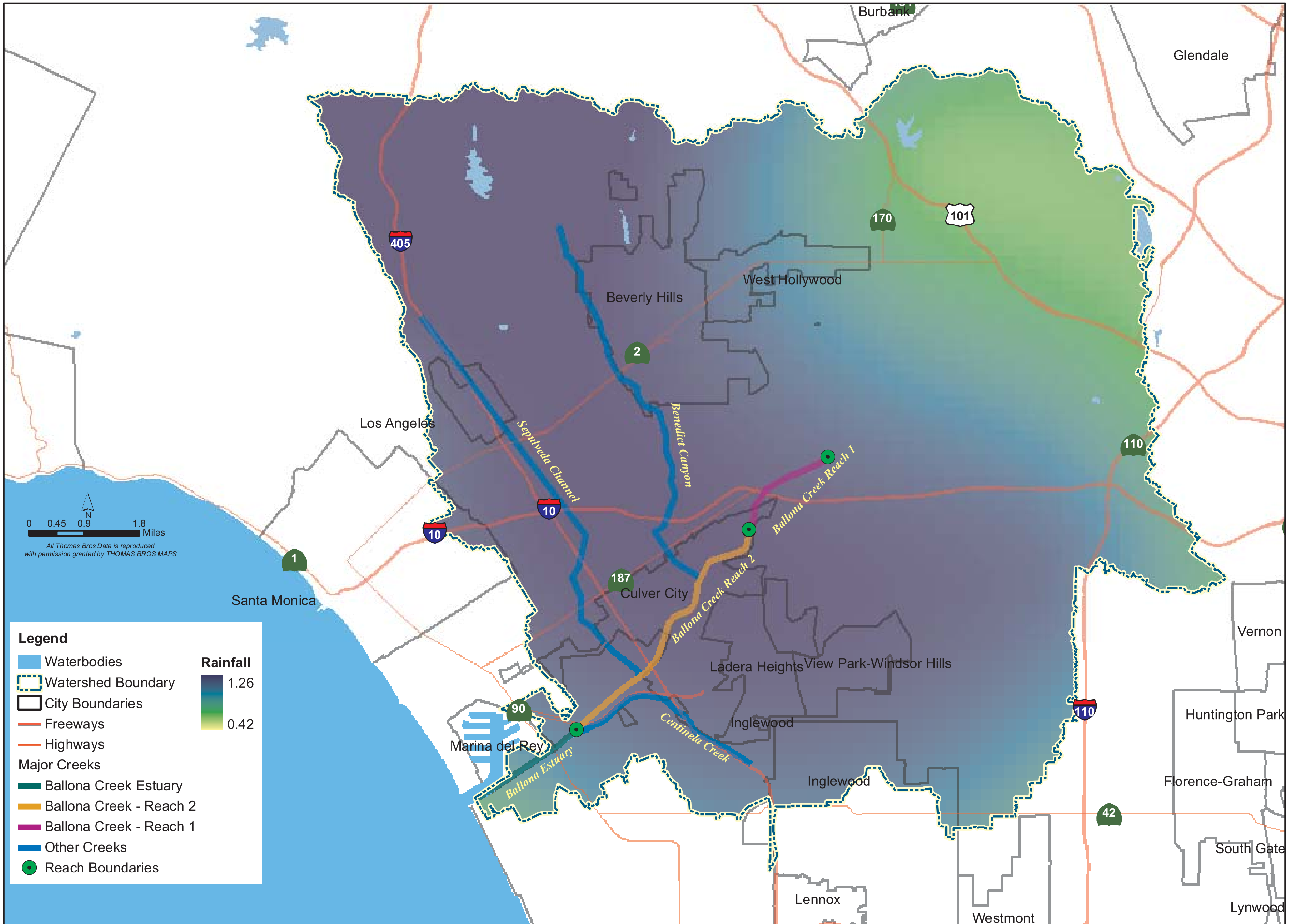
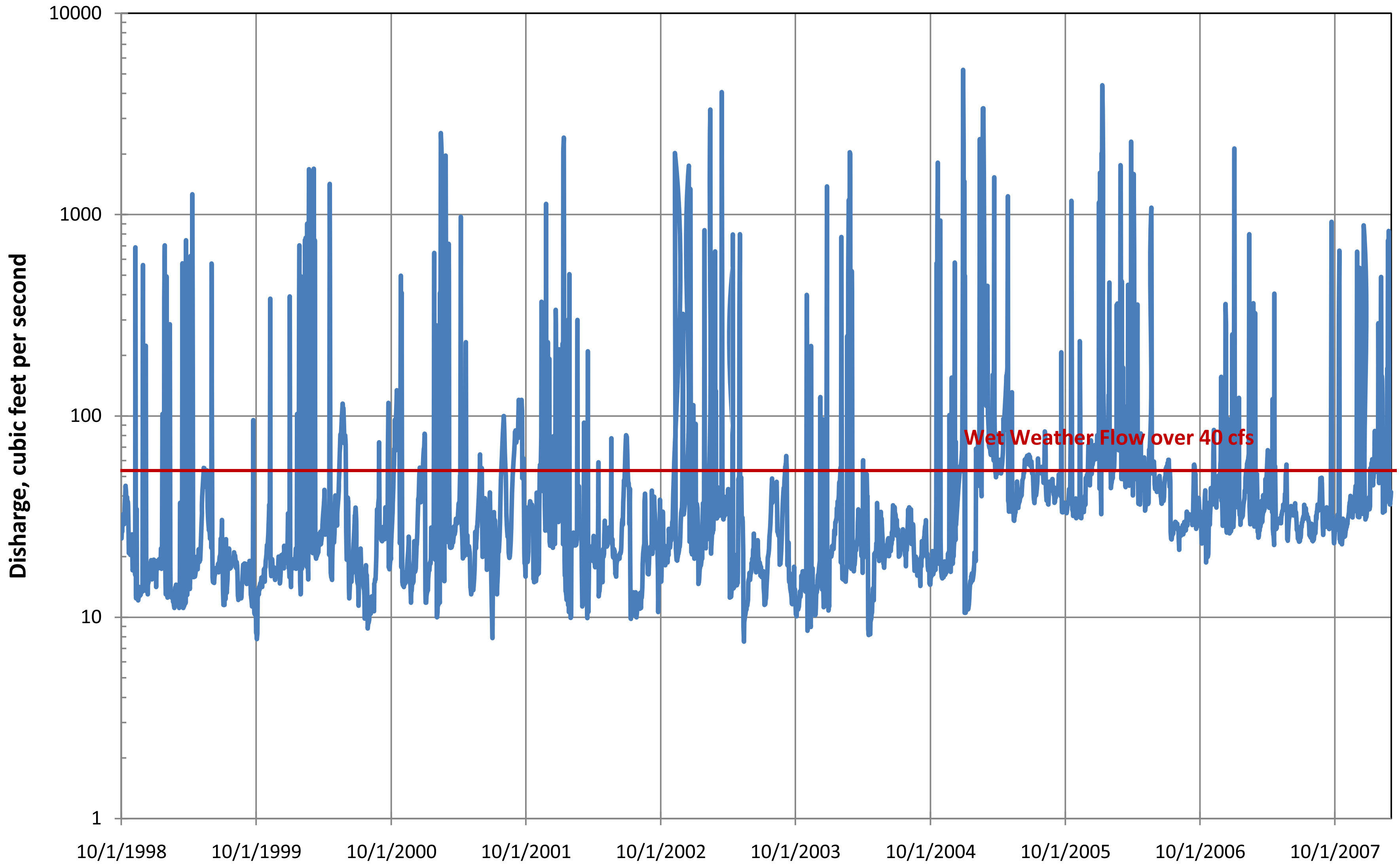


Figure 2-11 Ballona Creek Watershed - Rainfall (85th-percentile 24-hour rainfall depths)

Figure 2-12
Average Flow at Ballona Creek above Above Sawtelle Boulevard
October 1998 to March 2008



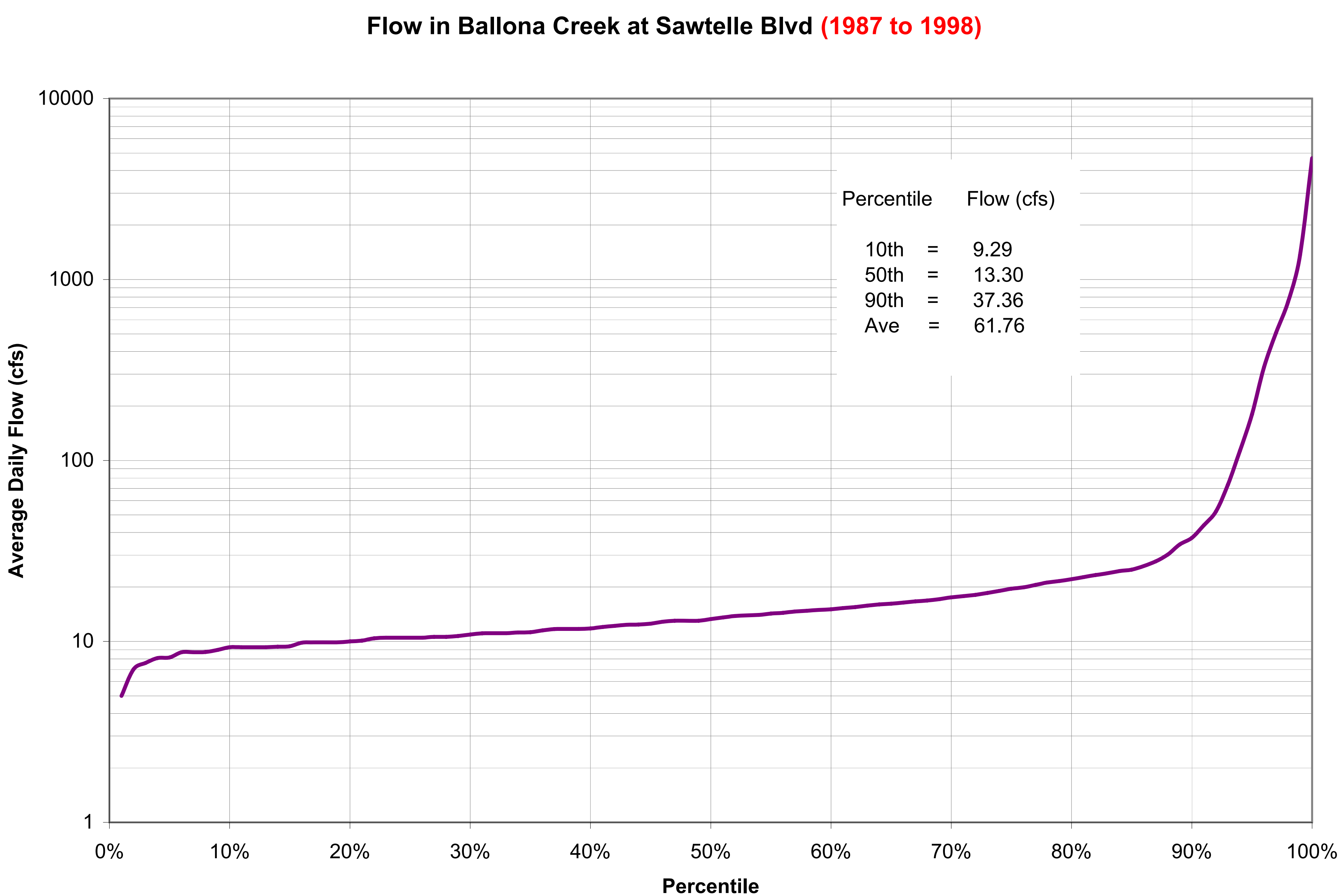


Figure 2-13
Flow In Ballona Creek at Sawtelle Blvd (1987 to 1998)

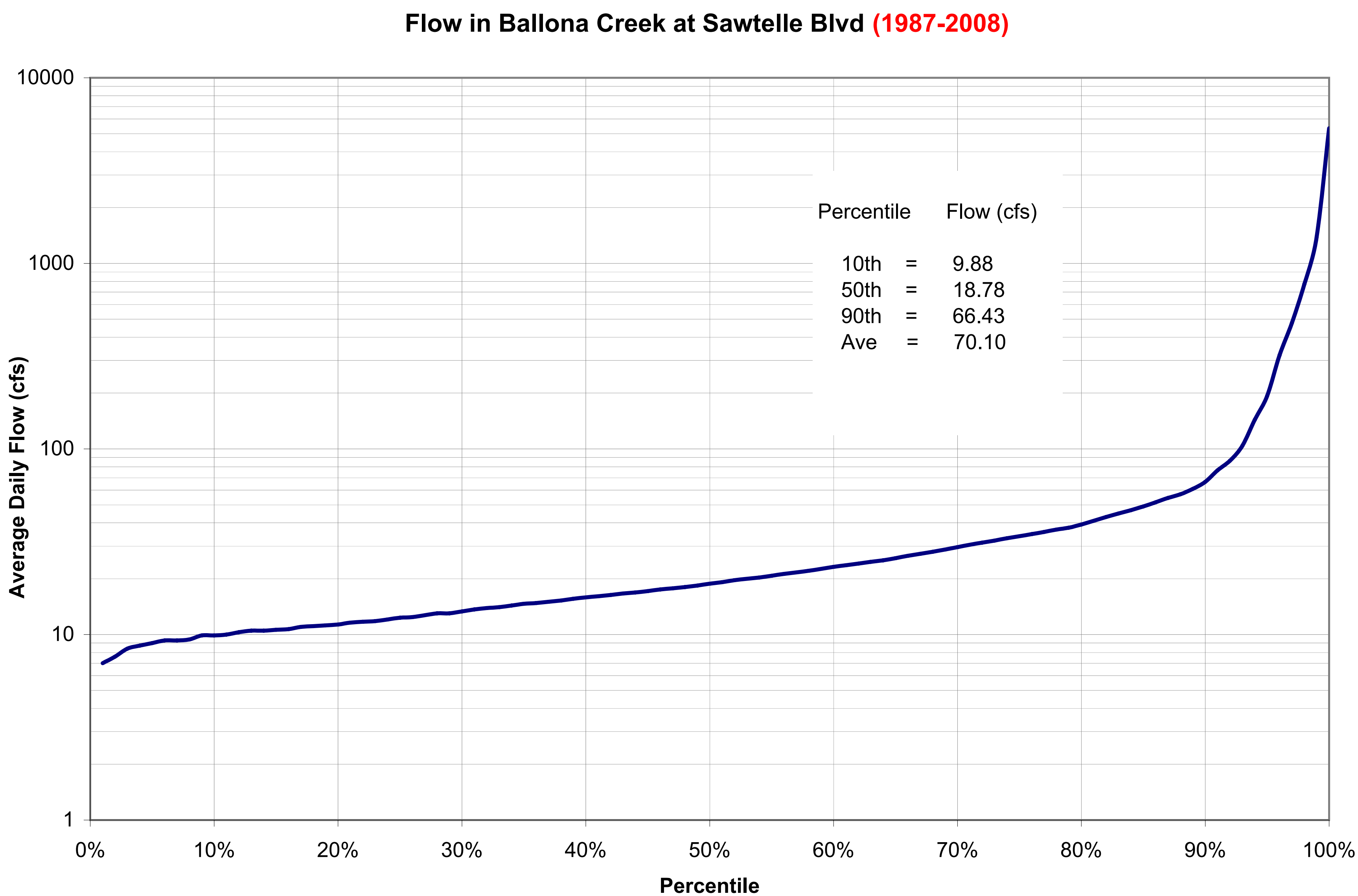
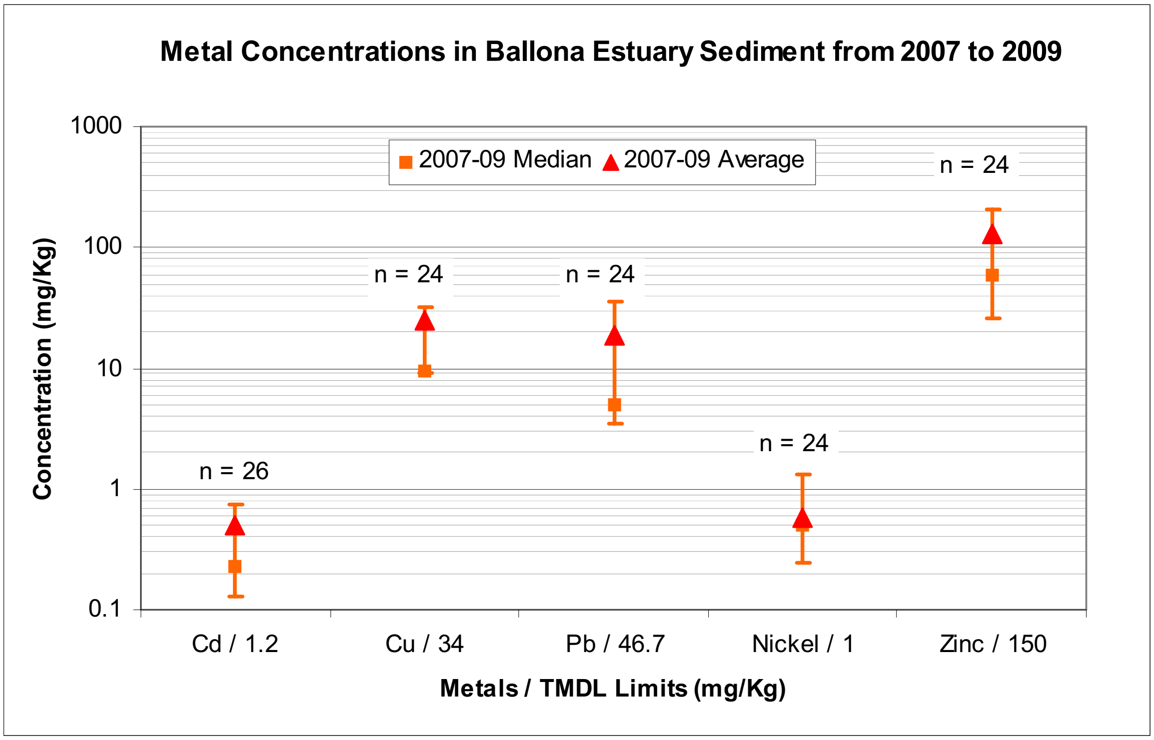
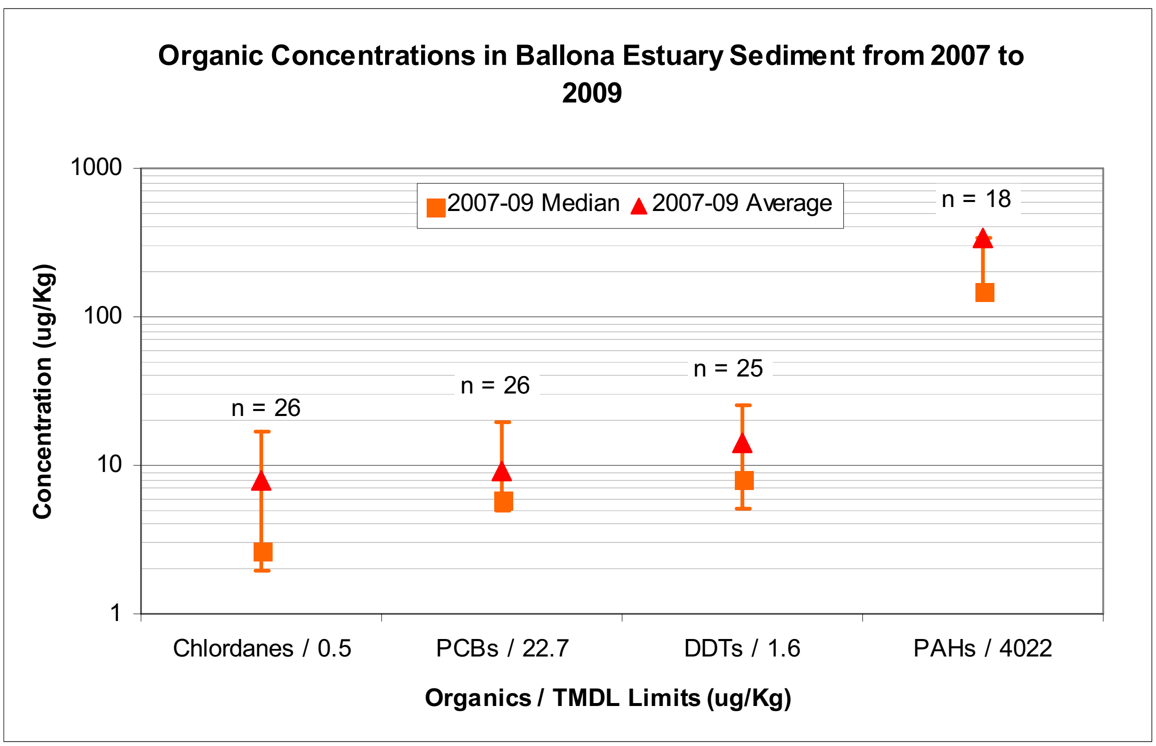


Figure 2-14
Flow In Ballona Creek at Sawtelle Blvd (1987 to 2008)

Figure 2.15 Estuary Sediment Metals and Organic Concentrations from TIE Study.





Note: Samples were taken at six sampling locations from 2007 to 2009.

Section 3
Stakeholder-Based Planning

One of the guiding principles of this Implementation Plan is to identify opportunities to improve upon existing programs. Accordingly, an important step in developing the Implementation Plan included consulting with stakeholders on potential BMP implementation opportunities. Identifying these opportunities creates the foundation for collaborative implementation of water quality improvement projects. This section summarizes the processes used to coordinate with stakeholders, ongoing watershed planning activities, and specific BMP opportunities identified by stakeholders.

3.1 Coordination with Stakeholders

During the development of this Implementation Plan, the responsible jurisdictions conducted community stakeholder workshops, participated in Ballona Creek Watershed Task Force meetings, and held one-on-one discussions with key Non-Governmental Organizations (NGOs).

Workshops

Three stakeholder workshops were held as follows:

- *Workshop 1*: Watershed Characterization, City of Culver City Council Chambers, November 6, 2008

- *Workshop 2*: Best Management Practices Strategies, City of Los Angeles Hyperion Treatment Facility, March 3, 2009

- *Workshop 3*: Ballona Creek Estuary Toxic Specific Workshop, City of Los Angeles Hyperion Treatment Facility, September 21, 2010.

Appendix C provides the agenda and presentation for each workshop. Each workshop was well attended and included open discussions. Workshop 2 provided an opportunity for stakeholders to break up into smaller groups and discuss opportunities for structural and institutional BMP implementation based on their local knowledge of the watershed. Workshop 3 discussed strategies to reduce sediment toxicity in the Estuary.

Ballona Creek Watershed Task Force

The Ballona Creek Watershed Task Force prepared the Ballona Creek Watershed Management Plan (BCWMP) in 2004. The BCWMP includes many projects and programs with opportunities for collaboration with the TMDL Implementation Plan.

Several responsible jurisdictions, including the City of Los Angeles, several City Council Districts, County of Los Angeles, and Culver City are regular participants of the Ballona Creek Watershed Task Force, which meets every other month. Other participants include the following:

- Ballona Creek Renaissance
- Santa Monica Bay Restoration Commission (SMBRC)
- Mar Vista community groups
- Mountains Recreation and Conservation Authority
- Surfrider Foundation
- Heal the Bay
- Santa Monica Baykeeper
- Private residents
- US Army Corps of Engineers
  Baldwin Hills Conservancy
- Ballona Wetlands (including: Ballona Institute, Friends of Ballona Wetlands, Ballona Wetlands Land Trust)
- Los Angeles Regional Water Quality Control Board
- Playa Vista
- California State Coastal Conservancy

BMP Opportunities Developed with Stakeholders

City of Los Angeles Watershed Protection Division staff met on many occasions with stakeholders on an individual basis to obtain information on specific BMP opportunities in the watershed, both active and proposed. Consultations with stakeholders were held over a period of ten months.

Stakeholder meetings were also held with specific watershed organizations, including the SMBRC, Ballona Ecosystem Education Project, Ballona Creek Watershed Task Force, and the Ballona Renaissance. In addition, the former Ballona Creek Watershed Coordinator provided substantive input on potential watershed projects based on previous work performed as the watershed coordinator. Some of the projects discussed are described in the following documents: B*allona Creek Watershed Management Plan 2004, Santa Monica Bay Restoration Plan 2008, and the Green Solution Project 2008.* Meetings included field inspections of potential BMP sites, and discussion regarding projects and programs needed to address Ballona Creek water quality. The following sections describe some of the key structural and institutional BMPs recommended during these consultations.

3.2 Structural BMPs

Potential BMP opportunities identified by watershed stakeholders are located throughout the watershed (Figure 3-1 northwest quadrant; Figure 3-2 southwest quadrant; Figure 3-3 northeast quadrant; Figure 3-4 southeast quadrant). Table D-1 in Appendix D provides additional information regarding each of the potential BMP sites identified in these figures. Some BMP projects[1] investigated with stakeholders and potential collaboration partners include:

- *Mar Vista (Oval Street)* –curbcuts, bioswales, and subsurface infiltration swales, serving a drainage area of approximately 150 acres. The Mar Vista Community Council has been identified as the potential collaboration partner for this project.

- *Ballona Creek Street Ends from Cochran Avenue to Hauser Boulevard* –bioswales and native tree planting at several streets that end at Ballona Creek, serving a drainage area of approximately 25 acres. The Ballona Creek Watershed Task Force would be the potential collaboration partner for this project.

- *Occidental Boulevard* –utilize the wide parkway medians by installing vegetated swales, curbcuts, and porous pavement, serving a drainage area that ranges between approximately 31 and 83 acres, depending upon the length of the area of implementation. The Ballona Creek Watershed Task Force would be the potential collaboration partner.

- *Venice Blvd. New Preschool* – bioretention in parkways with underdrains along Venice Boulevard, serving a drainage area of approximately 22 acres.

- *Exposition Boulevard Rail Line*—upon coordination with MTA and other responsible parties, this project proposes implementation of stormwater BMPs within the open space along the rail line. This project is located in the area of moderately-high to high pollutant loading. Potential partners include MTA, Ballona Creek Watershed Task Force, Ballona Ecosystem Education Project, and others.

3.3 Institutional BMPs

Stakeholders also provided information on institutional BMP projects. Based on their experience in the region, stakeholders identified barriers that have delayed many proposed BMPs and programmatic issues that are recommended for resolution. The following sections summarize these findings. Many of these issues were included in the *Santa Monica Bay Restoration Plan Check-up; Implementation Progress Update 1995 – 2008*, SMBRC, 2008.

3.3.1 Program-Specific Institutional BMPs

Program-specific institutional BMPs are activities that require implementation of structural BMPs or the establishment of new programs. Three key areas recommended for consideration include:

- *Residential Downspout Disconnection Program* – Stakeholders identified the need for a downspout disconnection program as a priority in the watershed. A grant-funded pilot program is currently on hold due to State financial issues. This pilot program includes participation by up to 600 residential and commercial property

[1] Note: At this time, the following projects represent concepts. No technical planning efforts have been implemented; accordingly engineering and cost feasibility analyses have not yet occurred.

owners and would reduce urban runoff entering Ballona Creek by more than one million cubic feet per year.

- *Education & Outreach Program* – A number of existing educational programs are ongoing in the watershed, including development and implementation of the Environmental Learning Center at the Hyperion Treatment Plant. However, funding varies substantially from year to year. Accordingly, there is a need for a long-term, stable funding source.

- *Downtown Parking Lot Conversion* – Implementing stormwater infiltration BMPs in the highly impervious spaces of the City of Los Angeles downtown area, a portion of which is in the Ballona Creek Watershed, is a challenge due to space constraints. A potential solution is the conversion of downtown asphalt parking lots into permeable pavement designed to retain stormwater runoff onsite in lieu of conveying the runoff to the storm drain system.

3.3.2 Collaborations

A number of stakeholder recommendations in this area are consistent with the second strategy of the WQCMPUR (City of Los Angeles 2008), as discussed in Section 1. These recommendations include the need for greatly improved coordination, collaboration, and planning by all city agencies. Similar recommendations provided by stakeholders included:

- *Inter-Agency Coordination* – Urban runoff management is correctly recognized as an inter-agency responsibility and as such, there is a need for improved coordination in planning and approval processes. Examples include working with development agencies (such as Los Angeles Community Redevelopment Agency) or departments tasked with water management (such as the Los Angeles Department of Water and Power (LADWP)) to consider urban runoff management needs when developing projects for implementation.

- *General Plan Updates* – All cities have an approved General Plan that guides all development activities. An important tool for improving water quality can include reviewing these plans to ensure that urban runoff management elements are incorporated into the planning process.

- *Inter-Agency Task Force* – Stakeholders recommended the establishment of a task force that includes appropriate representation, including decision-makers associated with responsible city or agency departments, NGOs, and SMBRC. The primary purpose of this task force would be to coordinate the review and revision or adoption of new policies and ordinances in a consistent manner throughout the watershed. Other functions could include facilitation of BMP implementation and coordination of similar programs across jurisdictions.

- *Watershed Management Support* – NGOs have completed several key studies in the watershed that contain recommendations for improved urban runoff management, such as the Ballona Creek Watershed Management Plan, Green Solutions Project, and Santa Monica Bay Restoration Plan. It is recommended that the responsible jurisdictions work with the NGOs to plan and implement many of the projects already identified, or potentially fund elements that would help support NGO management efforts.

3.3.3 Regulations and Enforcement

Stakeholders have identified the need for responsible jurisdictions to have sufficient authority and programmatic structure to move urban runoff management activities in a common direction towards synergy rather than conflict. Similar to the issues described in the previous section, many of the identified needs in this area are key elements already identified in the WQCMPUR (City of Los Angeles, 2009). Specific issues highlighted by stakeholders include:

- *Ordinances* – Adopt or revise ordinances that promote urban runoff management such as a stream protection ordinance that limits development adjacent to waterbodies (note that the City of Los Angeles is currently working on developing such an ordinance).

- *Policy* – Develop policies or revise current policies such as beneficial reuse of stormwater, green building, permeable pavement, possible use of Quimby Act fees to buy vacant properties for BMP use, and purchase of properties along stream alignments when available.

- *Incentive and Rebate Programs* – Establish incentive/rebate programs to encourage improved urban runoff management. Examples include (a) programs to encourage retention of urban runoff on individual parcels through activities such as installation of rain barrels and/or creation of rain gardens; and (b) conversion of lawns to drought tolerant gardens with low water use, or installation of smart irrigation to reduce dry weather runoff.

- *Standard Urban Stormwater Mitigation Plan (SUSMP) Enhancement* – Enhance the current NPDES Permit SUSMP requirements to include LID principles (e.g., increase permeable surfaces, maintain pre-development hydrology).

- *Enforcement* – Evaluate enforcement authority to increase penalties for over-consumption of water. Coordinating ongoing LADWP conservation efforts with the need to reduce dry weather runoff sources would help meet TMDL compliance requirements.

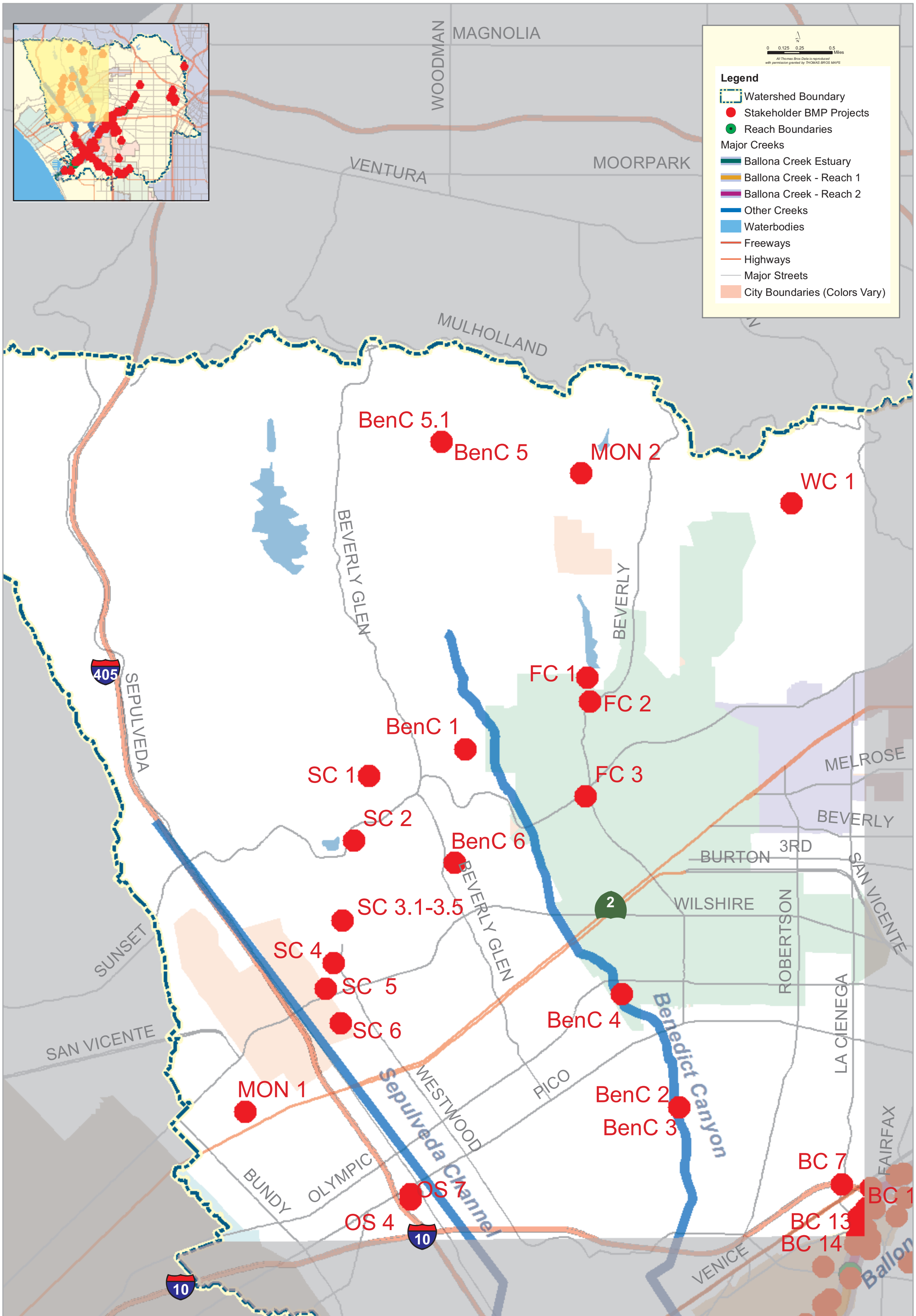


Figure 3-1 Stakeholder Identified BMP Opportunities (NW Quadrant)

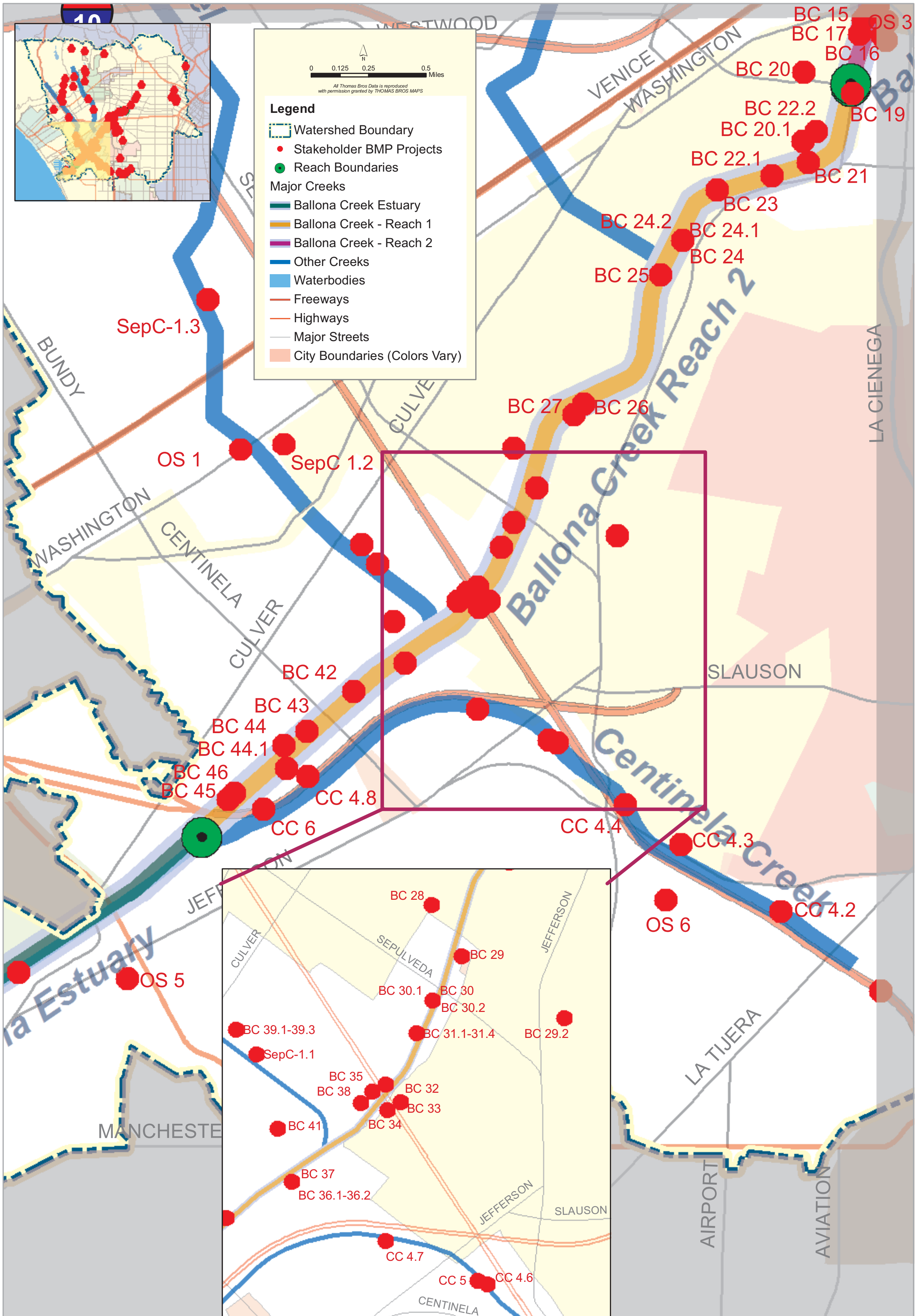


Figure 3-2 Stakeholder Identified BMP Opportunities (SW Quadrant)

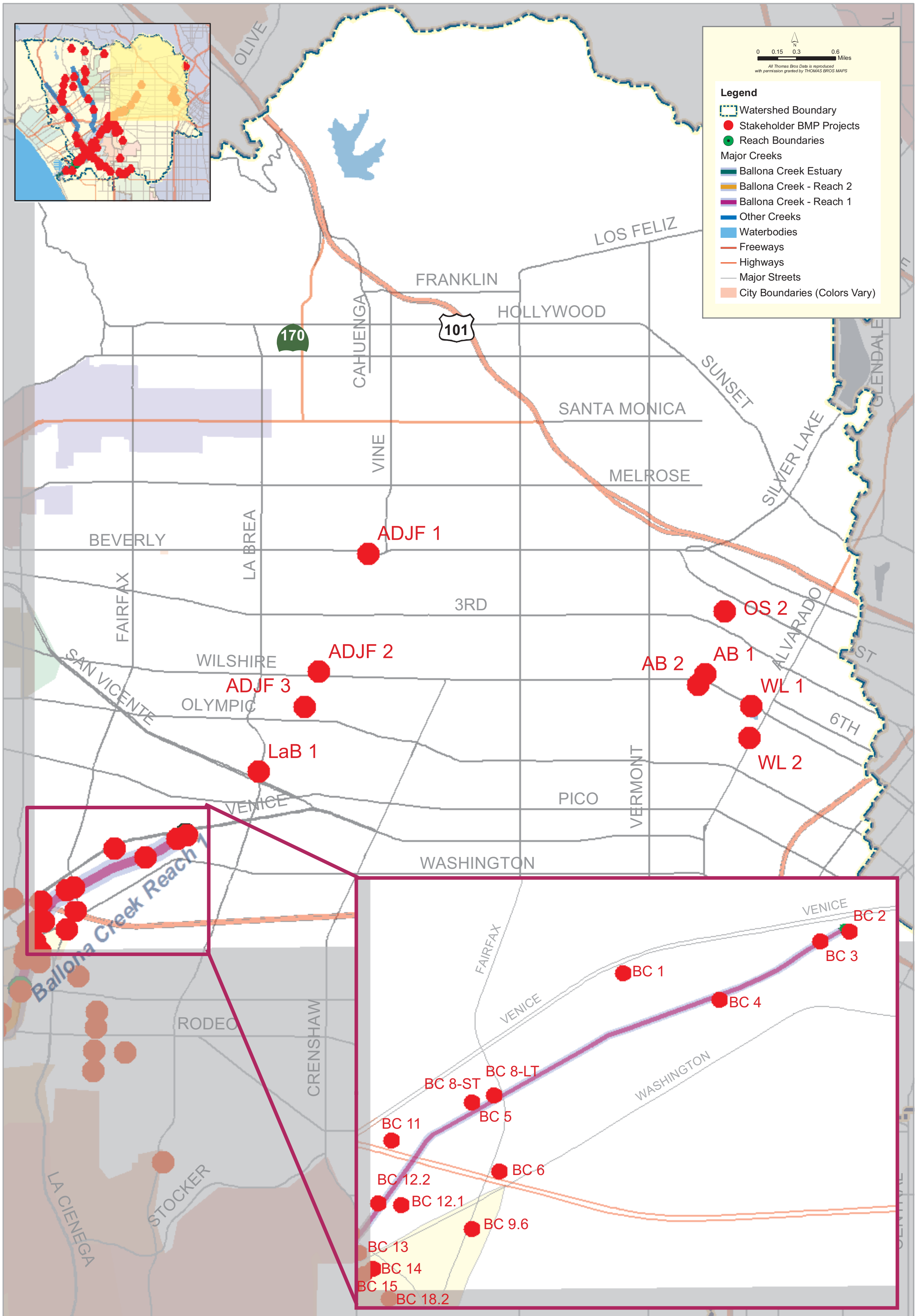


Figure 3-3 Stakeholder Identified BMP Opportunities (NE Quadrant)

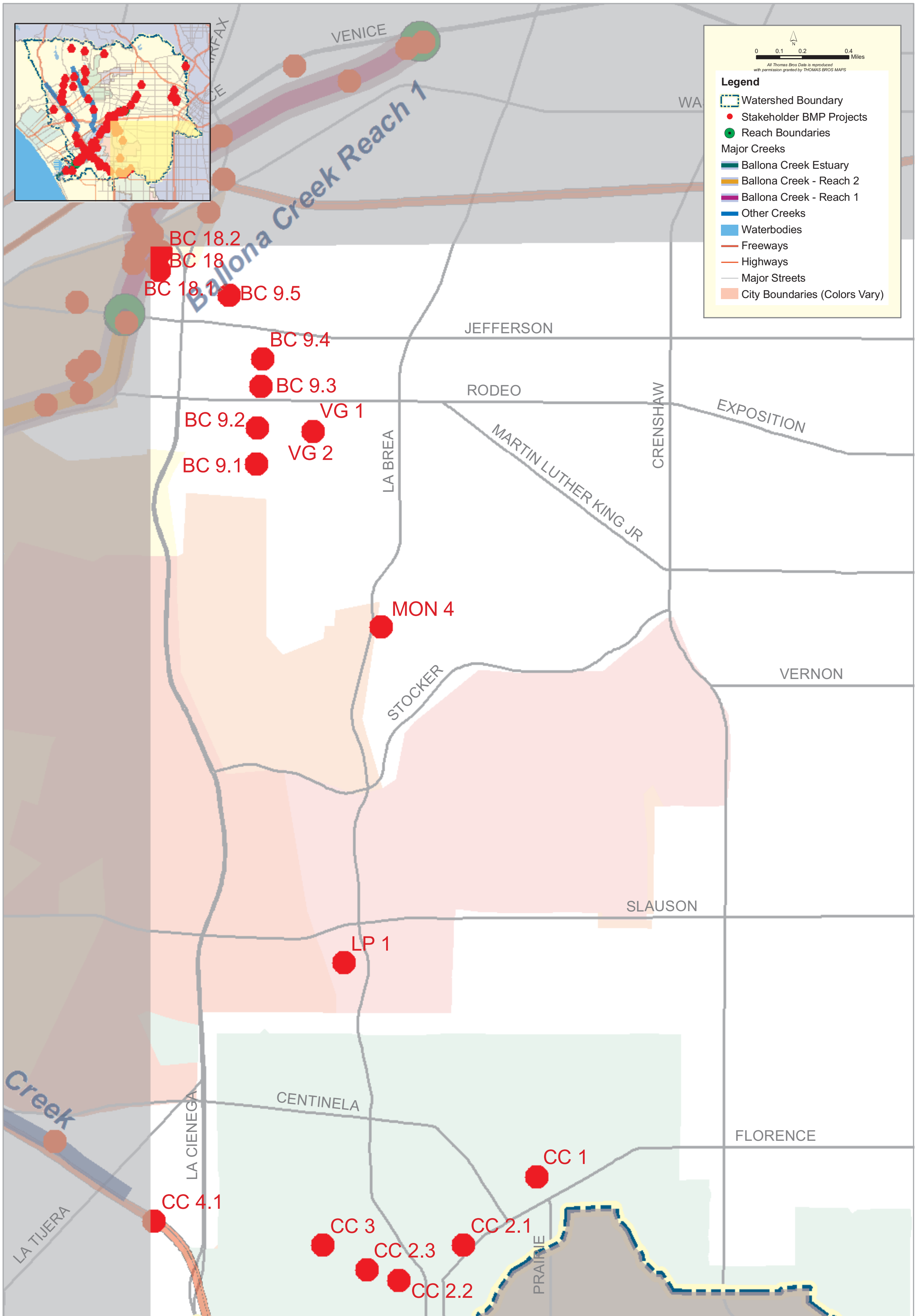


Figure 3-4 Stakeholder Identified BMP Opportunities (SE Quadrant)

Section 4
Technical Analysis

This Implementation Plan relies on both structural and institutional BMPs that, in combination, work together towards achieving compliance with TMDL targets. Where possible, the selection of BMPs emphasizes an integrated water resources approach that relies first on the implementation of green solutions. The process for selecting appropriate BMPs varied depending on whether the BMP was structural or institutional, and both of these processes will be outlined in this section. In addition, structural BMPs include one of two types:

- *Regional BMPs* - Defined as centralized stormwater facilities, typically placed near the outlet of a catchment (a drainage area of approximately 40 acres) or subwatershed (a group of catchments with a common outlet) that are designed to treat urban runoff from a relatively large drainage area (drainage areas ranging from 20 acres to several hundred acres). These BMPs include, for example, infiltration facilities, detention basins, subsurface flow (SSF) wetlands (including detention), surface flow (SF) wetlands, treatment facilities, manufactured separation systems (e.g., hydrodynamic separators and trash nets/screens), and channel naturalization (e.g., storm drain daylighting, revegetation, and wetland channel establishment).

- *Distributed BMPs* - Defined as stormwater collection devices and landscaping practices dispersed throughout a catchment that serve relatively small drainage areas (typically 10 acres or less). These BMPs include, for example, cisterns, bioretention, vegetated swales, green roofs, porous/permeable pavements, gross solids removal devices, media filters, and catch basin inserts.

Sections 4.1 through 4.2 describe the methods used to identify structural BMP opportunities throughout the watershed, and the method utilized to select the best BMP projects for implementation. Section 4.3 summarizes institutional BMP opportunities and the selection process for BMP implementation.

4.1 Structural BMP Selection Methodology

The Los Angeles County-wide Structural BMP Prioritization Analysis Tool (SBPAT)[1] provided the means for identifying potential BMP locations and types for implementation. SBPAT screens areas based on *need* (i.e., pollutant load generation and downstream impairments), and then identifies *opportunities* (i.e., appropriateness of the area, adjacent storm drains) for BMP implementation. SBPAT uses a GIS-based decision tool that relies on four steps for identifying BMP implementation opportunities (Figure 4-1):

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1 Developed by Geosyntec Consultants for the County of Los Angeles Department of Public Works, Heal the Bay, and the City of Los Angeles Bureau of Sanitation

1. ***Catchment Prioritization*** - Prioritize catchments based on water quality management need (e.g., pollutant-loading, receiving water issues) (Section 4.1.1).

2. ***Identification of Structural BMP Opportunities*** - Identify potential BMP opportunities within high priority catchments based on factors such as parcel size, land use, and ownership (Section 4.1.2).

3. ***Structural BMP Prioritization*** - Identify appropriate BMPs based on factors such as cost, maintenance, and effectiveness for the pollutants of concern (Section 4.1.3).

4. ***Site-Specific BMP Evaluation*** - Develop site-specific implementation strategies based on desktop analyses and field investigations (Section 4.2).

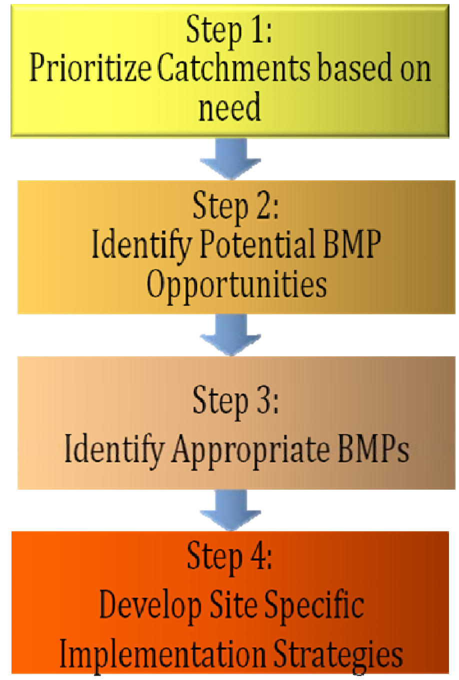


Figure 4-1
Steps for Selection of Structural BMPs

The following sections summarize the implementation of these analysis steps in the Ballona Creek Watershed. A more detailed explanation of the methodology can be found in Appendix E and Appendix L of this Implementation Plan or in the SBPAT Guidance Manual.

In general, SBPAT utilizes USEPA Storm Water Management Model (SWMM) as a data processor to generate statistical estimates of hydrologic and hydraulic responses, but not directly to simulate pollutant load generation, water quality routing, or change in water quality as a result of BMPs. Instead, output from SWMM is aggregated to storm event summaries as is necessary for input for Monte Carlo estimation of water quality (page B-3, Technical Appendices of Appendix L).

Monte Carlo Method utilizes these storm event summaries and statistical distribution of land use runoff pollutant concentrations and BMP effluent pollutant concentrations developed from BMP performance monitoring data [2] (page A-8, Technical Appendices). These "performance measures" include summary of median effluent

[2] ASCE/EPA International Stormwater BMP Database (www.bmpdatabase.org) compiled by Water and Environmental Federation, WERF.

concentrations and confidence intervals for various BMPs [3], and the number of studies conducted (Table C-1, C-2, Technical Appendices). These BMPs are ranked based on the level of effectiveness resulting in a simplified effectiveness matrix (Table C-4, Technical Appendices) to be used for running the SBPAT model.

Sensitivity Analysis of Design Parameters for various stormwater BMPs is demonstrated in *Section 5.2.6*. Due to the complexity and intensity of running the SBPAT model at a watershed-wide scale, a sample catchment was selected for a demonstration model run to demonstrate total suspended solids (TSS) load removal vs. percent variance from design storm parameters (Figure 5-3, Draft I-Plan). Land use composition of the sample catchment is representative of Ballona Creek watershed land use (Table 5-11). "Associated key parameters" of the BMPs selected for sensitivity analysis include rainfall intensity (in/hr), storm intensity (in), and ratio between BMP footprint to tributary area (acre/acre) [Table 5-10] in addition to other initial parameters (screening criteria [4]) such as project feasibility and fatal flaws (Table 7, page A-47, Technical Appendices).

4.1.1 Catchment Prioritization

Overview

This step identifies the catchments within the entire Ballona Creek Watershed that have the potential to generate the highest pollutant load during wet weather events. This analysis relies on Event Mean Concentration (EMC) data applicable to different land uses.

To evaluate potential pollutant loadings based on land use, SBPAT modeled specific constituents. In some cases, these constituents were the same as the TMDL listing. In other cases, a surrogate constituent was used. For example, for bacteria, fecal coliform was modeled and was used as a surrogate for enterococcus and *E. coli.* To establish the reduction in toxics entering the Ballona Creek Estuary, Total Suspended Solids (TSS) was used as a surrogate. Using TSS as a surrogate was established as discussed in Section 5 in the TMDL Staff Report prepared by the LARWQCB.

Further, while this Implementation Plan is being submitted to meet the requirements of the Toxics TMDL, the other pollutants of concern (discussed in Section 1) were considered when prioritizing catchments and selecting BMPs. Since one of the guiding principles of this Implementation Plan is that it be integrated, and since selecting BMPs that address multiple pollutants follows this principle, this catchment prioritization step also considered bacteria and metals.

SBPAT calculated a CPI for each of the 2,819 catchments in the Ballona Creek Watershed based on the potential for each catchment to contribute pollutant loads for any modeled pollutant of concern. The CPI assigned to each catchment ranges from 1

[3] BMPs that were used for the study includes detention ponds, biofilters, hydrodynamic devices, media filters, wet ponds, wetland basins, wetland channels.
[4] Page E2-2 through E2-9, Appendix E of Draft I-Plan,

to 5, with 5 representing the highest priority. For a more detailed explanation of the CPI calculation, see Step 1 of the SBPAT Guidance Manual (Geosyntec, 2006). Following is a brief summary of the key elements of this step.

First, pollutant-specific CPI scores were calculated for each catchment as the product of area-weighted pollutant EMCs, area-weighted 85th-percentile precipitation depths (see Figure 2-10 – rainfall isohyet figure in Section 2), and area-weighted volumetric runoff coefficients (based on land use from Southern California Association of Governments [SCAG] and land use runoff coefficients reported by Ackerman & Schiff, 2003; Table 4-1 below).

Table 4-1
Runoff Coefficient based on Land Use

Land Use	Runoff Coefficient[(1)]
Commercial/Educational	0.61
Industrial/Transportation/Other Urban	0.64
Open	0.06
Residential	0.39

[(1)]Source: Ackerman, D. and K. Schiff. Modeling Storm Water Mass Emissions to the Southern California Bight. J. of Environmental Engineering. April 2003. pp. 308-317.
Notes: "Other urban" category, which includes "mixed industrial/commercial" and "under construction" SCAG land use categories, represents <1% of total County area

Second, the pollutant CPI scores for each catchment were then normalized by the maximum observed score for each pollutant and weighted by pollutant group based on the relative importance assigned to each pollutant group.

Third, the adjusted metals and fecal coliform pollutant CPI scores for each catchment were multiplied by 3 to weight them higher because they represent constituents for which a TMDL has already been adopted. This adjustment resulted in a preliminary CPI score. Final CPI scores were obtained by normalizing the preliminary CPI scores to a maximum possible score of 5.

After consultation with SBPAT model developers (Geosyntec Consultants), it was concluded that the pollutant weight for Trash should be given zero for it was an existing TMDL that has already been addressed, pollutant weight for bacteria (fecal coliform) should be reduced to 10 and the pollutant weight for metals increaded to 15 (for metals corresponds to both Metals and Estuary Toxics TMDLs). During the second, third and forth model run, pollutant weights for TSS was set at 10, 15 and 5 respectively. The model outputs (catchment prioritization index (CPI) maps) for three different pollutant weights of TSS resulted in very little difference (less than +5% difference) in prioritizing catchments. Accordingly, the project team and SBPAT developers decided that the CPI maps produced by the third run as the most representative of multi-pollutant approach. Figure 4-4 and Figure 4-6 display minimal variation of catchments between lead and TSS.

Table 4.2. CPI Scores (pollutant loads) for various TMDL pollutants for catchment prioritization of Ballona Creek Watershed.

	Fecal Coliform Weight	Metals Weight	Sediments Weight	Trash Weight
First Run	10	10	10	5
Second Run	15	15	15	0
Third Run	**10**	**15**	**5**	**0**
Forth Run	10	15	15	0

Catchment-Specific Catchment Prioritization Index (CPI)

The project team members performed several SBPAT model runs using different pollutant weights for fecal coliform, metals, and sediments. After each model run, the overall results were reviewed at watershed-wide level as well as catchment level (several individual representative catchments) to ensure that SBPAT model outputs were representative of existing watershed, catchment, and site conditions. Table 4.2 below describes different pollutant weights given to TMDL pollutants during several model runs.

The first and the second model runs did not provide satisfactory outputs and model results were inconsistent with actual site conditions for some catchments. For example, the outputs indicated that SBPAT was selecting almost exclusively residential land use as opportunity areas for BMPs although other land uses that generated higher metal pollutants.

Catchment Prioritization

A CPI analysis was completed for each of the analyzed pollutants (fecal coliform, copper, lead, zinc, TSS). The prioritization results for each pollutant (1–lowest priority to 5-highest priority) are illustrated in the following Figures 4-2 through 4-6:

- Fecal Coliform (Figure 4-2)
- Copper (Figure 4-3)
- Lead (Figure 4-4)
- Zinc (Figure 4-5)
- TSS (Figure 4-6)

An integrated catchment prioritization map was developed which represents the weighted average of all of the analyzed pollutants (Figure 4-7). This integrated map provides a final catchment-specific prioritization that is multi-pollutant based.

A “nodal” catchment prioritization index, or NCPI, was used to group hydrologically linked high-priority catchments with “downstream” catchments that may be utilized for potential regional BMP implementation. Using the downstream catchment attribute, catchments tributary to each network node were identified and an area-weighted average CPI score for that node was computed. After rounding to the nearest integer, each catchment was assigned the NCPI value of its associated outlet node. This is illustrated in Figure 4-8, which provides the final NCPI results.

Catchments with high NCPI scores are characterized as having an upstream tributary area that contains a relatively large proportion of high priority catchments. A comparison of the spatial distribution of NCPI scores (Figure 4-8) with CPI scores shows general agreement regarding the classification of priority catchments. High priority NCPI catchments are typically down-gradient of, or are themselves, high priority catchments as determined by the CPI score (see Figure 4-7).

Prioritization Results

Based on the analysis described above, Table 4-3 summarizes the distribution of CPI scores for distributed BMPs and Nodal CPI scores for regional BMPs. The catchments with scores of 3 or greater were carried forward to that next step, SBPAT Step 2. The method for determining the number of distributed and regional opportunity sites that corresponds to each score is described in the following Section 4.1.2.

Table 4-3
Number of Catchments Compared to Potential Opportunities (by ranking)

Score	Distributed Sites		Regional Sites	
	Total # of Catchments	# of Distributed Opportunities	Total # of Catchments	# of Regional Opportunities
5	131	18	80	161
4	353	48	240	49
3	1,109	128	1,276	0
2	1,198	577	1,213	0
1	28	1578	10	0
0	NA	470	NA	2,609
Total	2,819	2,819	2,819	2,819

4.1.2 Identification of Structural BMP Opportunity Sites

Step 2 of the methodology focuses on locating potential BMP opportunities within the high priority catchments identified in Step 1. Priority catchments identified in Step 1 were screened to determine the best opportunities to implement regional and distributed structural BMPs, based on screening factors such as parcel size, land use, and ownership. In addition, proximity to storm drains was an important factor for regional BMP opportunities. A more detailed explanation of the process for identifying BMP opportunities is included in Step 2 of the SBPAT Guidance Manual (Geosyntec, 2006).

Based on the selected screening factors, regional and distributed structural BMP opportunity scores were calculated for each catchment in the Ballona Creek Watershed. These structural BMP opportunity scores served as the basis for prioritizing the catchments for BMP implementation by ranking them on a scale from 1 to 5, with 5 representing the best opportunity for implementation. Table 4-3 summarizes the number of catchments with high CPI and NCPI scores and their corresponding BMP types. Catchments with high CPIs are selected for distributed BMPs and those with high NCPI are selected for regional BMPs.

The high priority regional and distributed BMP catchments selected (per the above method) were carried forward to the Step 3 level of analysis. 2819 Catchments were screened based on parcel size, landuse, and public versus private. The result is the "Total Number of Catchments" (2nd and 4th columns in Table 4-3) which are arranged in the order of descending score (5 to 1).

All 2819 catchments were screened again for BMP opportunity based on proximity to stormdrains, soil type, slope, and groundwater depth. The result is the "Number of Distributed Opportunities" and "Number of Regional Opportunity" (3rd and 5th columns in Table 4-3). For distributed sites, all catchments with rankings of 3 to 5 (column 2 and 3) were screened again and the results are 189 catchments (Figure 4-10). The same process is repeated for regional sites and the results are 87 catchments(Figure 4-19).

4.1.3 Structural BMP Prioritization

SPBAT Step 3 uses four general screening categories to determine which types of structural BMPs may be most appropriate for each of the priority catchments identified in Step 2. These categories include:

- Effectiveness
- Cost
- Ease of implementation
- Other environmental factors

The output from implementing this step is a series of catchment-specific comparison tables that apply user-defined weights to a variety of BMP evaluation criteria. This calculates relative scores for each distributed and regional BMP type. The result is a ranking of potential BMPs for each site. The following sections describe the types of BMPs considered for implementation under this step. Appendix F provides the relative BMP scores calculated for each catchment.

4.1.3.1 Regional BMPs

- *Infiltration Systems* - Volume-based BMPs similar to stormwater retention systems but are constructed with a highly permeable base specifically designed to infiltrate captured runoff. Because it is usually not practical to infiltrate runoff at the same rate that it is captured, these facilities usually include both storage and drainage components. Pretreatment BMPs such as swales, filter strips, and sediment forebays/basins/manholes that minimize sediment loading to the infiltration facility are recommended to increase longevity and reduce maintenance costs.

- *Detention Basins* (also known as dry ponds and detention ponds) – Detention systems are BMPs designed to collect and store runoff for gradual release. Basins should have outlets designed to detain the storm runoff for 36 to 48 hours to allow sediment particles and associated pollutants to settle and be removed. These facilities may also be used to provide hydromodification and/or flood control by modifying the outlet control structure design and including additional detention storage.

- *SSF Wetlands with Detention* –Engineered, below-ground treatment wetlands that include many of the natural treatment processes of surface flow constructed wetlands as well as the filtration mechanisms of media filters. Water flows through a granular matrix, which typically supports the growth of emergent wetland vegetation on the surface. The matrix provides a significant surface area for the filtration of particulate bound constituents and the growth of bacterial biofilms that metabolize and degrade many pollutants including nutrients, bacteria, dissolved metals, and organic compounds. Due to the low treatment flow rates, an equalization basin is typically needed to handle peak flows and provide near constant discharge to the facility.

- *Constructed Wetlands/Wetponds – A* naturalistic retention system BMP that includes a permanent or seasonal pool of water. Aquascape facilities, such as artificial lakes, are a special form of wetpond that can incorporate innovative design elements to allow them to function as a stormwater treatment facility in addition to an aesthetic water feature. The main pollutant removal mechanism is sedimentation. Other pollutant reduction processes include dilution and biological processes such as microbially-mediated transformations and plant uptake and storage.

- *Treatment Diversion* – Urban runoff may be diverted from the storm drain system to a conventional wastewater treatment facility. Additionally, there are proprietary treatment technologies that could possibly provide runoff treatment on a small scale in localized drainage areas before discharging to receiving waters. Small packaged systems are available using traditional treatment methods such as grit removal, primary sedimentation, secondary sedimentation/filtration, and disinfection using chlorine. An equalization basin upstream of the treatment plant would typically be required to smooth the peaks of runoff events.

- *Hydrodynamic Devices* - Flow-based mechanical BMPs that remove pollutants from stormwater by physical separation processes making use of the influent flow stream energy. Removal processes include physical separation of solids and associated pollutants. Hydrodynamic separators are typically installed in-line with storm drains and require regular maintenance of the filtration devices.

- *Channel Naturalization* - Includes projects such as storm drain daylighting, channel revegetation, and wetland channel establishment. Natural pollutant attenuation processes can occur in these types of water systems.

4.1.3.2 Distributed BMPs

- *Cisterns* - Volume-based BMPs that collect and store runoff from storm events for use or disposal after the storm event has ended. Cisterns range in size from rain barrels to underground storage tanks.

- *Bioretention Facilities* - Volume-based BMPs resembling vegetated, landscaped, shallow depressions that provide storage, infiltration, and evapotranspiration. Bioretention areas also remove pollutants by filtering stormwater through plants adapted to the local climate and soil moisture conditions, and an engineered soil mix. In bioretention areas, pore spaces, microbes, and organic material in the engineered soils help to retain water in the form of soil moisture and to promote the adsorption of pollutants, such as dissolved metals and petroleum hydrocarbons, into the soil matrix. Bioretention areas function to reduce runoff volumes by capturing and infiltrating stormwater. However, underdrains can be provided where the underlying soils have low permeability.

- *Vegetated Swales* - Flow-based BMPs resembling open, shallow channels with low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. Vegetated swales provide pollutant removal through settling and filtration in the vegetation (usually grasses) lining the channels; provide the opportunity for volume reduction through infiltration and evapotranspiration; and reduce the flow velocity, in addition to conveying stormwater runoff.

- *Porous/Permeable Pavement* - Area-based BMPs that include a variety of different paving methods that allow infiltration of stormwater, including pavers, porous asphalt, porous concrete, and others. Each is characterized by the ability to rapidly infiltrate water from the surface into subsurface storage for eventual infiltration. Typically designs include an aggregate or sand reservoir below the wearing surface that accumulates water during a storm and draws down by infiltration and evaporation. Impervious surfaces may drain to permeable pavement, thereby further reducing runoff.

- *Green Roofs* - Area-based BMPs that include a variety of roof-top landscaping that promote water retention and attenuation of peak runoff from roofs. Designs range from those consisting of simple layers of aggregate and soil to those including various layers of soil, synthetic retention layers, gravel, and underdrains. Each is characterized by the ability to store a portion of the water from a storm event and evapo-transpire stored water between events. Note that, as shown in Section 5, no green roofs are included in this Implementation Plan through 2021.

- *Gross Solids Removal Devices (GSRDs)* - Flow-based BMPs that include a variety of proprietary BMPs to remove large solids, such as trash and litter, from stormwater by physical separation processes, making use of the energy of the influent flow. Removal processes include physical separation of solids and associated pollutants. GSRDs are characterized by relatively small storage volume compared to treatment flow rate, resulting in minor changes to site hydrology as a result of implementation. Note that, as shown in Section 5, no GSRDs are included in this Implementation Plan through 2021.

- *Media Filters* - Flow-based proprietary and non-proprietary BMPs that remove pollutants from stormwater by media filtration. Removal processes include physical separation (filtration of solids), sorption of some dissolved solids, and limited biological activity. Media filters are characterized by relatively small storage volume compared to filtration flow rate, resulting in minor changes to site hydrology as a result of implementation. Note that, as shown in Section 5, no media filters are included in this Implementation Plan through 2021.

- *Catch Basin Inserts* - Manufactured filters or fabric placed in a drop inlet to remove sediment and debris and may include sorbent media to remove floating oils and grease. There are a multitude of inserts of various shapes and configurations, typically falling into one of three groups: socks, boxes, and trays. Inserts are an easy and inexpensive retrofitting option as drain inlets are already a component of most standard drainage systems. Note that, as shown in Section 5, no catch basin inserts are included in this Implementation Plan through 2021.

4.1.3.3 Green Solution and Multi-Benefit BMPs

The BMP rankings, based on technical analyses specific to each catchment, were used to assist with the selection of the best regional and distributed BMPs for each site (as described in the list above). Also considered was the opportunity to use integrated water resources approach and implement green solution BMPs, or BMPs that provide multiple benefits.

Green solution structural BMPs focus on: (1) reducing the volume of urban runoff (thereby indirectly improving water quality); and (2) removing pollutants from urban runoff through natural processes. Similarly, multi-benefit BMPs can provide ancillary benefits to the watershed, harvesting stormwater for irrigation, infiltration for groundwater recharge, and other beneficial uses such as creating more green open spaces.

Table 4-4 categorizes the regional and distributed BMPs discussed above, taking into account the other benefits that may be obtained through implementation. All BMPs used in this Implementation Plan fall into one of these categories, with most falling into at least two categories.

Table 4-4
Green Solutions and Multiple Benefit BMPs

BMP Type	Benefits		
	Natural Process	Water Reuse	Treat Multi-
Regional Projects			
Infiltration Facilities	X	X	X
Detention Basins	X		X
SSF Wetlands with Detention	X		X
Constructed Wetlands/ Wetponds	X		X
Treatment Facilities			X
Hydrodynamic Devices			X
Channel Naturalization	X		X
Distributed Projects			
Cisterns	X	X	X
Bioretention Facilities	X		X
Vegetated Swales	X		X
Green Roofs	X		X
Porous/Permeable Pavement	X	X	X
Gross Solids Removal Devices (GSRDs)			X
Media Filters	X		X
Catch Basin Inserts			X

4.2 Proposed Structural BMPs

4.2.1 Regional BMP Opportunities

The fourth step in the SBPAT methodology is a site-specific screening step. Planning and siting of potential regional structural BMPs is particularly challenging because of the highly developed conditions in the watershed. Because the majority of structural BMPs will need to be retrofit into developed areas of the watershed, the structural BMP analyses required significant preliminary data collection and field inspections in order to screen, prioritize, and select sites. This section summarizes the methods and results of the process used to (1) identify potential structural regional BMP sites in the watershed, and (2) conduct field inspections to further evaluate the sites. This activity is applied only to those sites that have met all potential criteria up to this point in the analysis process. Three technical steps were followed to further evaluate the 87 regional priority catchments for suitability for regional BMP implementation, as described here.

GIS –Level Screening

This activity relied on GIS to screen sites using a series of "constraints" layers such as landslide zones, poor soil infiltration zones, and environmentally sensitive zones. Based on this analysis, a number of catchments were eliminated from the original list of 87 catchments. Of the remaining potential sites, a representative sample of 30 sites was selected for additional screening (Refer to Appendix E and Appendix L for additional information on this process). The outcome of this step included site-specific maps with the following information:

- Catchment-specific constraints maps (with landslides, slopes, etc.)
- Catchment-specific opportunity maps (with aerial photos, storm drains, parcel ownership, etc.)
- Subwatershed-level drainage/opportunity maps (with drainage patterns)
- Regional opportunity catchment maps (zoomed in maps of the opportunity sites shown in Figure 4-9)

Desktop-Level Screening

This step evaluated individual parcels within each of the 30 selected catchments, and preliminarily selected potential BMP sites. Since, by definition, the regional sites have at least a 50-acre area tributary to the site, the location needs to have sufficient space to construct a BMP and manage the runoff generated from the tributary area. Where opportunities for construction of a regional BMP could not be identified within a catchment, the location was screened out.

In addition to the data provided by SBPAT, this desktop analysis relied on the following tools: Navigate LA, (storm flow, catchment information, boring logs, etc.); ZIMAS (Zoning Information and Map Access System [lot sizes, owner information, planning maps, etc]); Google Earth (aerial and panoramic images); Los Angeles Bureau of Engineering Vault records (as-built drawings of storm drain lines); and information available at www.LAStormdrain.net. Using these sources, the following information was summarized for each site:

- General area description (cross streets, land use, landmarks)
- Drainage area
- Description of potential parcels for BMP Implementation
- Storm drain information
- Subsurface utilities
- Existing BMPs and project proposals

- Neighborhood Council information
- Parks and open space areas
- Utility corridors
- Blacktop areas (school playgrounds)
- Roadways
- Sidewalks and parkway

The outcome of this analysis was the preparation of maps and figures to aid the field investigator when visiting the site to further assess the opportunity to implement a regional BMP at the location.

Based on this desktop analysis, 11 of the 30 potential BMP opportunity sites were eliminated as inappropriate for BMP implementation. The remaining 19 sites were included in the field screening activity. Of these sites, three of them were also identified as opportunities by stakeholders. Appendix F provides the desktop-level screening results.

Field-Level Screening

The final phase in the screening process is a field investigation to evaluate each site as an opportunity for implementing a regional BMP. The purpose of this visit is to: (1) verify previously identified constraints, and (2) identify any additional fatal flaws (e.g., flood control limitations, jurisdictional issues, storm drain proximity, public safety concerns, etc.) or opportunities (e.g., opportunity to implement distributed BMPs in the area). For each site visit, the information generated from the GIS and desktop-level screenings was verified, supplemented, and/or corrected as needed in the field.

Screening Results

Based on the review of the 19 regional BMP sites, eight sites were selected as priority sites for implementation. These eight sites are described in Section 5. Many of the remaining sites could be considered in the future for implementation.

4.2.2 Distributed BMP Opportunities

Opportunities to implement distributed BMPs on a particular catchment vary depending on the existing land use and other factors. However, because distributed BMPs include multiple individual small-footprint facilities requiring much less space, opportunities exist to retrofit distributed BMPs in most catchments. The process involved in identifying the distributed BMP opportunities was the same as the process for the regional sites, except for the types of BMPs considered and the area served. This section summarizes the methods and results of the process used to (1) identify potential structural distributed BMP sites in the watershed, and (2) conduct field inspections to further evaluate the sites. The same three steps applied to the 87 site-specific regional BMP opportunities were also applied to the 189 distributed BMP opportunities: GIS, desktop, and field screenings (see Section 4.2.1 for additional details).

Similar to the process for evaluating regional BMP sites, the evaluation of distributed BMP sites considered the knowledge of Ballona Creek Watershed stakeholders. As discussed in Section 3, stakeholders identified approximately 120 sites for BMP implementation (See Figures 3-1, 3-2, 3-3 and 3-4 and Appendix D). Most of these opportunities are associated with the retrofit of parcels with distributed BMPs. This information was evaluated along with other identified distributed BMP opportunities to establish a priority list for implementation.

GIS –Level Screening

The same factors evaluated for regional BMP sites were evaluated for potential distributed sites using GIS tools. Of the 189 distributed BMP opportunity sites, 70 were selected and carried forward for desktop-level screening.

Desktop–Level Screening

The desktop-level screening involved reviewing the individual parcels within each of the 70 catchments, and preliminarily identifying potential BMP opportunities. Since the distributed sites are identified as having at least 10 acres of tributary area, the sites identified needed sufficient space for the footprint required for a BMP that could manage runoff generated from this tributary area. If sufficient area was not present, the site was screened out. Based on the desktop analysis, all 70 sites were determined to have opportunities for distributed BMP implementation. Therefore, all 70 sites were included in the field-level screening activity.

Field –Level Screening

For each site visit, the investigator carried a packet of information generated from the GIS and desktop-level screenings. This information was supplemented and corrected as needed in the field. The distributed BMP field investigation activities generated numerous field data sheets and photographs for each of the 70 sites. Appendix F includes a summary of this information.

Screening Results

Ultimately, the field investigation phase did not rule out any potential sites for implementing distributed BMPs. This is an expected result given that for any catchment, at least some portion can typically be retrofit with distributed BMPs. Accordingly, the stakeholder sites were combined with the 70 opportunity sites identified by the SBPAT analysis to create a list from which priority sites were selected (Note: some of the stakeholder sites were also identified as opportunity sites).

After review of the potential distributed BMP site list, it was determined that 27 priority distributed sites would be selected for implementation during the first phase of the Implementation Plan. These sites are discussed in Section 5. Several of the 27 sites were also included on the stakeholder provided list. Selecting the stakeholder identified sites provides benefits to the implementation process since in many cases, these sites were identified during previous planning efforts and also it provides a substantial opportunity to collaborate with watershed stakeholders during the implementation process.

4.3 Identification of Institutional BMP Programs

Sections 4.1 and 4.2 identified the method and selection of priority regional and distributed BMPs for implementation throughout the watershed. These structural BMPs will be implemented in combination with institutional BMPs to comply with the Toxics TMDL compliance targets. Because of the highly developed nature of the watershed and limited availability of sites for construction of new urban runoff infrastructure, the responsible jurisdictions will have to rely on an implementation program that includes both structural and institutional elements to achieve compliance. The benefits of incorporating a strong institutional BMP program are numerous, and include:

- ***Potential cost savings*** - While the long-term operating costs for institutional programs may be significant, these BMPs do not require large capital expenditures to construct facilities. Operating costs may be spread out over many years, reducing overall annual program costs.

- ***Areal treatment coverage*** - Many institutional BMPs are implemented through watershed-wide programs, such as BMPs that target the reduction of water use and resulting runoff through better irrigation practices. Unlike a structural BMP facility, the coverage and water quality benefits are not limited to the catchment area served.

- ***Retrofit potential*** - Institutional BMPs may be applied to existing development which counters problems generated by the lack of open space prevalent in a built-out urban environment, as is the case in the Ballona Creek Watershed.

- ***Target specific pollutants*** - Institutional BMPs can target a specific pollutant parameter of concern. For example, BMPs that reduce copper in brake pads will reduce the amount of copper that enters the storm drain.

The following sections describe the approach used to evaluate and select institutional BMPs for implementation in the watershed.

4.3.1 Methodology

Development of the institutional component of the Toxics TMDL Implementation Plan relied on information gathered from three sources:

- ***Existing institutional BMP program implementation*** – Existing watershed institutional BMP programs, such as those implemented through the MS4 stormwater permit, were evaluated to determine (1) water quality benefits achieved under the existing level of effort, and (2) evaluate how these programs may be enhanced or expanded to achieve additional water quality benefits.

- ***Priority stakeholder institutional BMP programs*** – During development of the Implementation Plan, meetings were held with a number of watershed stakeholders to discuss BMP implementation opportunities (see Section 3 for more information). In particular, stakeholders provided their perspective on effective institutional BMP programs and opportunities for collaboration between government agencies and stakeholder groups in implementing these BMPs.

- ***Other regional, national institutional BMP programs*** – Institutional BMP programs implemented in other regions of the United States were assessed to (1) guide selection of institutional BMPs, (2) assess short- and long-term implementation strategies, and (3) develop methods to quantify their effectiveness for the Ballona Creek Watershed. Examples of organizations or programs consulted include the Center for Watershed Protection and the cities of Portland, Seattle and Minneapolis stormwater management programs.

4.3.2 Opportunities for Collaboration with Stakeholders

Section 3 summarized the input obtained from watershed stakeholders regarding institutional BMP implementation. As a result of stakeholder input, it is clear that significant opportunities exist for collaboration on institutional BMP implementation in the Ballona Creek Watershed. Collaboration may occur in several ways, including but not limited to:

- Participating in the development of policies and guidance that support urban runoff management.

- Contributing to education and outreach activities by assisting in the development of appropriate materials, and by potentially serving as an extension of the staff of the responsible jurisdictions and taking a lead role in implementing education and outreach activities.

- Continuing to implement elements of existing efforts, such as Ballona Creek Watershed Management Plan and Green Solutions Project, and also working with responsible jurisdictions to develop cost-share opportunities that create cost-effective opportunities to resolve localized urban runoff management concerns, such as green street projects.

- Assisting with the roll-out of new BMP programs by participating in efforts to educate property owners on the benefits of the programs, such as downspout retrofit or incentivized retrofits of private properties. This could also include a targeted program to reduce the use of pyrethroids, the primary cause of toxicity in the estuary, and could include public education on proper application of pesticides to reduce offsite discharge, and the use of less toxic alternatives and other methods to control pests.

- Supporting development of new programs or data collection to support effectiveness evaluations of existing programs.

Finally, it is recognized that the nature of collaboration with stakeholders is dictated, to a large degree, by funding and staff resources, which includes not only funding to the responsible jurisdictions, but the stakeholders as well. Accordingly, an important institutional BMP incorporated into this plan is the need to establish stable, long-term funding sources for education and outreach. Having this funding in place would increase opportunities for active collaboration.

4.3.3 Recommended Institutional BMP Program

Extensive opportunities exist for implementing institutional BMPs. The institutional BMP program for this Implementation Plan was developed in conjunction with the structural BMPs. Accordingly; the recommended institutional BMPs are described in Section 5.

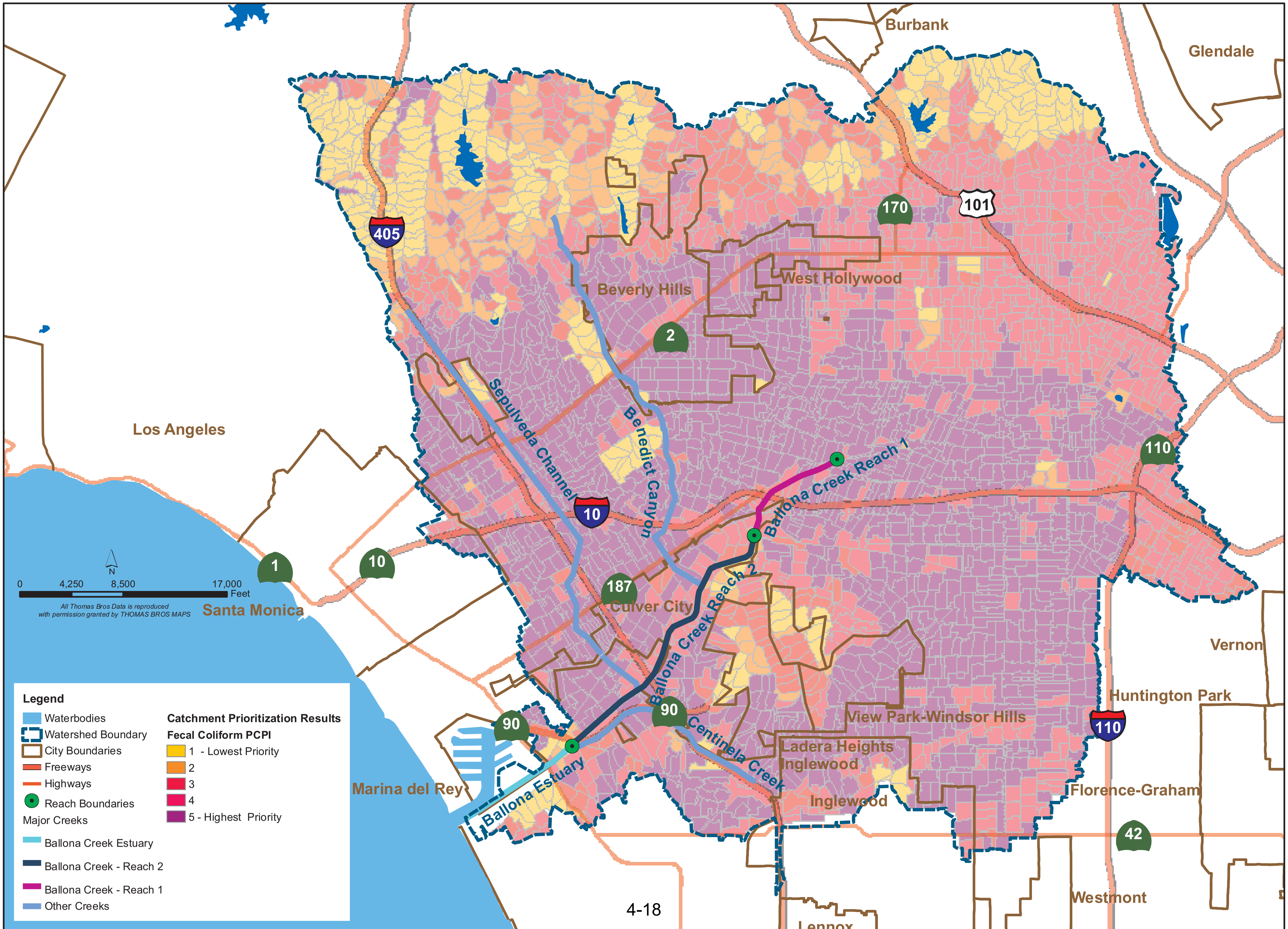


Figure 4-2 Ballona Creek Watershed - Fecal Coliform Catchment Prioritization Index

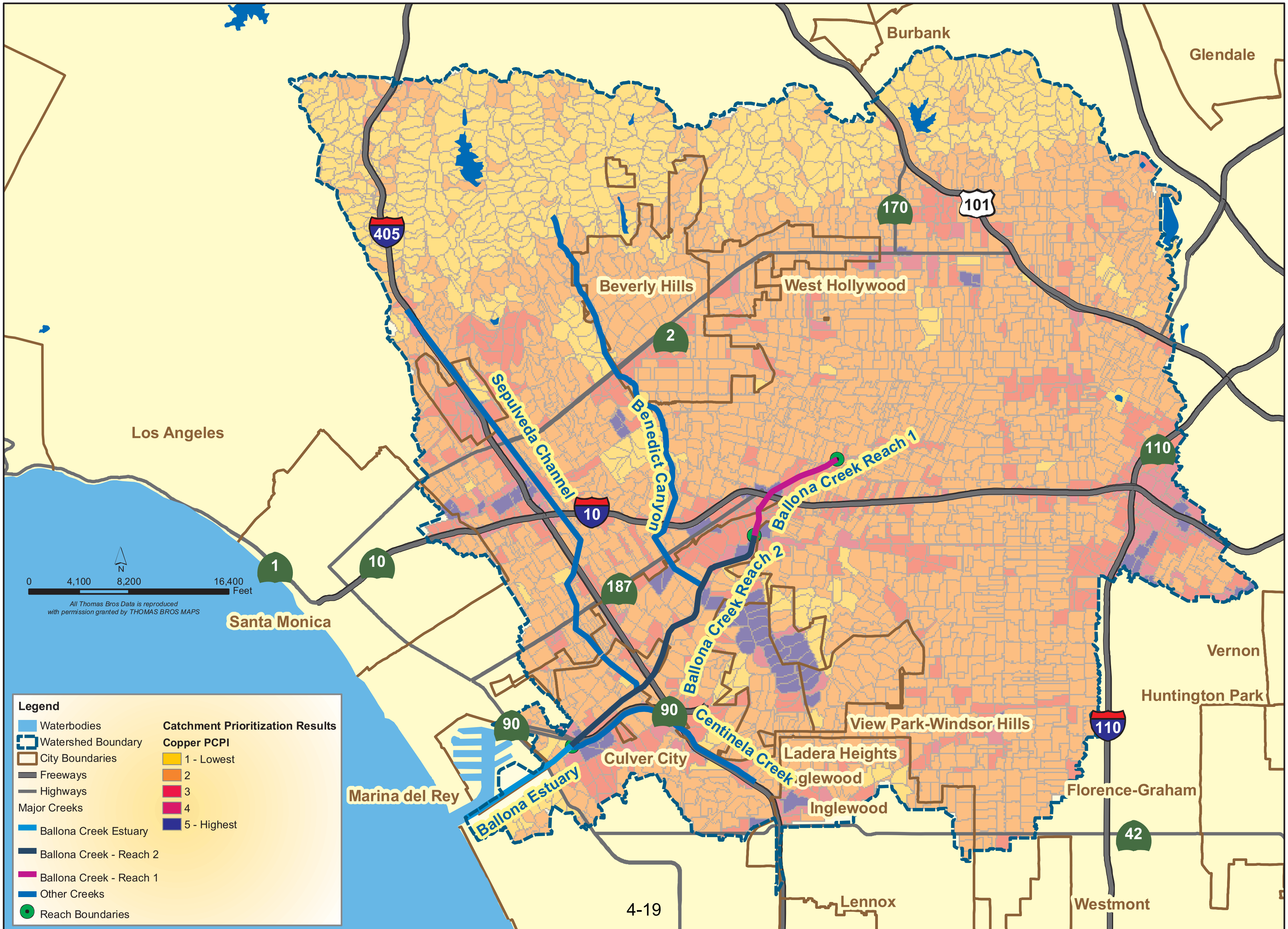


Figure 4-3 Ballona Creek Watershed - Copper Catchment Prioritization Index

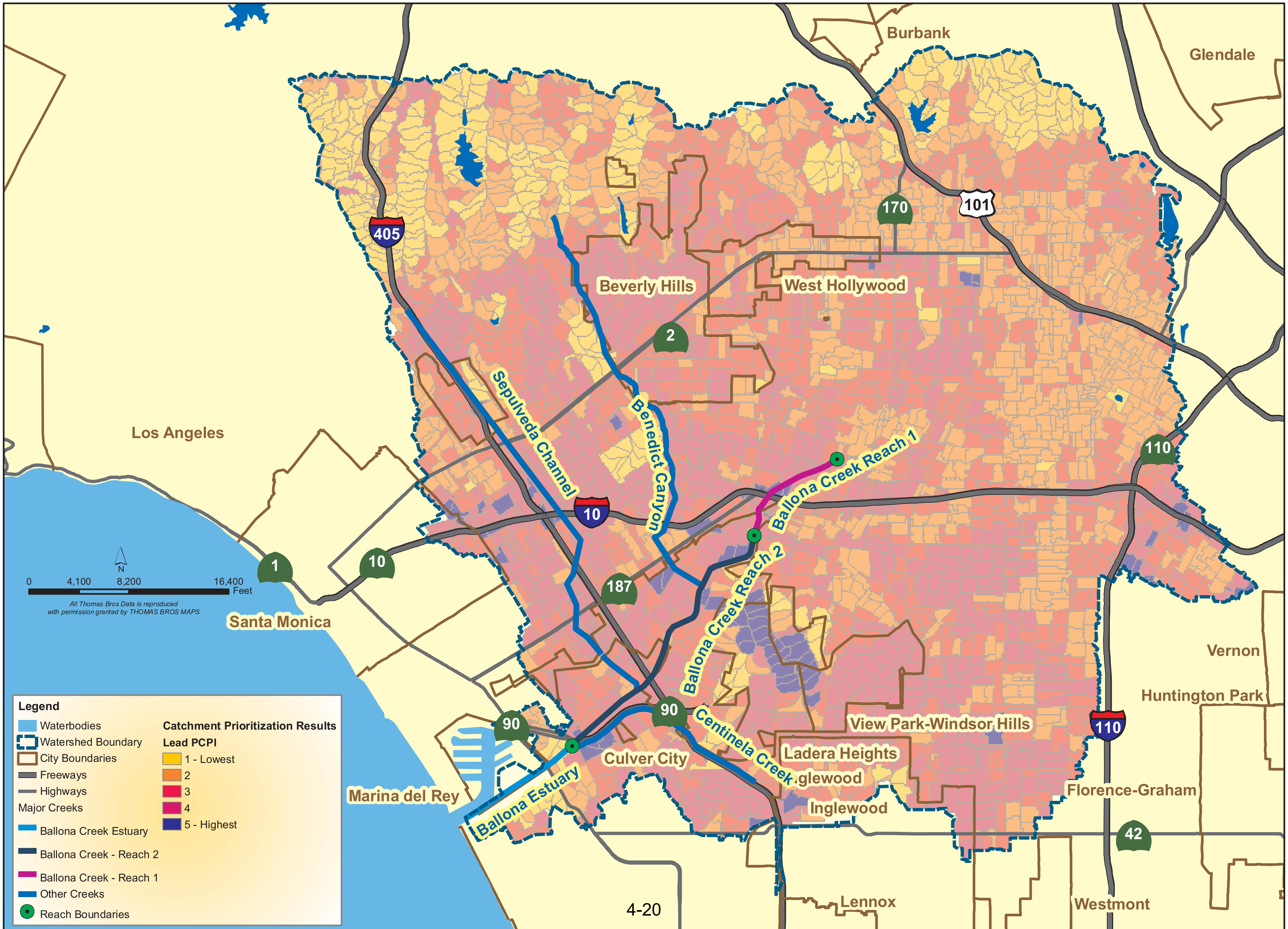


Figure 4-4 Ballona Creek Watershed - Lead Catchment Prioritization Index

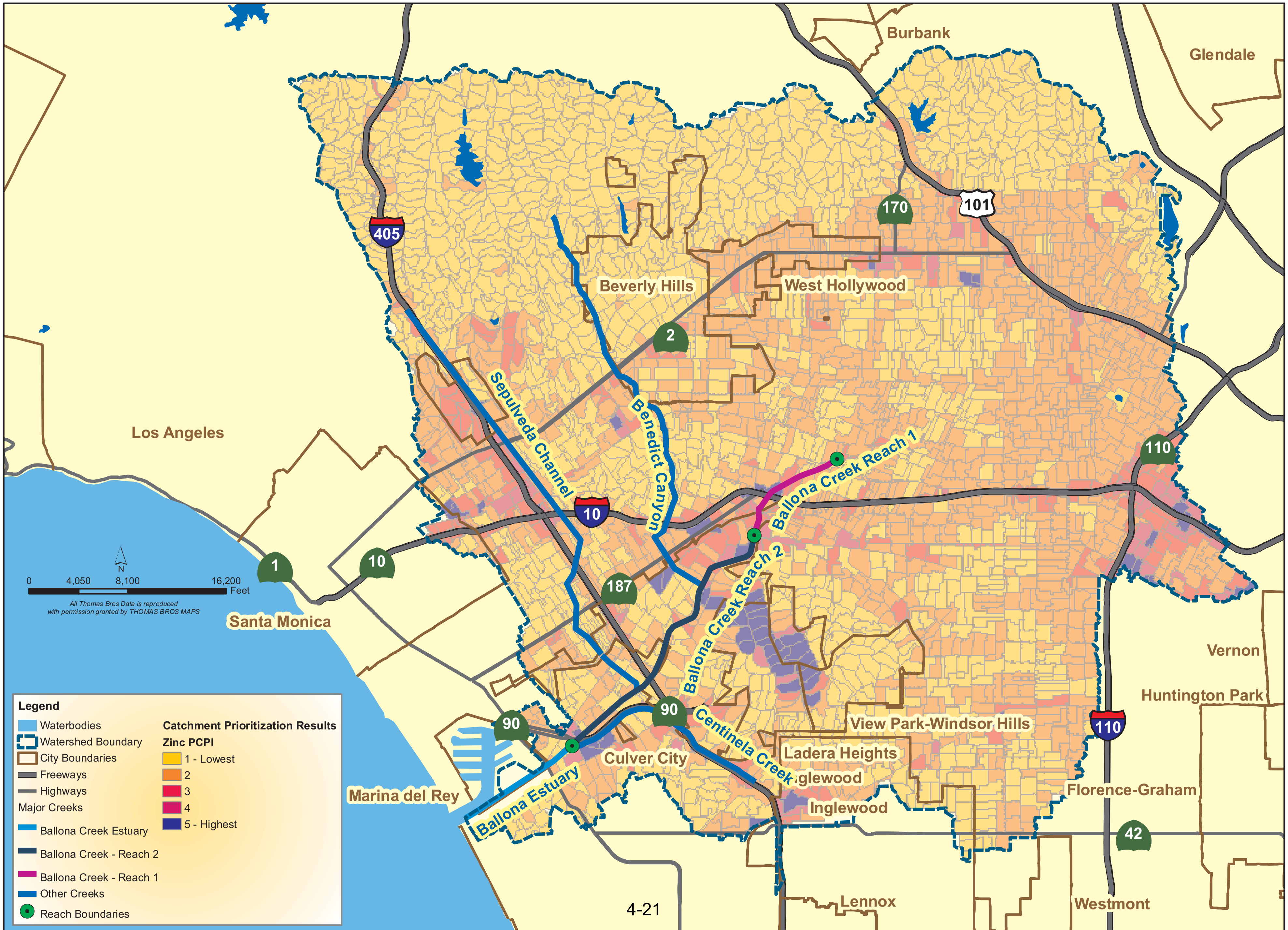


Figure 4-5 Ballona Creek Watershed - Zinc Catchment Prioritization Index

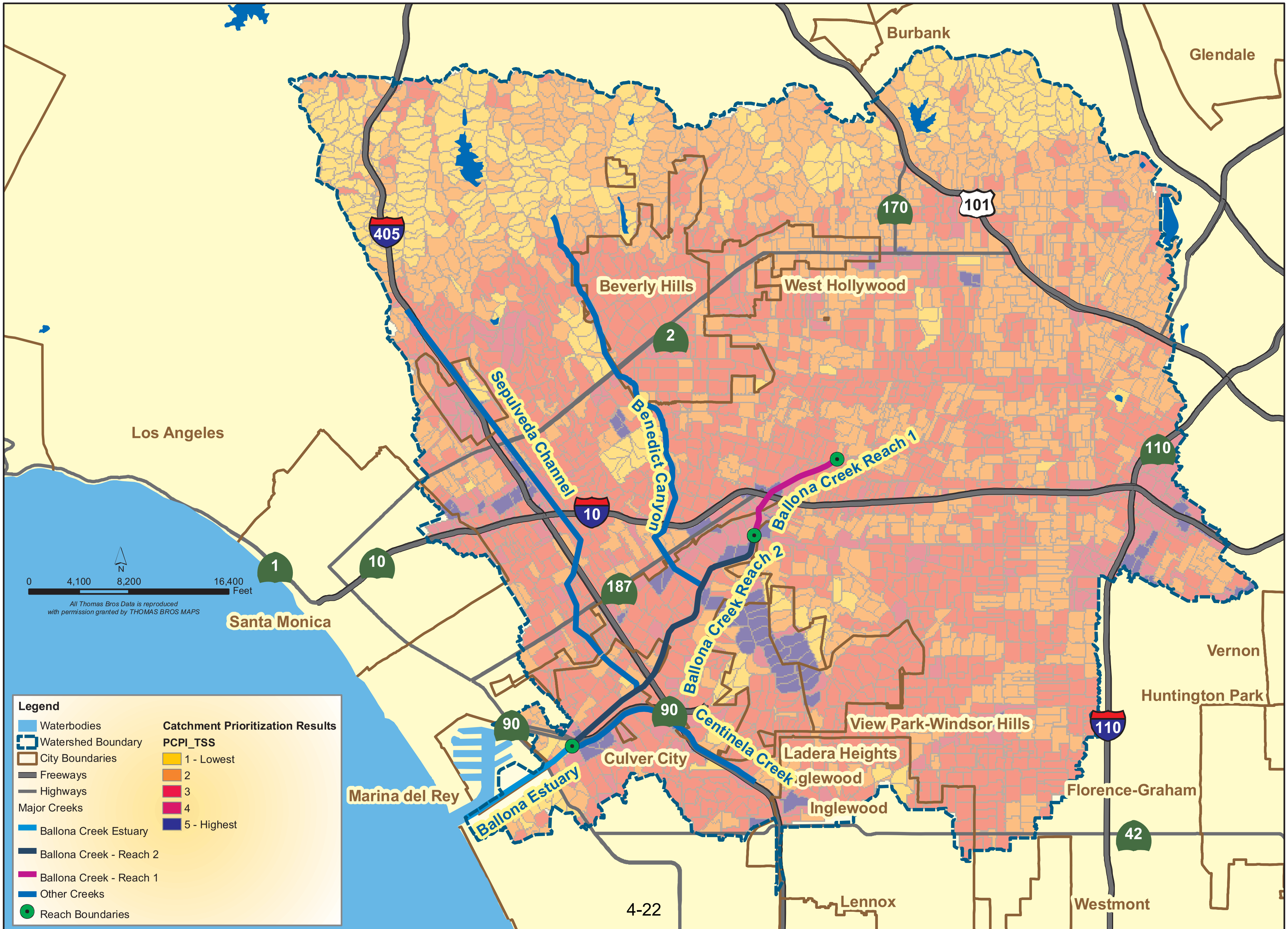


Figure 4-6 Ballona Creek Watershed - TSS Catchment Prioritization Index

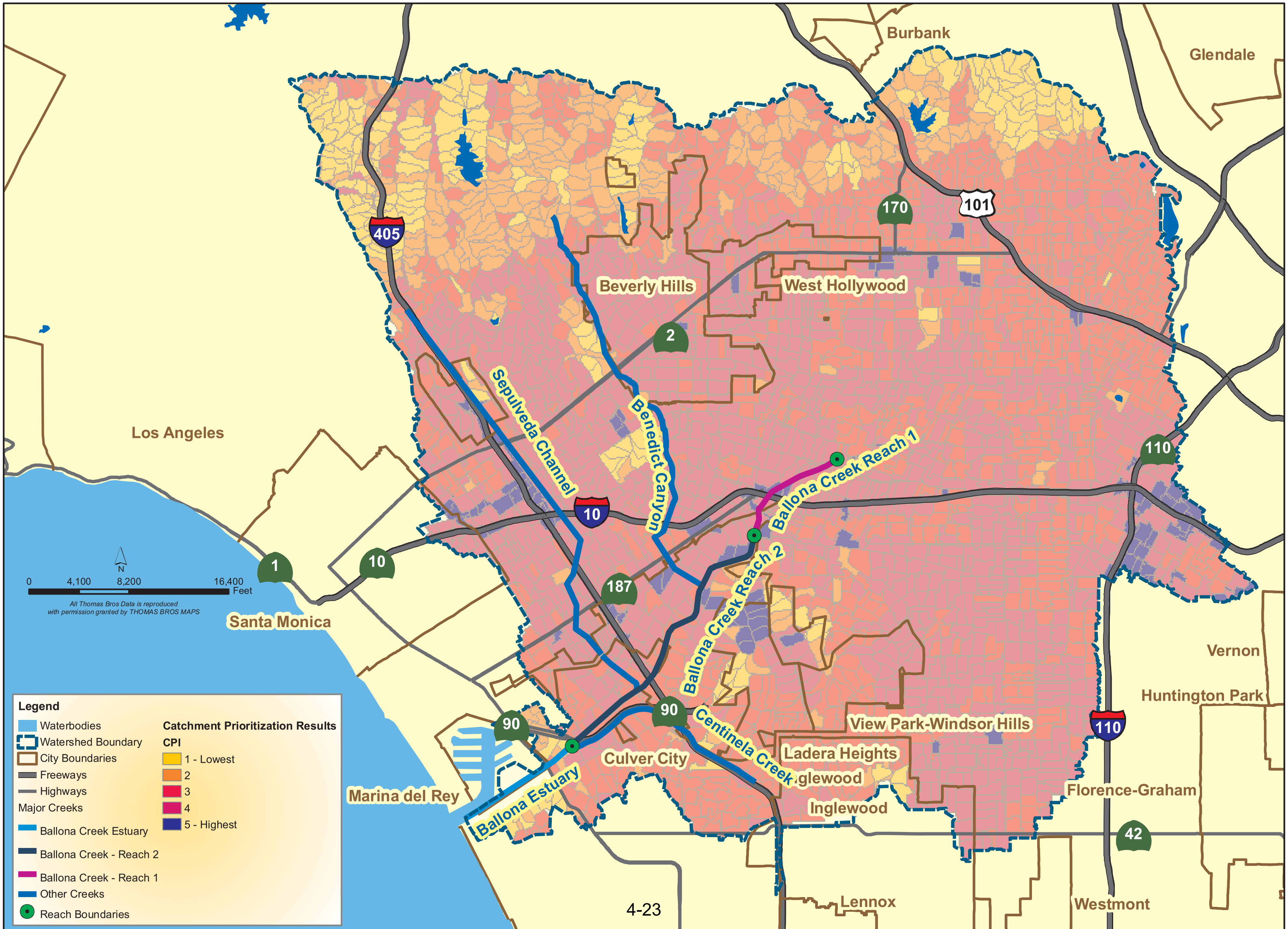


Figure 4-7 Ballona Creek Watershed - Catchment Prioritization Index

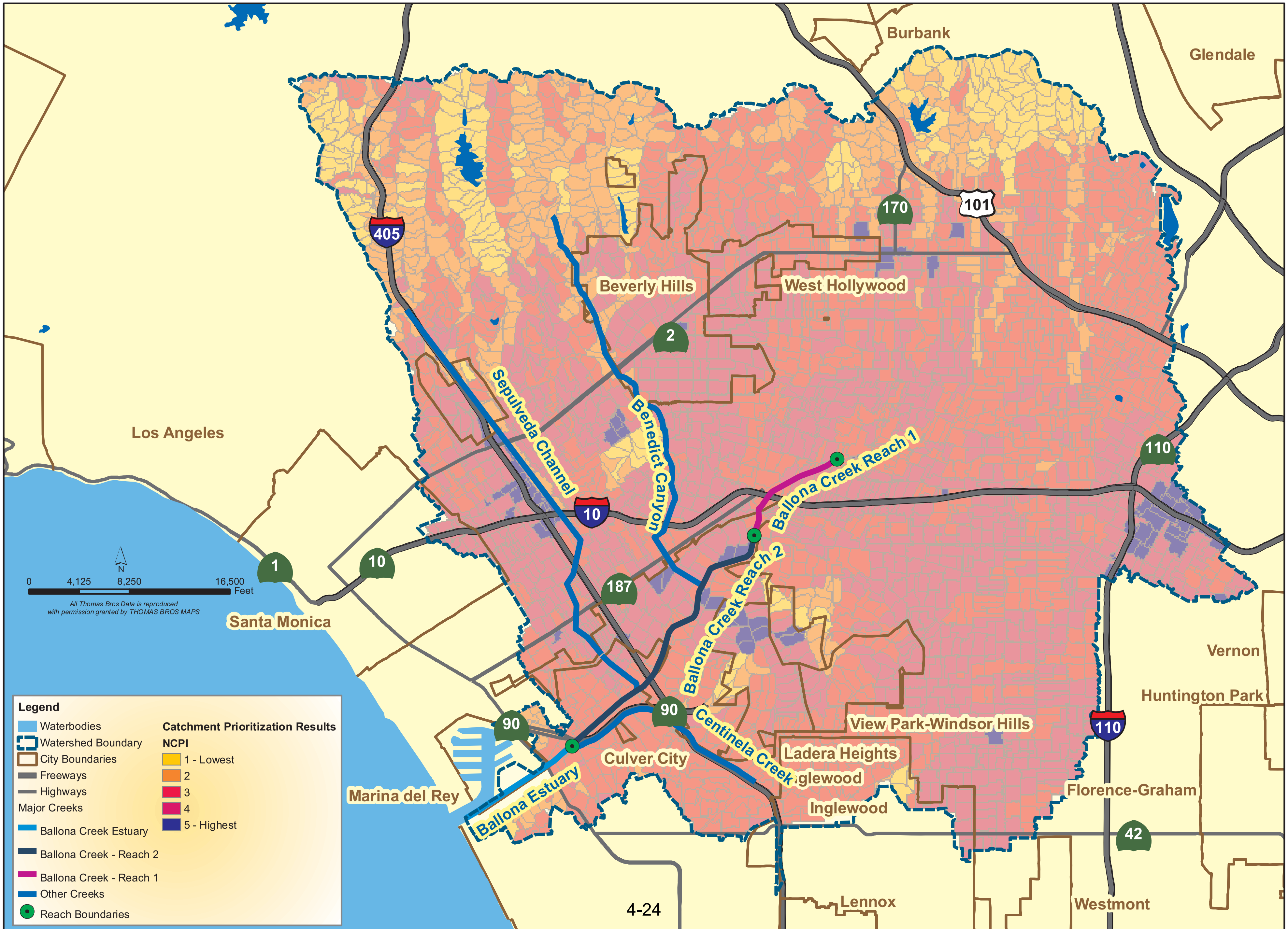


Figure 4-8 Ballona Creek Watershed - Nodal Catchment Prioritization Index

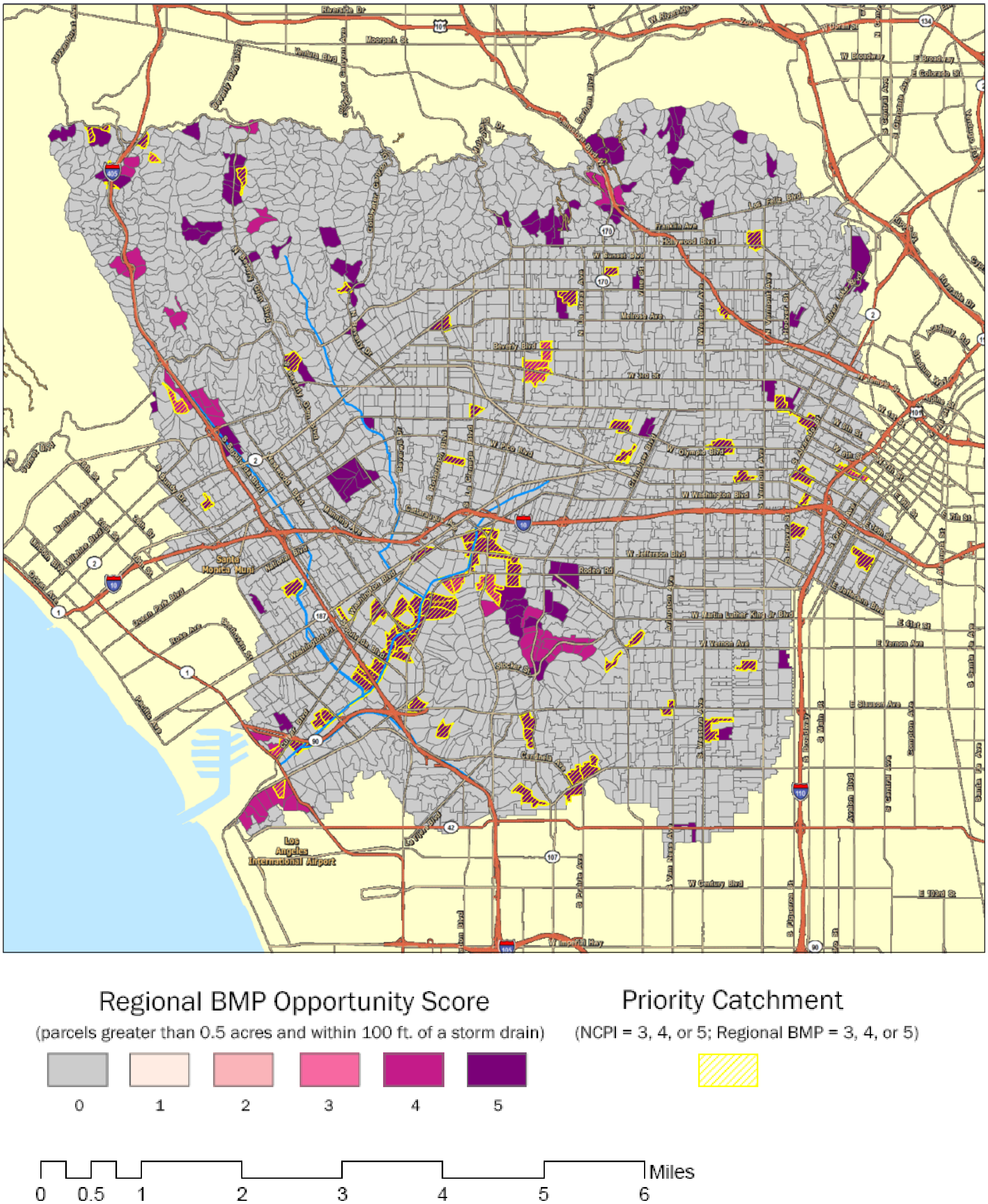


Figure 4-9
Regional BMP Opportunities

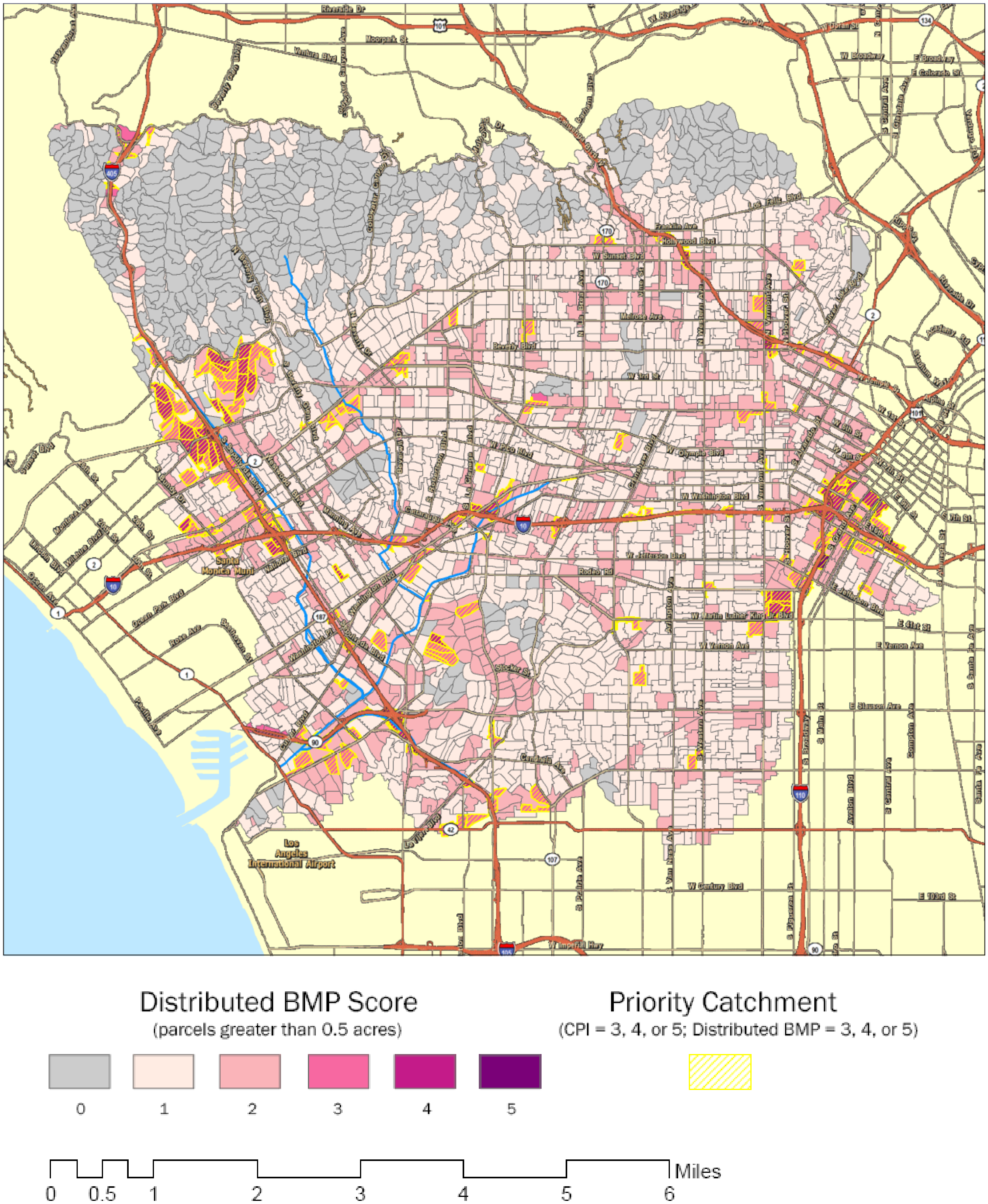


Figure 4-10
Distributed BMP Opportunities

Section 5
Proposed Implementation Plan

The implementation approach for achieving compliance with the Ballona Creek Estuary Toxic Pollutants TMDL was based largely on local stakeholder input. The responsible jurisdictions are committed to including stakeholder input in order to achieve broader water quality benefits, and establish multi-objective goals to enhance the Ballona Creek Watershed. Watershed stakeholders are interested in solutions that will reduce toxic pollutant loadings in Ballona Creek estuary and comply with TMDL numeric limits, with an emphasis on watershed-based strategies and institutional BMPs.

Since this Implementation Plan was developed in conjunction with the Ballona Creek Bacteria TMDL Implementation Plan and the Ballona Creek Metals TMDL Implementation Plan, the upstream watershed structural and institutional BMPs described herein are the same projects identified in the Bacteria and Metals TMDL Implementation Plans.

This section describes the following:

- Recommended Watershed BMPs (Section 5.1): The watershed wide BMPs that will reduce loading of all of the pollutants of concern (bacteria, metals, and sediment bound toxics) from the upstream watershed, both structural and non-structural;

- Compliance with the Toxics TMDL (Section 5.2).

5.1 Implementation of Recommended Watershed BMPs

The Implementation Plan relies on a combination of measures designed to decrease loading and transport of toxics, including metals and organics, as well as other pollutants such as trash, and bacteria by (1) reducing the amount of dry weather and wet weather anthropogenic/urban runoff, (2) providing localized source control to reduce pollutant loads, and (3) incorporating opportunities for beneficial use of urban runoff.

Recommended BMPs include three general categories:

- Institutional BMPs to provide watershed wide pollutant reductions (Section 5.1.1);

- Regional and distributed structural BMPs for dry- and wet-weather treatment (Section 5.1.2); and

- Low Flow Treatment Facilities (LFTFs) to provide additional dry-weather runoff treatment (Section 5.1.3).

5.1.1 Recommended Institutional BMPs

The following sections describe the range of institutional BMPs that were evaluated and considered for inclusion in the Toxics TMDL Implementation Plan. While all of these BMPs are expected to provide a reduction in pollutant loading, only the estimated benefits associated with the improved street sweeping program were quantified (see Section 5.2.1.1 for information regarding quantified benefits). Information about the institutional BMPs described here was obtained from existing BMP implementation in the Ballona Creek Watershed, stakeholder input, and programs implemented elsewhere in the United States. For those BMPs already undergoing implementation in the watershed, the evaluation considered how BMPs could be enhanced to provide additional water quality benefits. The following sections also present BMP performance data, where available, from other jurisdictions and targeted research studies. While the extent of these data is varied and much of it is not necessarily applicable to the Ballona Creek Watershed, this information may later provide guidance for evaluating potential water quality benefits that may be gained from implementing the BMP in the Ballona Creek Watershed.

5.1.1.1 Education and Outreach

Education and outreach programs for residents and businesses about water quality impacts from controllable sources of metals include brochures, posters, websites, event attendance, utility bill inserts, and surveys. Education and outreach programs require a change in consumer behavior to be effective. To evaluate BMP performance, the City of Portland Bureau of Environmental Services assumed that eight percent of the public would change their habits based on educational programs. This figure was derived from public relations outreach data developed by Clean Water Services (Herrera, 2006).

Education and outreach implementation opportunities related to the Ballona Creek Toxics TMDL Implementation Plan could include:

Urban Runoff Websites—The City of Los Angeles will continue to manage its stormwater Website (www.lastormwater.org) to provide information on urban runoff management practices, and specific information on Toxics TMDL implementation will be added.

Regulatory and Policy Education—The responsible jurisdictions will develop and implement a process to educate and provide outreach to appropriate agency departments to support implementing newly developed policies, ordinances, and incentive programs.

Rapid Transit Promotion—The responsible jurisdictions will continue to promote the use of rapid transit to minimize the number of vehicle miles driven in the watershed. In addition, the responsible jurisdictions will evaluate opportunities to develop and implement incentives to further reduce miles driven.

Education and Outreach Effectiveness Evaluation—The responsible jurisdictions will develop evaluation and monitoring methods to better understand the performance of education and outreach programs. Based on this information, prioritize educational campaigns on the basis of their effectiveness (e.g., information dissemination through brochures, public meetings, signage, school education, etc.).

Watershed-wide Education—The purpose of this ongoing BMP is to improve the consistency and efficiency of urban runoff management education efforts watershed-wide. The responsible jurisdictions will continue to collaborate with other jurisdictions and NGOs to develop appropriate watershed-wide educational programs.

Education and Outreach Funding—The responsible jurisdictions will work with watershed partners to establish a long-term stable fund for supporting watershed-wide education activities that is cost-shared among jurisdictions and organizations including, but not limited to, the responsible jurisdictions, Los Angeles County, and NGOs. Establishing this fund would include developing an agreement on the methods for governing fund expenditures.

Environmental Learning Center—The City of Los Angeles will complete construction of the Environmental Learning Center, and establish a secure funding source so that the facility is regularly available to provide environmental education.

Targeted Metals Education & Outreach—The City of Los Angeles currently implements a comprehensive education program to reduce potential mobilization of metals into storm drains from car washing (both at home and charity car washes, see below), hosing down driveways, improper disposal of used oil, and vehicle maintenance activities at home. The City of Los Angeles will evaluate its existing education and outreach program to determine the need to enhance this effort to improve the effectiveness of this BMP.

Individual Car Washing – This BMP targets car owners that wash their own cars. Past surveys have indicated that 56 to 73 percent of car owners wash their own cars and over 90 percent of those let water drain to the pavement (CWP, 2008). This activity washes metals off of the car, increases dry weather urban runoff, and mobilizes metals present on impervious surfaces. To reduce metals loads and other toxic pollutants that are transported via urban runoff, educational outreach could be increased to encourage car owners to minimize washing activities that result in flow to storm drains. Educational materials could encourage car owners to use commercial car washes or wash cars on permeable surfaces.

LADWP has a six phase Emergency Water Conservation Ordinance that includes restrictions on car washing. In the first phase, car washing is only permitted with a hose equipped with a shut-off device. In the fourth phase car washing is only permitted at commercial car wash facilities, and all commercial car washes are required to either recycle their wash water or send it to a clarifier that is connected to the sewer system.

5.1.1.2 Product Replacement

The purpose of this BMP is to reduce a significant source of metals and other toxic pollutants in the environment by developing safe alternative products. To implement this BMP, the City will continue to support efforts to reduce metals in vehicle brake pads (SB 346), which recently passed both the California House and Senate, and wheel weights (SB 757). If opportunities arise to participate in studies or legislation to reduce the metal content in other products, the responsible jurisdictions will consider participating in those efforts.

Additional legislation may someday be pursued, to limit the use of pyrethroids since pyrethroids have been identified as the source of toxicity in the estuary (see Section 2). The responsible jurisdictions will work towards identifying and supporting safer alternatives.

5.1.1.3 Street Sweeping

Street sweeping removes sediment, debris, and other pollutants from road and parking lot surfaces. Several studies conducted on the effectiveness of street sweeping for pollution reduction have shown variable results dependent on traffic volume, type of sweeper used, frequency of sweeping, land use, and pavement type (Herrera, 2006). Another study showed annual sediment removal for a residential street of 20 to 31 percent for mechanical sweepers and 50 to 88 percent for new vacuum sweepers, depending on sweeping frequency (Rosselet, 2007). A separate study found that the frequency of street sweeping necessary to maximize sediment removal is once every week (Brinkman and Graham, 2001). Given the number of variables involved, including sweeping frequency or sweeper efficiency, the effectiveness of this program can vary widely. Accordingly, the street sweeping program will be evaluated to increase efficiency of pollutant removal from surfaces by 15 percent (see Section 5.2.1.1 for additional information).

5.1.1.4 Catch Basin Cleaning

Studies have shown that catch basins can be effective in removing 40 to 50 percent of total suspended solids (Herrera, 2006). Catch basin performance declines as flow increases, catch basin turbulence increases, and retention time decreases. In addition, when over 50 percent of the catch basin is full, previously captured sediments can be re-suspended (Herrera, 2006). Catch basin cleaning can maintain higher pollutant removal rates and reduce remobilization of pollutants entrained in the sediments including metals and organics. However, increasing the cleaning frequency to more than quarterly provides little additional benefit. For example, one study determined that semi-annual cleaning is optimal for the average catch basin (Herrera, 2006). Overall, catch basin cleaning is an important institutional BMP, but the benefits of increased frequency of catch basin cleaning should be evaluated.

5.1.1.5 Downspout Retrofit

This BMP redirects runoff from roofs to pervious areas, resulting in reduced flow to storm drains. Implementation options include redirecting downspouts to lawns, gardens or swales, or installing a rain barrel or cistern to collect roof runoff for later use. The City of Portland has been implementing an effective downspout retrofit program since 1996. The program's Website indicates that over 56,000 property owners have disconnected downspouts. Given that the average Portland area rooftop sheds approximately 35,000 gallons of water over an average winter, the reduction in potential pollutant loading to storm drains from urban runoff is substantial (City of Portland Website). Downspout retrofit is an effective institutional BMP for commercial, industrial, and public buildings as well. This opportunity is especially important since buildings associated with these land use types tend to have roofing materials containing higher leachable metals content.

The City of Los Angeles currently has a pilot program in place for downspout retrofit of single family residential roofs. The first phase will disconnect approximately one-sixth of the single family residential roof areas in the watershed and the second phase would disconnect another one-sixth of the single family residential roof areas, for a total of one-third of all single family residential rooftop areas being disconnected.

5.1.1.6 Programmatic Enhancements

A critical component of institutional BMP implementation is the establishment of a programmatic structure that creates consistency in urban runoff management, encourages application of green solutions, provides adequate legal authority, and includes appropriate levels of coordination, planning, and collaboration. The WQCMPUR identified the need for improvement in a number of programmatic areas (City of Los Angeles, 2009). Watershed stakeholders have also indicated the importance of implementing a new, comprehensive approach to urban runoff management and have provided many examples where change is needed. Accordingly, this Implementation Plan includes a number of institutional BMPs directed at improving programmatic issues. Quantifying the water quality benefits that can be attributed to these improvements is not possible. However, the intangible benefits of these BMPs, when focused on achieving a common purpose (improved urban runoff management), have demonstrated an increase in the integration of water resources and long-term water quality improvements.

5.1.2 Wet Weather Structural BMPs

The Implementation Plan includes structural BMPs that would be designed to treat wet weather runoff, but which would in many cases also treat dry weather runoff. Structural BMPs include regional projects serving multiple catchments as well as distributed BMPs that consist of small-scale decentralized, structural BMPs.

Structural BMPs include existing projects, new priority projects, and potential future projects. The potential future projects were identified during stakeholder workshops and during field meetings with stakeholder groups.

5.1.2.1 Existing Projects

SUSMP Projects

The Standard Urban Stormwater Mitigation Plan (SUSMP) requirements of the existing MS4 permit apply to new development and redevelopment projects. The MS4 in the Ballona Creek Watershed is permitted under a single permit issued to Los Angeles County and 84 incorporated cities (all except the City of Long Beach). An important part of the MS4 permit is the SUSMP requirements. In general, SUSMP applies to new developments and redevelopments of a certain minimum size. The BMPs installed on-site must be able to infiltrate, capture and reuse, or treat all of the runoff from an 85th percentile storm, which is approximately a 3/4-inch, 24-hour storm in the Ballona Creek watershed. New guidelines approved on July 9, 2008 require developers to give top priority to BMPs that infiltrate stormwater and lowest priority to mechanical/hydrodynamic units. Table 5-1 provides a summary of the number of projects required to meet SUSMP requirements in the City of Los Angeles in recent years. It is estimated that in future years, similar numbers of projects will be built resulting in additional treatment, Citywide, on these categories of properties.

Table 5-1
City of Los Angeles Projects Reviewed and Conditioned to meet SUSMP Requirements[1]

Year	Single Family	10+ Housing Dev.	Commer-cial/ Industrial	Auto-motive Services	Retail Gaso-line	Restau-rants	Parking Lots	Discharges to ESAs[2]	All Category Total
01-02	5	0	22	2	1	2	8	0	40
02-03	76	46	42	1	1	4	15	2	187
03-04	184	219	98	11	5	3	21	1	542
04-05	303	207	125	10	4	5	24	9	687
05-06	215	202	76	9	2	1	32	6	543
06-07	165	192	81	4	6	0	42	21	511
07-08	246	179	132	9	5	4	56	38	669
08-09	90	104	78	11	7	2	47	20	359
Total:	**1284**	**1149**	**654**	**57**	**31**	**21**	**245**	**97**	**3538**

Notes:
*[1] **Los Angeles County MS4 Permit (City of Los Angeles Annual Report Summary)***
*[2] **Permits issued to projects located in or directly adjacent to or discharging directly to an environmentally sensitive areas***

Proposition O Water Quality Projects

Los Angeles voters passed Proposition O in November 2004, which authorized the City of Los Angeles to issue up to $500 million in general obligation bonds for projects that mitigate water pollution in order to meet federal CWA requirements. Proposition O also funds improvements to protect water quality, provide flood protection, and increase water conservation, habitat protection, and open space.

Proposition O projects in the Ballona Creek Watershed include the Westside Park Rainwater Irrigation Project and the Mar Vista Recreation Center Stormwater BMP. The Westside Park Rainwater Irrigation Project has a drainage area of 3,700 acres. The project consists of installing a flow diversion facility, a stormwater lift station, a subsurface rainwater irrigation use system that can store up to 180,000 gallons of surface runoff, and a dry creek to return water to the storm drain system. Additionally, there will be recreational elements such as park benches, exercise equipments, and playground structures.

The completed Mar Vista Recreation Center Stormwater BMP Project diverts dry weather flows and the "first flush" from the Sawtelle Channel (78 inch Reinforced Concrete stormdrain) to the adjacent Mar Vista Recreation Center and Park where the facility treats up to 5 cfs of stormdrain flow. The project consists of a stormwater lift station, flow diversion facility, a hydrodynamic separator, an underground detention tank, chlorination facility, final effluent pump station, recirculation pump and overflow piping.

Trash TMDL Implementation

In September 2001, the Environmental Protection Agency adopted the Ballona Creek and Ballona Creek Wetlands Trash TMDL, which established limits on the amount of trash allowed into Ballona Creek. The TMDL required Southern California cities discharging into Ballona Creek to reduce their trash contribution to these water bodies by 10 percent each year for a period of 10 years with the goal of zero trash in the two waterways by 2015. The first milestone was a 20 percent trash reduction in Ballona Creek by September 30, 2006, which the City met. Since then, the City has achieved every yearly milestone, solely based on its structural measures without having to take credit for its implemented institutional measures.

Implementation of BMPs to address the Trash TMDL is also expected to help reduce TSS loadings, which will assist in achieving compliance with the Toxics TMDL waste load allocations.

The Watershed Protection Division (WPD) of the Bureau of Sanitation is the lead office in charge of the city-wide Trash TMDL Implementation. In its undertaking of the Trash TMDL, WPD in the spring of 2002 completed a study entitled High Trash Generation Areas and Control Measures, which identified the spatial distribution of trash in the City for both the Los Angeles River and Ballona Creek watersheds. The study examined the amount of trash accumulating in City-owned catch basins beginning in 1999 through the end of 2003. The ensuing analysis of the data resulted in the identification of three categories of trash generation potential (low, medium, and high) to describe areas within the City. The high trash generation area was shown to contribute approximately sixty percent of the trash within the City. It was concluded that implementing both institutional and structural control measures first in the high and medium trash generating areas would have the greatest impact in reducing trash discharged to the Ballona Creek.

The City's strategy for compliance is based on using the following two-prong approach: 1) implementing institutional measures such as, public outreach, street sweeping, catch basin cleaning, enforcement, etc., with a special focus on the high trash generation areas, and 2) installing structural trash control devices in the storm drain system, targeting first the high trash generating areas of the City, followed by the medium and low trash generating areas.

As of September 2008, the City has installed over 7,700 catch basin inserts in the high trash generating areas and 14,900 catch basin opening screen covers in the high and medium trash generating areas of the City. In addition, 13 netting systems and three CDS units certified as full capture devices, have been strategically installed throughout the City and continue to operate effectively in preventing the trash from getting to the LA River and Ballona Creek. Thus far, the City has invested approximately $39 million to achieve compliance using online structures and catch basin capture devices.

At the inception of the program, the implementation of the trash TMDL in the City was projected to cost well over $1.5 billion in capital costs to achieve full compliance. Through the City's leadership and use of its strategic two-pronged approach, paralleled with a commitment to invest in piloting new products and BMPs, the capital costs are now projected at approximately $85 million to achieve compliance. The last phase will be undertaken through a contract over a period of several years, funded through Proposition O, and will address the future regulatory milestones by installing catch basin opening covers. The City will achieve full compliance several years before the mandated compliance deadlines.

5.1.2.2 New Priority Projects

Distributed Structural BMPs

Section 4 summarized the process for identifying distributed BMP project opportunities. Of these opportunities, an initial set of 27 distributed BMP sites were selected for near term implementation (Figure 5-1). For these sites, Table 5-2 presents a short BMP project description, jurisdiction, and the integrated water resources benefits provided by each project. Preliminary concept drawings are included in Appendix G. Implementation of these projects, which provide multi-pollutant benefits, will be subject to confirmation of engineering feasibility and, where appropriate, the water quality treatment approach may be modified.

Regional Structural BMPs

As a result of the extensive desktop and field analyses conducted in the watershed (as discussed in Section 4), eight sites were selected as priority regional sites based on opportunity potential, site conditions, ownership, drainage area, and geographic distribution (Figure 5-1). Table 5-3 summarizes the characteristics of each of these eight recommended regional structural BMPs. A concept level drawing for each of these sites is provided in Appendix G. These preliminary concepts are subject to change and modification upon additional more detailed study. Implementation of these projects, which will provide multi-pollutant benefits, will be subject to confirmation of engineering feasibility and, where appropriate, the water quality treatment approach may be modified.

Table 5-2
Summary of Phase 1 Distributed BMP Sites in Ballona Creek Bacteria, Metals and Estuary Toxic Pollutants TMDL Implementation Plans[1]

Site ID[2]	Title/Location	Catchment #/ Catchment Area	BMP/Project Description	Jurisdiction	Other IWRA Benefits[3]
1	Baldwin to Ballona Trail: Jefferson Blvd & Fairfax Ave	205869 28.2 acres	Vegetated swales, bio-retention in parkway with underdrains, permeable pavement, bio-retention facilities	Los Angeles	1, 2
2	Ballona Greenway: Berryman Ave at Ballona Creek East of 405 Fwy	207784 23.8 acres	Bio-retention in parkway with underdrains, vegetated swales, bio-retention facilities	Los Angeles / Culver City	1
3	Ballona Greenway: Milton Street at Ballona Creek near Bundy	208755 28.5 acres	Bio-retention in parkway with underdrains, vegetated swales, Permeable Pavement	Los Angeles	1
4	Ballona Greenway: Washington and Ballona Creek east of Fairfax	203627 19.3 acres	Bio-retention in parkway with underdrains, vegetated swales	Los Angeles	1
5	Ballona Greenway: Hauser Blvd at Ballona Creek	205522 33.2 acres	Bio-retention in parkway with underdrains, green street medians	Los Angeles	1
6	Occidental Blvd & 2nd St	200551 30.7 acres	Bio-retention in parkway with underdrains	Los Angeles	1
7	405 Fwy & Wilshire Blvd	208406 18.4 acres	Vegetated swales and bio-retention facilities	Los Angeles County/Caltrans	1
8	Ballona Greenway: Street ends, Cochran to Fairfax	203586 11.2 acres	Bio-retention in parkway with drains, vegetated swales, green street medians	Los Angeles	1, 2
9	Ballona Greenway: Fairfax Ave & Apple St	203979 20.5	Permeable pavement, bio-retention in parkway connected via drains, vegetated swales	Los Angeles	1, 2

Table 5-2 (Continued)
Summary of Phase 1 Distributed BMP Sites in Ballona Creek Bacteria, Metals and Estuary Toxic Pollutants TMDL Implementation Plans[1]

Site ID[2]	Title/Location	Catchment #/ Catchment Area	BMP/Project Description	Jurisdiction	Other IWRA Benefits[3]
10	Ballona Greenway: Fairfax Ave & 10 Fwy, including Ballona Narrows Park	203980 52.0 acres	Permeable pavement, bio-retention facilities	Los Angeles	1, 2
11	Ballona Greenway: Jefferson Blvd at Ballona Creek	206647 38.2 acres	Bio-retention in parkway with underdrains, permeable pavement, green street medians	Culver City	1, 2
12	Baldwin to Ballona Trail: Between Rodeo Rd & Jefferson Blvd east of La Cienega	206625 30.4 acres	Permeable Pavement, bio-retention, green street medians, bio-retention on parkway w/underdrains, vegetated swales	Los Angeles	1, 2
13	Ballona Greenway: Duquesne Ave at Ballona Creek	206698 6.8 acres	Permeable pavement, vegetated swales, bio-retention in parkway w/underdrains	Culver City	1, 2
14	Martin Luther King Jr. Dr. & Crenshaw Blvd	206562 30.2 acres	Permeable pavement, vegetated swales, cisterns	Los Angeles	1, 2, 4
15	Ballona Greenway: Ballona Creek near Sepulveda Blvd	207618 36.7 acres	Permeable pavement, bio-retention in parkway with underdrains, vegetated swales, bio-retention	Culver City	1, 2
16	Mar Vista Oval Street Project: Mar Vista Oval St & Venice Blvd	208701 27.8 acres	Bio-retention in parkway w/underdrains	Los Angeles	1
17	Ballona Greenway: Lindberg Park at Ballona Creek near Sepulveda Blvd	207628 32.2 acres	Bio-retention in parkway with underdrains, permeable pavement	Culver City	1, 2
18	405 Fwy & Sunset Blvd	208374 33.6 acres	Vegetated swales, bio-retention facilities	Los Angeles/Caltrans	1
19	Venice Blvd: Wade St to Walgrove Ave	180101 21.8 acres	Bio-retention facilities	Los Angeles	1
20	S Vermont Ave & W Pico Blvd	200753 6.5 acres	Permeable pavement, bio-retention in parkway with underdrains	Los Angeles	1, 2

21	N Fairfax Ave & Rosewood Ave	204074 35.7 acres	Bio-retention in parkway with underdrains, pervious pavement	Los Angeles	1, 2

Table 5-2 (Continued)
Summary of Phase 1 Distributed BMP Sites in Ballona Creek Bacteria, Metals and Estuary Toxic Pollutants TMDL Implementation Plans[1]

Site ID[2]	Title/Location	Catchment #/ Catchment Area	BMP/Project Description	Jurisdiction	Other IWRA Benefits[3]
22	S San Pedro St & E 30th St	205439 17.1 acres	Bio-retention in parkway with underdrains, pervious pavement	Los Angeles	1, 2
23	110 Fwy & W 30th St	205717 26.3 acres	Pervious pavement, bio-retention in parkway with underdrains, cisterns	Los Angeles/Caltrans	1, 2, 4
24	S Western Ave & Exposition Blvd	205819 19.7 acres	Pervious pavement, cisterns	Los Angeles	1, 2, 4
25	W Jefferson Blvd & Rodeo Dr	206670 35.2 acres	Vegetated swales	Culver City / Los Angeles	1, 2
26	W Beach Ave & W Hazel St	208829 37.2 acres	Permeable pavement, bio-retention facilities	Inglewood	1, 2
27	S La Cienega Blvd: W 58th Pl to W Fairview Blvd	208938 32.3 acres	Bio-retention facilities	Los Angeles County / Los Angeles / Inglewood	1

Notes:
[1]The BMPs listed here will reduce both metals, bacteria and sediments containing toxic pollutants.
[2] Site numbers correspond to sites shown in Figure 5-1
[3] Integrated Water Resources Approach (IWRA) Criteria (Basin Plan Amendment Attachment A to Resolution No. 2006-011, p.7):

1. ***Provides reductions in other pollutants***
2. ***Provides groundwater recharge benefits***
3. ***Provides multi-use benefits***
4. ***Provides beneficial reuse of urban runoff***

.

Table 5-3
Summary of Phase 1 Regional BMP Sites in Ballona Creek Bacteria, Metals and Toxic Pollutants
TMDL Implementation Plans[1]

Site ID[2] (Figure ID)	Title	Catchment #/ Tributary Drainage Area	BMP Description/Footprint Area	Jurisdiction	Other IWRA Benefits[3]
A (Figure G-28)[4]	Centinela Park (Centinela Ave & Florence Ave)	208805 736 acres	Sub-Surface Flow Wetland with Storage – 20 acres	Inglewood	1, 2, 3
B (Figure G-29)	La Cienega Park (La Cienega Blvd & Olympic Blvd)	204346 374 acres	Multi-Use, Sub-Surface Detention Basin – 5.1 acres	Beverly Hills	1
C (Figure G-30)	Harvard Recreation Center (Harvard Blvd & 61st St)	206172 235 acres	Multi-Use, Sub-Surface Detention Basin – 4.6 acres	Los Angeles Council District 8	1
D (Figure G-31)	Rancho Cienega Sports Center	206496 162 acres	Multi-Use Subsurface Detention Basin – 4.3 acres	Los Angeles Council District 10	1, 3
E (Figure G-32)	MacArthur Park (Alvarado St & 6th St)	200624 135.5 acres	Bio-retention Basin with Under Drains – 3 acres	Los Angeles Council District 1	1, 2, 3
F (Figure G-33)	Los Angeles Unified School District Site (Los Angeles and 23rd St)	205397 99 acres	Multi-Use, Sub-Surface Detention basin – 8.3 acres	Los Angeles Council District 9	1
G (Figure G-34)	Lemon Grove Recreational Center (Lemon Grove Ave & 101 Fwy)	200283 63.2 acres	Extended Detention Basin – 0.4 acres	Los Angeles Council District 13	1, 3
H (Figure G-35)	Van Ness Recreation Center and Street Median (W. Slauson Ave and 2nd Ave)	206223 36 acres	Stormwater Drywell Infiltration System – 0.5 acres	Los Angeles Council District 8	1, 2

Notes:
[1]The BMPs listed here will reduce both metals, bacteria and sediment containing toxic pollutants.
[2] Site numbers correspond to sites shown in Figure 5-1. Site layout figures can be found in Appendix G
[3] Integrated Water Resources Approach (IWRA) Criteria (Basin Plan Amendment Attachment A to Resolution No. 2006-011, p.7):

1. Provides reductions in other pollutants
2. Provides groundwater recharge benefits
3. Provides multi-use benefits
4. Provides beneficial reuse of urban runoff

[4] Figures can be found in Appendix G.

5.1.2.3 Additional Future Projects

Section 5.1.2.2 describes the priority projects planned for implementation. However, it is expected that many additional BMP projects will need to be implemented to meet TMDL compliance requirements. The estimated level of implementation required, sorted by land use, is summarized in Table 5-4. As shown, runoff from 11,300 acres, or 13.9 percent of the Ballona Creek watershed, will need to be treated by distributed BMPs in order to meet the TMDL limits. Many of these projects are implemented as a result of SUSMP, and as such, these projects are currently ongoing and therefore are included in all phases of the Implementation Plan. Refer to Section 5.2 for further discussion.

During the development of this Plan, additional specific structural BMP projects were identified that may be implemented after priority projects are completed, provided conditions at these sites do not change in the interim. Alternatively, if during design, a priority project is deemed unsuitable, then one of these projects could be implemented instead, upon further investigation. These projects are summarized as follows: (a) Stakeholder BMP projects, Table D-1 in Appendix D; (b) Regional BMPs, Table F-1 in Appendix F; and (c) Distributed BMPs, in Appendix F (summary of field investigations at approximately 70 catchments throughout the watershed).

Table 5-4
Summary of Phase 2 Distributed BMP Implementation Levels

Distributed BMPs	% of Land Use Treated	Acres Treated	% of Watershed
Commercial	17%	1,861	2.3%
Green Streets	15.4%	1,691	2.08%
SUSMP Redevelopment	1.6%	170	0.21%
Education	4%	108	0.1%
LAUSD and UCLA	3.6%	92	0.11%
SUSMP Redevelopment (Private Schools)	0.6%	16	0.02%
Industrial	6%	214	0.26%
Green Streets	1.9%	74	0.09%
SUSMP Redevelopment	3.7%	140	0.17%
Transportation	27%	453	0.6%
Class A Catchments (high priority/high opportunity)	22.8%	377	0.46%
Class B Catchments (high priority/low opportunity)	4.6%	76	0.09%
Single Family Residential	19%	5,683	7.0%
Green Streets	10.1%	3,077	3.78%
Downspout Disconnect	8.6%	2,607	3.20%
Multiple Family Residential	16%	2,919	3.6%
Green Streets	11.4%	2,039	2.50%
SUSMP Redevelopment	4.9%	880	1.08%
Total Distributed		11,200	13.8%

Note: for Distributed BMPs designated as SUSMP redevelopment, it is assumed that these acres will be retrofit at the expense of the property owner, as described in the SUSMP program.

5.1.3 New Dry Weather Low Flow Treatment Facilities

This Implementation Plan includes the construction of up to two LFTFs in the watershed. The purpose of these LFTFs is to provide an additional reduction in pollutant concentrations (including sediments containing toxic pollutants) during dry-weather conditions (Figure 5-2).

Since the Toxics TMDL requires that the annual loading of sediment bound toxic pollutants be below the WLAs defined in the TMDL, by reducing the loading of sediments from the dry weather flows, the total load will be reduced in the estuary. Essentially, a portion of sediment from dry weather flows will be removed by the LFTF and not reach the estuary. However the amount of sediment expected to be removed from the dry weather flow has not been quantified. Therefore, for the purpose of the Toxics TMDL Implementation Plan, it is assumed that the LFTF treatment will provide an additional factor of safety in the removal of the toxic pollutants listed in the TMDL.

It should be noted that since these diversion facilities are not able to treat flows upstream of the diversion point, the other non-structural and structural BMPs being implemented upstream are intended to manage the pollutant loading from the upper Ballona Creek watershed to meet the requirements of the Bacteria, Metals and Toxics TMDLs. Below is a description of the planned diversion facilities.

The average dry weather flow in Ballona Creek is approximately 29 cfs based on a dry weather flow rate of 230 gallons/day/acre (CREST, 2005). It is expected that over time with implementation of institutional and structural BMPs in the watershed, the volume of dry weather flow will gradually decline, resulting in even less flow in Ballona Creek. Institutional BMP activities and structural BMPs in this Implementation Plan are projected to reduce 2013 urban runoff levels by approximately 4.2 cfs (2.7 mgd) and 0.4 cfs (0.26 mgd), respectively. However, even with this reduction in urban dry weather flow to Ballona Creek, the toxic sediment concentrations of the remaining dry weather runoff may be a concern because there will still be significant upstream drainage areas where implementing effective urban runoff controls is not feasible. To supplement planned watershed BMP activities, the Implementation Plan includes up to two LFTF projects to achieve compliance with dry weather limits, Figure 5-2. Conceptually, the primary LFTF projects are described as follows:

- *LFTF-1* – This LFTF would be constructed at a location adjacent to the North Outfall Treatment Facility (NOTF) to capture, pump and treat dry weather flows from the Hollywood, Cienega and Culver City sub-watersheds. Treated dry weather flows that comply with the bacteria and metals water quality objectives will be discharged back to Ballona Creek.

- *LFTF-2* – This LFTF would be constructed at a location along Sepulveda Channel to treat flows prior to discharge to Ballona Creek. The captured dry weather flow will be diverted into a double infiltration trench with additional irrigation application in adjacent landscaped areas.

Conceptual drawings for these two LFTFs are shown in Appendix I. LFTF-1 include alternatives that were developed as part of the Ballona Creek Treatment Facility Feasibility Study and Preliminary Design report (Los Angeles, 1996). These alternatives, as well as the layout for LFTF-2, are subject to change during the design phase. Consultation with appropriate local, state and federal agencies (e.g. the Department of Fish and Game) will occur during planning and design to ensure that requirements for wild life and other beneficial uses are met.

Detailed Description of LFTF-1

A dry weather diversion in Ballona Creek will be constructed adjacent to the existing NOTF. Retained flow would be pumped to the NOTF for treatment and downstream release or reuse. The NOTF is located approximately ½ mile upstream of the Overland Avenue crossing, near Jackson Avenue, on the south bank of Reach 2 of Ballona Creek (Figure 5-2). The facility is owned by the City of Los Angeles; originally it was constructed between 1986 and 1987 to detain and provide partial treatment of sanitary sewer overflows to Ballona Creek. Improvements to the City's interceptor sewer system, in particular construction of the North Outfall Relief Sewer, substantially reduced the potential that the NOTF would be needed for its intended purpose of treating sewage overflows. Later, recognizing the need to evaluate options for improving water quality in Ballona Creek, the City prepared a feasibility study and preliminary design report in 1995 to assess the potential for using this facility to capture and treat dry weather runoff flows and a portion of wet weather runoff flows.

As constructed, the facility can provide 1 million gallons of storage capacity and has a capacity for treatment of up to 150 cfs-, including screening (course and fine screens) and disinfection (with sodium hypochlorite, NaOCl) (City of Los Angeles, 1996). At this time, the NOTF is not currently in use. With this facility already in place, implementing this BMP would require the construction of a diversion structure at a location adjacent to the NOTF, and associated pump stations and conveyances.

This LFTF will capture 100 percent of the dry weather flows in Ballona Creek at the diversion point. Flow data from each Ballona Creek sub-watershed is somewhat limited. However, since approximately 65 percent of the Ballona Creek Watershed is upstream of NOTF (City of Los Angeles, 1996) and since the total dry weather flow in Ballona Creek, as stated above, is 29 cfs, the portion of the flow that is upstream of NOTF is approximately 19 cfs. Assuming that approximately 16 percent of the upstream flow would be reduced through the implementation of institutional and structural BMP programs, the average dry weather flow available for capture and diversion from upstream subwatersheds to the NOTF is 15.9 cfs. Treatment at the NOTF will involve filtration to remove sediments and associated metals to levels below water quality objectives and disinfection to comply with Bacteria TMDL numeric limits. Treated dry weather flow would be discharged to Ballona Creek. However, additional options for the treated water include:

- *LFTF-1 Implementation, Option 1* - This option considers upgrading the NOTF to allow reuse of a portion of the captured dry weather flow. If implemented, additional treatment facilities will be constructed to achieve water quality equivalent to Title 22 requirements for unrestricted irrigation. A portion of the captured dry weather flow will be diverted for reuse and a portion will be discharged to Ballona Creek. The relative portion of captured dry weather flow used for reuse vs. discharged to Ballona Creek will vary by season and demand for water reuse. Assuming an average captured flow of 15.9 cfs (as described above); if this option is implemented at least 7 cfs will at all times be returned to Ballona Creek.

- *LFTF-1 Implementation, Option 2* – This option would utilize the 1 million gallons of available storage, and would requires that the NOTF be operated in a manner that allows for the diversion, treatment and return of as much wet weather flow as possible without construction of additional storage. Using the available storage and screens with additional retrofit facilities, it was previously estimated that the

NOTF could be operated to manage and partially treat up to 150 cfs of wet weather flow. This would be approximately equivalent to the flow in Ballona Creek at that location resulting from a rainfall event in the range of 0.15 – 0.2 inches. The responsible jurisdictions will consider incorporating this operational element into this BMP as they evaluate water quality benefits gained from implementation of other elements of its wet weather management program.

Detailed Description of LFTF-2

A second LFTF will be constructed to divert flow from Sepulveda Channel to the "oval" streets, which are East Boulevard, Park Avenue and Marcasel Avenue. The proposed diversion would consist of a 4.5-mile long double infiltration trench with an irrigation element. The project could be implemented in three phases, with each phase consisting of approximately 1.5 miles of retrofit.

Sepulveda Channel flows as a rectangular open channel for 1.2 miles from Military Ave and Queensland St before flowing as an underground channel from Venice Blvd and McClaughlin Ave. It reemerges as a rectangular open channel at Washington Blvd and McClaughlin Ave before discharging into Ballona Creek 0.8 miles downstream. Tributary area for Sepulveda Channel is approximately 18 percent of the total watershed or 14,760 acres (Bacteria CMP, City of Los Angeles). Using dry-weather runoff generation rate of 230 gal/acre/day (CREST, 2005), Sepulveda Channel discharges approximately 5.25 cfs of flow into Ballona Creek Reach 2.

Implementation of LFTF-2 requires limited infrastructure – construction of an interception and diversion facility to divert flow from Sepulveda Channel at Venice and McClaughlin, pump station, and conveyance to the location of the infiltration trench. LFTF-2 is expected to divert and treat approximately 2.5 cfs dry-weather flow. Treated water will flow back into the Channel at Washington Blvd. Further details are provided in Appendix I (under Option 2 for LFTF-2).

LFTF Implementation Assumptions

Timely implementation of LFTF BMPs is based on the following three critical assumptions:

- Diversion of dry weather flow from Ballona Creek does not adversely impact beneficial uses within the Ballona Creek Estuary. Various investigations over the years have generally demonstrated that flow in the estuary is dominated by tidal flow; the fresh water outflow from Ballona Creek during non-storm flow conditions is confined to a narrow freshwater lens near the surface of the estuary. Therefore, it is assumed that estuarine conditions will not be significantly affected by a reduction of small amount of dry weather flows.

- Implementation of a diversion, treatment, and discharge facility for LFTF-1 does not result in a requirement for the NOTF facility to obtain an NPDES permit for the discharge of treated stormwater back to Ballona Creek (Note: However, if the facility is upgraded to allow reuse of treated dry weather flow, then Waste

Discharge Requirements developed with input from California Department of Public Health would need to be obtained for implementation of the reuse option).

- Monitoring for compliance with the TMDL for corresponding reaches may be conducted downstream of the two LFTF locations.

Issues related to permitting, public outreach, and environmental impact of the LFTFs will be investigated and addressed during pre-design phase of the structures.

5.2 Quantification of Water Quality Benefits

5.2.1 Methodology

The Ballona Creek Toxics TMDL limits the loading of sediment bound toxic pollutants discharged into the estuary. The amount of sediment removal from implementation of BMPs in the watershed is converted to removal of toxic pollutants by multiplying the total sediment removed by the measured concentration (mg of each toxic/kg of total sediment) of each toxic pollutant of concern in sediments from the Ballona Creek Estuary. Following is a description of the method used to determine the potential amount of sediment removed by BMPs in this Implementation Plan from the baseline load. Section 5.2.2 compares the load removed to the Toxics TMDL WLAs.

Potential sediment reductions associated with the proposed structural BMPs were quantified using SBPAT (Section 4 and Appendix E and L). Sediment reduction from institutional BMPs was only quantified for enhanced street sweeping by using a spreadsheet model that accounts for predicted performance based on literature values, mass balance accounting, and best professional judgment. The predicted sediment reductions associated with the proposed structural and institutional BMPs were then combined to estimate the range of progress towards reducing sediment loading to the Ballona Creek Estuary.

The BMP performance and pollutant load reductions are based on the effluent concentrations of the target pollutants. Load reduction values are expressed in high, low and average values in Section 5.2.2.2. For the purpose of compliance analysis, average values are used in this Implementation Plan.

In order to ensure that load reductions at 100 percent compliance point were not overestimated, the analysis ensured that load reductions in any given catchments of the watershed were not double counted. For example, in areas where a regional or distributed BMP was installed, no credit was taken for load reductions from institutional BMPs. Further, where a regional BMP was installed, also no credit was taken in the entire tributary area of the regional BMPs for load reductions due to any distributed BMPs.

The general approach taken to quantify pollutant reductions is as follows:

- Pollutant reductions by the year 2021 are quantified for the implementation of institutional BMPs, regional BMPs, and distributed BMPs, described in Sections 5.1.1 through 5.1.3 and Section 4.3.

- Estimated sediment removal from institutional BMPs, regional BMPs, and distributed BMPs are evaluated together to predict the total sediment load reduction for the entire watershed. **The catchment areas tributary to each treatment BMP and the implementation areas for institutional BMPs were assumed to not overlap to avoid over-predicting load reductions.**

- The predicted BMP sediment reduction results for the watershed are summarized in terms of average annual load reduction. Ranges of potential annual load reductions are also provided to show the variability in results.

- Predicted sediment load reductions were subtracted from the baseline sediment loading to estimate post-BMP sediment loading to the estuary.

- Based on the sediment characterization presented in Section 2, the concentration (mg/kg) of each 303(d) listed toxic pollutant was applied to the predicted post-BMP sediment load to estimate post-BMP toxic pollutant loading

- Predicted toxic pollutant loads to the estuary were compared with the Toxics TMDL WLAs to evaluate compliance.

5.2.1.1 Institutional BMPs

Institutional BMPs reduce pollutant loads by either reducing the source of a pollutant or capturing built-up pollutants before they can be washed off by stormwater. Quantifying the sources of metals and organics in urban watersheds is difficult because sources and activities that mobilize different metals and organics are numerous and diverse. Nationwide, watershed management plans identify vehicle brake pads, tire tread, roadway sediment, used motor oil, and building materials as significant sources of metals in urbanized watersheds. Reductions of copper, lead, and zinc from these pollutant sources can be achieved by implementing institutional BMPs. Pesticide use is a major cause of toxicity caused by organic toxic pollutants. Finding alternatives and educating the public on the proper use of material with these pollutants are ways that the discharge of these pollutants can be reduced.

Institutional BMPs reduce pollutant loads by either reducing the source of a pollutant or capturing built-up pollutants before they can be washed off by stormwater into local waterbodies. Estimating the pollutant load reduction achieved through the implementation of these BMPs involves two distinct computations:

- Pollutant Buildup – Determining the relative contribution of the pollutant from a targeted source to the watershed land surface.

- Pollutant Wash-off – the transport of pollutants from the watershed surface to downstream waterbodies.

Load Quantification Methodology

A total of 57 years of historical rainfall records were used to estimate the buildup of metals from controllable sources prior to a storm event (Pt), as a function of preceding dry days (DD). Using SBPAT, watershed-wide hydrologic simulations were used to estimate runoff volumes for distinct storm events in the historical rainfall record. The produced time series of discrete runoff events were then used in a spreadsheet model to estimate the wash-off of pollutants from the watershed surface (W), as a function of runoff depth (R). Numerous studies have found that pollutant buildup and wash-off are most appropriately estimated using non-linear relationships. Pollutant buildup occurs at the fastest rate in the initial days following a wash-off event, but decline as buildup approaches the maximum carrying capacity (Pmax) for the watershed over longer dry periods (Sartor and Boyd, 1972; EPA NURP Study, 1983). Maximum possible mass build-up occurs after approximately 20 dry days within an urban watershed (Pitt and Shawlee, 1982). These studies also show that the greatest amount of pollutant wash-off occurs with the first ½ inch of runoff, with lower wash-off rates associated with each increment of additional runoff. Therefore, exponential functions were used to estimate pollutant buildup and wash-off associated with specific sources of metals in the watershed. These exponential functions are consistent with the TMDL model (SCCWRP, 2004) and other researchers (Chen and Adams, 2006) and include:

$$P_t = P_{\max} * [1 - e^{(-k_b * DD)}] + [P_{t-1} - W_{t-1}] * e^{-k_b * DD}$$
$$W_t = P_t * [1 - e^{(k_w * R)}]$$

Where:
P_t is the pollutant buildup for the current storm (lbs)
$P_{\max}$ is the maximum possible mass build-up (lbs)
k_b is the build-up rate coefficient (hr^{-1})
P_{t-1} is the pollutant build-up of the previous storm (lbs)
W_{t-1} is the pollutant wash-off of the previous storm (lbs)
DD is the dry interevent period (hr)
k_w is the wash-off rate coefficient (in^{-1})
R is the runoff depth (in)

Pollutant buildup and wash-off analyses were completed for street sediment to quantify water quality benefits associated with enhanced street sweeping.

Water quality benefits from other institutional BMPs included in this TMDL Implementation Plan (See Section 5.1.1 and 4.3) were not quantified due to limited available data. -Water quality monitoring will determine if these non-quantified BMPs provide an additional benefit, which could translate into a reduction in the need for structural BMPs to comply with later compliance milestones.

Enhanced Street Sweeping

Metals and organics released to the urban environment during dry weather conditions are likely to adsorb on street sediments, and can then be transported to downstream waterbodies (Golding, 2006). The City of Los Angeles Bureau of Street Services (BSS) currently operates a street sweeping program that includes over 130 mechanical broom sweepers with a staff of over 100 operators. Citywide, BSS conducts Routine Street sweeping for 7,600 curb-km of posted streets on a weekly basis, and an additional 13,000 curb-km of non-posted or arterial streets on a monthly basis. Approximately 6,500 curb-km (4,000 curb-mi) of these swept roads (both weekly or monthly frequency) are within the City's portion of the Ballona Creek Watershed.

Several alternatives exist for BSS to enhance its program by capturing more sediment for roads within the City, including increased frequency of sweeping on non-posted roadways or replacement of aging mechanical broom sweepers within the current fleet with new more efficient types of street sweepers. The City of Dana Point doubled sediment removal by increasing street sweeping from biweekly to weekly (Dana Point 2005). Several studies comparing mechanical broom sweepers to newer high efficiency alternative equipment have shown increases in sediment removal of 35 percent (Pitt 2002), 15 to 60 percent (Minton 1998), and up to 140 percent (Schwarze Industries). This TMDL Implementation Plan uses a conservative target of increasing current sediment removal by 15 percent with enhancements to street sweeping. Appendix J provides an analysis of the number of additional curb-miles that would need to be swept to achieve this goal of increasing street sweeping by 15 percent. Additional studies and potential pilot programs, working closely with BSS, will be necessary to evaluate the most effective and suitable approach to achieve this target.

Findings of local studies of accumulation rates provide necessary information to quantify the sediment loading. Sartor and Gaboury (1984) estimated sediment accumulation for impervious surfaces to range from 12 to 21 kg/curb-km/day. In a more recent study to support the Brake Pad Partnership in California, Rosselot (2007) measured a street sediment accumulation rate of 14 kg/curb-km/day. Using this rate of accumulation for 20 days following a wash-off event, and the estimated 6,500 curb-miles within the City's portion of the Ballona Creek Watershed, a maximum carrying capacity of sediment on streets within the watershed is approximately 1.8 million kg. The mass of accumulated sediment on a given day is an exponential function of this maximum carrying capacity and the number of dry days prior to the event, plus the residual pollutant not washed off during the preceding runoff event.

The predicted additional average annual sediment load reduction achieved by increasing street sediment removal by 15 percent from current levels based on the load quantification methodology described above is approximately 42 tons per year (tons/yr).

5.2.1.2 Structural BMPs

The BMP modeling and analysis component of SBPAT, also referred to as the Nexus Tool, utilizes a modified U.S. EPA Storm Water Management Model (SWMM) and a Monte Carlo water quality model to predict average annual runoff volumes and loads from user-specified urban drainage areas. Appendix B of the SBPAT user document (which is included in Appendix L of this Implementation Plan) summarizes the modeling approach and assumptions of SBPAT. Appendix C, Section 3.2 Table C-10 and C-11 summarizes the input data sets including the mean land use EMCs and mean BMP effluent concentrations, as well as standard deviations associated with each. Both regional and distributed BMPs were modeled using the Nexus Tool with an assumed design storm volume of 0.75 inches for volume-based BMPs and an assumed design storm intensity of 0.2 inches per hour for flow-based BMPs[1], except where specifically noted for regional BMPs in Table 5-5 below. It should be noted that the SBPAT model explicitly accounts for the effects of storm size in relation to the BMP design capacity through the use of continuous simulation. Storms that exceed the storage capacity of the BMP will bypass untreated stormwater whereas storms that do not exceed the storage capacity will not. The variability in effluent quality is accounted for through the use of the Monte Carlo water quality simulations. While the treated effluent quality is not explicitly tied to the storm size, the variability of effluent concentrations included in the model are based on a wide range of storm sizes and resulting BMP effluent EMCs reported in the International Stormwater BMP Database. Thus, the SBPAT model accounts for many sources of variability including storm size when it computes load reduction estimates for BMPs.

[1] BMPs will be designed to treat the achievable tributary area given site constraints, such as topography, soils, and existing infrastructure, with the goal of treating storm sizes of 0.5-1 inch.

Table 5-5
Regional BMP Sites Modeled with the Nexus Tool

Site Location	Proposed BMP(s)	BMP Sizing Assumptions/Available BMP Area	Drainage Catchment Area (ac)[1]	Drainage Catchment Imperviousness
Centinela Park (Figure G-28)	Subsurface Flow Wetland with Equalization Storage	Tributary area-limited; assumed 0.75 inch design storm. Treatment flow rate equal to 24-hour drain time of subsurface storage. Area of subsurface flow wetland based on an estimated media porosity of 0.3, an average depth of 6 feet, and a 24-hour residence time. 20 acres available.	736	48%
La Cienega Park (Figure G-29)	Multi-Use Detention Basin	Tributary area-limited; assumed 0.75 inch design storm with 4 foot average ponding depth and a 48-hour drain time. 5.1 acres available.	374	78%
Harvard Recreation Center (Figure G-30)[2]	Multi-Use Detention Basin	BMP area limited; 4 foot volume depth. 6 foot average ponding depth and a 48-hour drain time. Approximate design storm is 0.4 in. 4.6 acres available.	235	63%
Rancho Cienega Sports Center (Figure G-31)	Multi-Use Detention Basin	Tributary area-limited; assumed 0.75 inch design storm with 4 foot average ponding depth and a 48-hour drain time. 4.3 acres available.	162	55%
MacArthur Park (Figure G-32)	Multi-Use Bio-retention with Underdrain	BMP area-limited; Volume equal to 18 inch ponding depth over 3 acre BMP area could be collected and treated. Treatment flow rate equivalent to a 2 in/hr filtration rate to underdrain. Approximate design storm is 0.5 in. 3 acres available.	135	85%
Los Angeles Unified School District Site (Figure G-33)	Multi-Use Detention Basin	Tributary area-limited; assumed 0.75 inch design storm with 4 foot average ponding depth and a 48-hour drain time. 8.3 acres available.	99	90%
Lemon Grove Recreation Center (Figure G-34)	Subsurface Detention Basin	BMP area-limited; Volume equal to 4 foot average ponding depth over 0.4 acre BMP area could be treated. 48-hour drain time. Approximate design storm is 0.4 in. 0.4 acres available.	63	71%
Van Ness Recreation Center and Street Median (Figure G-35)	Stormwater Drywell Infiltration System	BMP area limited; SUSMP volume with 4 foot average ponding depth and a 48-hour drain time. Approximate design storm is 0.4 in. 0.5 acres available.	36	73%

[1] The estimated drainage areas were based on existing catchment delineation.
[2] Figures can be found in Appendix G.

Regional BMPs

The priority regional BMP sites identified in Section 5.1.2.2 were selected for analysis using the Nexus Tool. Available BMP footprint areas and approximate tributary drainage areas were identified to estimate whether each BMP site could accommodate the 0.75-inch assumed design storm volume. Of the eight sites that were evaluated, Lemon Grove Recreation Center, MacArthur Park, Harvard Recreational Center, and Van Ness Recreational Center are area-limited, that is, the tributary catchment area is large in comparison to the area available to site the treatment BMP, so the design storm volume for these sites will be less than 0.75 inches. Table 5-5 summarizes the eight regional BMPs and sizing assumptions. Based on these assumptions, the total estimated catchment area tributary to these eight regional BMPs is approximately 1,840 acres (approximately 2.3 percent of the 82,000 acre watershed).

Distributed BMPs

Distributed BMP implementation levels were assigned for each of the following six primary land use categories: a) commercial, b) education, c) industrial, d) transportation, e) multi-family residential (MFR), and f) single family residential (SFR). The remaining land uses within the watershed include agriculture, open water, and vacant.

Private and public parcels within each land use category were identified by merging the Los Angeles County assessor's parcel database with the SCAG land uses. The merged datasets were also used to estimate the percent of each land use that consisted of roadways and rooftops. The transportation land use category consists only of major roadways (i.e., Caltrans parcels, primary highways, and arterials), while smaller secondary streets are included in each of the other land uses. Additional spatial analyses were conducted to identify parcels owned by specific public agencies such as the Los Angeles Unified School District (LAUSD). Agricultural and open water land uses areas within the watershed were not assigned distributed BMPs; institutional BMPs will be applied to these areas.

Agricultural lands are comprised of arboreta, nurseries, horse ranches, and orchards/vineyards, which have low imperviousness and make up a very small proportion of the watershed (0.04 percent). Open water comprises 0.4 percent of the watershed. Vacant land areas (17 percent of the watershed) are comprised of privately-owned parcels that are undeveloped and publicly-owned vacant parcels and open space. Privately-owned vacant parcels were assumed to be developed by 2021 and, as such, those parcels would be required to implement the new development stormwater treatment requirements (SUSMP requirements), such that the net change in runoff volumes and pollutant loads after development of these parcels would be negligible. Publicly-owned vacant parcels and open space were assumed to remain undeveloped.

The type of distributed BMPs and the extent of implementation vary among the six primary land uses based on catchment priority, parcel ownership type, field-identified opportunities, and programmatic-level assumptions. The levels of distributed BMP implementation applied to each land use category and the assumptions used in the Nexus modeling are summarized below.

Land Use Category: Commercial

Redevelopment of Commercial Parcels

- The rate of commercial parcel redevelopment was estimated based on the City of Los Angeles redevelopment project records between 2003 and 2009.
- The average number of redevelopment projects for automotive, retail gas, restaurants, and parking SUSMP classes [10 projects] and commercial projects [15 projects] was assumed to occur each year for 10 years.
- The average redevelopment project size is 0.25 acres for automotive, retail gas, restaurants, and parking lots and 1 acre for commercial projects.
- Distributed BMP type and relative implementation levels were based on the median levels recommended from the field investigations [47 percent swales, 21 percent cisterns, 19 percent bio-retention, and 13 percent permeable pavement].
- Using the above assumptions, approximately 17 acres of commercial land use will be redeveloped to SUSMP standards per year for 10 years [*170 acres treated by 2021*].

Green Street Projects in Commercial Areas

- 35 percent of the commercial land use area is roadways.
- Green street projects will accept 50 percent additional non-roadway drainage area from adjacent parcels, on average.
- Green street projects will incorporate bio-retention (50 percent) and vegetated swales (50 percent).
- 30 percent of roadways within the commercial land use will be retrofitted as green streets over 10 years [*1,691 acres treated by 2021*].

Land Use Category: Industrial

Redevelopment of Industrial Parcels

- The rate of industrial redevelopment was estimated based on the City of Los Angeles redevelopment project records between 2003 and 2009.
- The average number of industrial redevelopment projects is 7 per year.
- Average industrial redevelopment project size is 2 acres.

- Distributed BMP type and relative implementation levels were based on the median levels recommended from the field investigations [47 percent swales, 21 percent cisterns, 19 percent bio-retention, and 13 percent permeable pavement].

- Approximately 14 acres of industrial land use will be redeveloped to SUSMP standards per year for 10 years [*140 acres treated by 2021*].

Green Street Projects in Industrial Areas

- 4 percent of the industrial land use is roadways.

- Green street treatment would be sized to accept 50 percent additional non-roadway drainage area.

- Green street treatment achieved through equal implementation of bio-retention (50 percent) and vegetated swales (50 percent).

- 30 percent of roads within the industrial land use will be retrofitted as green streets over 10 years [*74 acres treated by 2021*].

Land Use Category: Transportation Land Use Areas

- The level of distributed BMP implementation for transportation land use areas within the watershed was based on the results of the BMP implementation field investigations.

  - Class A: High priority catchments with both catchment prioritizations index (CPI) and BMP opportunity scores ≥ 3.

  - Class B: High priority catchments with CPI ≥ 3 and BMP opportunity scores ≤ 2.

- 50th percentile levels of implementation from the range of distributed BMP implementation results from the field investigations were applied to Class A catchment areas [46 percent swales, 42 percent bio-retention, and 12 percent permeable pavement].

- 25th percentile levels of implementation from the range of distributed BMP implementation results from the field investigations were applied Class B catchment areas [59 percent swales, 24 percent bio-retention, and 17 percent permeable pavement].

- 377 acres in Class A, 76 acres in Class B would be treated over 10 years [*453 acres treated by 2021*]

Land Use Category: Education

Redevelopment of Education Parcels

- Rate of private education redevelopment assumed to be approximately equal to commercial redevelopment rate of 2.5 percent per year.

- Distributed BMP type and relative implementation for private schools were based on the median levels recommended from the field investigations in commercial land uses that were applied to private education land uses [47 percent swales, 21 percent cisterns, 19 percent bio-retention, and 13 percent permeable pavement].

- The LAUSD is currently engaged in a school construction building program. By approximately 2013, LAUSD will complete the construction of 132 new schools to accommodate growth in the student population. New schools and site expansions will require the acquisition of over 450 acres of land. The New Construction Program is composed of 417 overall projects, which include the new schools, 64 additions, 38 early education centers and expansions, and a variety of other projects.

  - New schools and expansion are assumed to redevelop existing urban parcels, equally distributed throughout the District.

  - 17 percent of LAUSD falls within the Ballona Creek Watershed, therefore approximately 67 acres will be developed as part of the New Construction Program.

- Based on the long range plan, the estimated redevelopment rate for UCLA is approximately 5 percent.

- No significant redevelopment or retrofit of the Culver City Unified School District or the Beverly Hills Unified School District was assumed.

- Public schools (LAUSD and UCLA) were assumed to implement bio-retention.

- Approximately 16 acres of private education land use will be redeveloped to SUSMP standards and approximately 92 acres of public education land use area will be treated by 2021 [*108 acres treated by 2021*].

Land Use Category: Single Family Residential (SFR)

Roof Downspout Disconnection

- 35 percent of SFR land use area is roof area (consistent with the median building footprint of SFR parcels of 25 percent, SCAG area weight imperviousness of 40 percent, and zoning set back requirements that would lead to 37 percent roofs for a standard lot size).

- SFR rooftops will be disconnected and routed into bio-retention cells via a Roof Downspout Disconnection Program.

- The roof downspout disconnection rate will be 33 percent within 10 years [*2,607 acres treated by 2021*].

Green Street Projects in Single Family Residential Areas

- 23 percent of the SFR land use is roadways and 50 percent of the SFR land use area drains or can be routed to the roadway.

- Green street treatment will be achieved through equal implementation of bio-retention (50 percent) and vegetated swales (50 percent) for the roadways and permeable pavement for alleys.

- 30 percent of the roadway area within the SFR land use area within the watershed will be retrofit within 10 years [*3,077 acres treated by 2021*].

Land Use Category: Multifamily Residential (MFR)

Redevelopment of MFR Parcels

- The rate of MFR redevelopment was estimated based on the City of Los Angeles redevelopment project records between 2003 and 2009. SFR projects subject to SUSMP (projects less than 10 residential units) as specified in the City records were considered MFR in this analysis.

- An average of 39 "10+ Unit" projects were redeveloped annually from 2003 to 2009. The average "10+" unit project size is approximately 2 acres.

- An average of 42 smaller MFR projects were redeveloped annually from 2003 to 2009. The average project size for these smaller projects is approximately 0.25 acres.

- Approximately 88 acres of MFR land use would be redeveloped to SUSMP standards per year for 10 years [*880 acres total area treated*].

Green Street Projects in MFR Areas

- 26 percent of the SFR land use is roadways and 50 percent of MFR land use area drains or can be routed to the roadway.

- Green street treatment will be achieved through equal implementation of bio-retention (50 percent) and vegetated swales (50 percent) for the roadways and permeable pavement for alleys.

- 30 percent of the roadway area within the MFR land use area within the watershed will be retrofit within 10 years [*2,119 acres treated by 2021*].

5.2.2 Expected Combined Benefits from Structural and Institutional BMPs

5.2.2.1 Baseline Load

SBPAT was used to estimate the baseline (2005) TSS load from all land uses (except open water areas) in the watershed. This was compared to the loading of fine sediments predicted by the Regional Board staff during the development of the TMDL. Results of the baseline analysis are provided in Table 5-6.

Table 5-6
Predicted Baseline (2005) Runoff Volume and Average Annual TSS Load for the Ballona Creek Watershed

Ballona Creek Watershed Area	81,038 acres
Total Runoff Volume	47,124 ac-ft/yr
TSS load determined by SBPAT[1]	5,712 tons/yr
Load of fine sediment predicted in TMDL	7,833 tons/yr (7,105,600 kg/yr)

Notes:
[1]SBPAT model results.
[2] Predicted in the TMDL based on a loading of fine sediments to applicable areas (areas A and G) of 5,044 m^3/yr, a bulk density of 1.42 metric tons/m^3 resulting in a load of fine sediments equal to: 5,044 m^3/yr x 1.42 metric tons/m^3) = 7,833 tons/yr.

SBPAT estimates the amount of total suspended sediments (TSS) transported from the watershed while the Regional Board used the amount of fine sediments, which is based on historical measurements of deposits to the estuary, to determine the loading capacity. It is assumed that a more appropriate representation of total sediment load would be by estimating the suspended sediment concentration (SSC)[2] and corresponding percent fine, rather than TSS. However, SBPAT is based on Event Mean Concentrations (EMCs) that only predict TSS loading. Therefore, for the purposes of this analysis, the higher fine sediment load as established in the TMDL was used as the baseline load rather than using the TSS values determined by SBPAT. This was done to ensure that the analysis did not under predict sediment loading. As stated previously in Section 5.2.1, to ensure that load reductions were not overestimated, there was no overlap between areas credited with load reductions due to distributed, regional or institutional BMPs.

Additionally, Section 5.2.6 explains the sensitivity of TSS load removal from a sample catchment and a suite of BMPs. As indicated in Figure 5.3, upper and lower limits of load removal are around +/- 45% from average values at different design parameters. For complete analysis of Sensitivity, refer to Section 5.2.6.

Ideally, to calculate the baseline loading of each constituent to the estuary, sediment samples taken directly from runoff flowing to the creek and estuary would have been analyzed to determine a concentration of each constituent in the inflowing sediment. This concentration would have been multiplied by the total annual sediment load to determine the total load of each constituent to the estuary. However, when this Implementation Plan was prepared, data was not available to characterize the constituent concentration in inflowing sediment. Rather, the results of the TIE study

[2] Per a USGS study (http://water.usgs.gov/osw/pubs/ASCEGlysson.pdf), the method of measuring TSS and SSC is different and can result in a different amount of sediment being measured. TSS is measured as the amount of sediment retained on a filter when a well mixed aliquot is taken from the water column sample. SSC is measured as the amount of sediment retained on a filter when the whole sample is filtered. While this report does not establish a link between TSS and SSC measured results, because the differences are too site specific, it does suggest that there are more sediments retained on the filter in the SSC method.

described in Section 2 are available, which provides the concentration of each constituent in the bottom sediments of the estuary. The risk associated with this method is that it is very difficult to distinguish between sediments that were deposited within one year of the sampling date versus sediments that were deposited a number of years prior. If, for example, the concentration of a certain constituent were decreasing over time, this method of testing may not identify that trend for a number of years. However, since the results of the TIE study provide the only available data, they were used in this analysis.

Using the fine sediment load presented in Table 5-6, and the average measured concentration in the estuary from the TIE study, the baseline load for each constituent listed in the TMDL is presented in Table 5-7.

Table 5-7
Baseline Load

Constituent	Average of Measured Concentrations in Estuary[1]	Watershed-wide Baseline Load[2]	Baseline Load (MS4 and Caltrans Portion)[3]
Metals	**(mg/kg)**	**(kg/yr)**	**(kg/yr)**
Cadmium	0.66	4.69	4.53
Copper	35.58	252.80	243.95
Lead	26.96	191.58	184.87
Silver	0.43	3.07	2.96
Zinc	147.67	1,049.31	1,012.58
Organics	**(µg/kg)**	**(g/yr)**	**(g/yr)**
Chlordane	2.53	17.95	17.32
Constituent	**Average of Measured Concentrations in Estuary[1]**	**Watershed-wide Baseline Load[2]**	**Baseline Load (MS4 and Caltrans Portion)[3]**
DDTs	7.66	54.44	52.53
PCBs	1.96	13.92	13.43
PAHs	141.96	1,008.74	973.43

Notes:
[1]The average measured concentrations of each constituent were based on the measured data reported in the 2007-2009 Toxicity Identification Evaluation (TIE) performed by SCCWRP and the City of Los Angeles, as summarized in Section 2 and included in Appendix B of this Implementation Plan.
[2]The baseline load is the concentration of each constituent multiplied by the fine sediment load of 7,105,600 kg/yr as presented in Table 5-6.
[3]The load that the MS4 Permittees and Caltrans (the preparers of this Implementation Plan) are responsible for is based on the portion of the loading capacity that they are responsible for, as listed in the TMDL. The MS4 Permittees and Caltrans are responsible for 96.5 percent of the load; therefore the watershed-wide baseline load was multiplied by 96.5 percent.

5.2.2.2 BMP Load Reductions

Based on the methodology and assumptions described, load reductions associated with the implementation of the regional and distributed structural BMPs and institutional BMP were estimated for the entire watershed. Predicted average annual TSS load reductions, estimated load reduction ranges, as well as area and the percent of the watershed treated, are provided for each type of BMP in Table 5-8 A, B, and C.

Load reduction ranges for regional BMPs are automatically generated during modeling. The values in Table 5-8A represent planning level estimates. In 2011 the City of Los Angeles developed a concept report for Rancho Cienega Sports Center with estimated pollutant removal 16 tons/year of TSS removal, which is significantly greater than 8 tons/year as estimated in Table 5-8A. Additional project opportunities identified during the concept development phase. The drainage area for Rancho Cienega was indentified to be approximately 8, 000 acres, compared to 162 acres estimated in this Implementation Plan.

Ranges associated with distributed BMP program reductions are based on a stochastic simulation of annual pollutant loads that considers the variability associated with runoff volumes and concentrations. SUSMP development and redevelopment rates are based on 10 years of data collected by the City of Los Angeles as reported in the Annual Report for NPDES MS4 Permit. The area to be treated by Green Streets are based on several discussions with City Planning Department, Bureau of Engineering, and other city-level governing offices with the anticipation that requirements for Low Impact Development be in place to create additional small scale stormwater treatment projects.[3] The 5th and 95th percentile annual loads computed were used to define the range.

Load reductions attributed to institutional BMPs were calculated based on the range of load reductions achieved per year for the 57 years of discrete build-up/wash-off storm events modeled. The 5th and 95th percentile annual loads computed were used to define the estimated range of load reductions.

[3] Low Impact Development Ordinance became effective in the City of Los Angeles in May 2012.

Table 5-8 A
Predicted TSS Load Removal by Regional BMPs by 2021

Regional BMP	Acres Treated	% of Watershed Treated by BMP	Load Reduction (tons/yr)[1,2]	
			Average	Estimated Range
Centinela Park	736	0.90%	38	9 - 80
La Cienega Park	374	0.46%	12	4 - 23
Harvard Recreation Center	235	0.29%	5	2 - 9
Rancho Cienega Sports Center	162	0.20%	8	2 - 15
MacArthur Park	135	0.17%	4	1 - 8
Los Angeles Unified School District Site	99	0.12%	12	3 - 22
Lemon Grove Recreation Center	63	0.08%	1	0 - 2
Van Ness Recreation Center	36	0.04%	1	1 - 2
Total Regional BMP Load Reduction	**1,840**	**2.3%**	**81**	**22 - 161**

Notes:
[1]Refer to Appendix E for a summary of the methodology for estimating load reductions and Appendix L for a complete copy of the SBPAT User Manual.
[2]There is no overlap between areas credited with load reductions due to institutional, regional and distributed BMPs.

Table 5-8 B
Predicted TSS Load Removal by Distributed BMPs by 2021

Distributed BMPs	% Landuse	Acres Treated	% of Watershed	Load Reduction (tons/yr)	
				Average	Range
Commercial	17%	1,861	2.3%	94	27 - 181
Green Streets	15.4%	1,691	2.08%	80	23 - 154
SUSMP Redevelopment	1.6%	170	0.21%	14	4 - 27
Industrial	6%	214	0.26%	35	10 - 68
Green Streets	1.9%	74	0.09%	13	4 - 25
SUSMP Redevelopment	3.7%	140	0.17%	22	6 - 43
Transportation	27%	453	0.6%	30	7 - 62
Class A Catchments (high priority/high opportunity)	22.8%	377	0.46%	24	6 - 50
Class B Catchments (high priority/low opportunity)	4.6%	76	0.09%	6	1 - 12
Education	4%	108	0.1%	8	2 - 17
LAUSD and UCLA	3.6%	92	0.11%	7	2 - 15
Private Schools Redevelopment	0.6%	16	0.02%	1	0 - 2
SFR	19%	5,683	7.0%	249	60 - 533
Green Streets	10.1%	3,077	3.78%	139	31 - 304
Downspout Disconnect	8.6%	2,607	3.20%	110	29 - 229
MFR	16%	2,919	3.6%	64	16 - 135
Green Streets	11.4%	2,039	2.5%	43	10 - 94
SUSMP Redevelopment	4.9%	880	1.1%	21	6 - 41
Total Distributed BMP Load Reduction		**11,238**	**13.8%**	**480**	**122 - 996**

Table 5-8 C
Predicted TSS Load Removal by Institutional BMPs by 2021

	Load Reduction (tons/yr)	
	Average	Estimated Range
Enhanced Street Sweeping (additional tons/yr of sediment removed)	42	25 – 59
Total Institutional BMP Load Reduction	**42**	**25 - 59**

Table 5-8 D
Predicted TOTAL TSS Load Removal by all BMPs by 2021

	Load Reduction (tons/yr)	
	Average	**Estimated Range**
Regional BMPs	81	22 - 161
Distributed BMPs	480	122 - 996
Institutional BMPS	42	25 - 59
TOTAL	***603***	**169 – 1,216**

In addition to the load reduction presented above, it is also expected that additional TSS load reduction will come from:

- Structural BMPs during dry weather;
- Dry weather low flow diversion;
- Trash captures devices installed to meet the requirements of the Trash TMDL; and
- Source controls to reduce metals loading (product replacement).

5.2.3 Compliance with TMDL WLA

To illustrate compliance with the TMDL WLA, the baseline load was compared with the post-BMP load, based on the BMPs presented in Table 5-8. Table 5-9 presents the post-BMP load of each constituent compared to the WLA.

This compliance analysis accounted for a great level of uncertainty in order to ensure that load reductions were not overestimated. At each step in the process, as previously described in this section, factors of safety were applied to the load reduction estimates in order to be conservative in the overall load reduction estimation at final compliance.

In addition to factors of safety, the method of quantification inherently provided a level of safety in that BMP effluent concentrations were used as opposed to percent removal efficiencies for each structural BMP. In addition, there was no overlap in areas treated with the various BMPs (e.g. for the entire tributary area of a regional BMP, no credit was taken for any institutional BMP or distributed BMP regardless of the likelihood that an institutional or distributed BMP may affect that tributary area). The range of post BMP loads presented also accounts for the variability of these estimates. It is therefore stated that every effort was taken to ensure that no overestimation was made in evaluating final compliance with the TMDL.

Table 5-9
Predicted Annual Load Compared to Waste Load Allocation (WLA)

Constituent	Baseline Load[1]	Load Reduction[2]	Post BMP Load[3]	WLA[4] (MS4 Permittees and Caltrans)	Percent Exceedance[5]
Metals	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**(kg/yr)**	**%**
Cadmium	4.53	0.48	4.05	8.11	0%
Copper	243.95	25.75	218.19	230.50	0%
Lead	184.87	19.52	165.35	316.70	0%
Silver	2.96	0.31	2.65	6.78	0%
Zinc	1,012.58	106.90	905.69	1,017.00	0%
Organics	**(g/yr)**	**(g/yr)**	**(g/yr)**	**(g/yr)**	**%**
Chlordane	17.32	1.83	15.50	3.39	357%
DDTs	52.53	5.55	46.99	10.71	339%
PCBs	13.43	1.42	12.01	154.00	0%
PAHs	973.43	102.76	870.67	27,300.00	0%

Notes:
[1]Baseline load: see Table 5-7 (MS4 Permittees and Caltrans portion of the load).
[2]The load reduction is based on the TSS load reduced by the proposed BMPs, which is based on SBPAT modeling results (603 tons/yr, Table 5-8). The percent reduction is based on the baseline TSS load established by SBPAT (5,712 tons/yr, Table 5-6) for consistent comparison. Therefore a percent reduction of 11 percent was established based on these values.
[3]The post BMP load is the baseline load minus the load reduction.
[4]The WLA is from the TMDL.
[5]The percent exceedance is the percent that the post BMP load exceeds the WLA for the MS4 Permittees and Caltrans.

Chlordane and DDT Exceedances Based on Above Analysis

As described above, the method for establishing the baseline load used the measured constituent concentrations found in the estuary bottom sediments as determined as part of the TIE study. Since this study represents sediments deposited over multiple years which were included in each sample, it is possible that sediments from previous years are erroneously showing high historical concentrations of some constituents. Specifically, it is expected that this applies to the exceedances shown for chlordane and DDT, since these pesticides are persistent in the environment. Following is a summary of these constituents.

Chlordane

- Chlordane was used as an insecticide until 1983 when it was banned for all uses except termite control. It was further banned from all uses in 1988.
- The soil half-life for chlordane is estimated at 350 days but can range from 37 days to 3,500 days (approximately 10 years) (US EPA, 2001).

DDT

- DDT was used as a pesticide until it was banned in 1972 for all uses except as an emergency vector control.
- The half-life of DDT in soil is from 2 to 15 years.
- The half-life of DDT in an aquatic environment is about 150 years.

Based on this information, it is expected that these two pesticides are showing up in high concentrations in the samples because of their persistence in the environment and their long half-life. It is likely that the estimates presented in Table 5-9 are higher than what would be found in samples taken from discharges from the Ballona Creek Watershed because they have been banned for many years. However, since neither of these constituents are the cause of toxicity in the estuary, as determined by the TIE study, this Implementation Plan will focus additional efforts on reducing the concentration of pyrethroids, the main cause of toxicity in the estuary. The Implementation Plan for pyrethroids is discussed in Section 5.2.4.

Compliance Analysis Conclusion

As shown in Table 5-9 several of the listed constituents are already in compliance with the TMDL based on the available sampling data. This includes cadmium, lead, silver, zinc, PCBs, and PAHs. Those that are not in compliance currently include copper, chlordane and DDTs. As described above, chlordane and DDT are likely showing exceedance due to the historic use and persistence in the estuary sediment environment. Therefore, only concentrations of sediment bound copper needs to be reduced to meet the TMDL requirements, and based on the data presented in Table 5-9, the current concentration of copper in the sediment must be reduced only by 6 percent to be below the WLA.

During the revision of the Implementation Plan, Ballona Creek Watershed Agencies analyzed the storm-born sediment data collected during 2011-12 storm season. Agencies collected samples from 14 storm events with average TSS of 285 mg/L. Total of 8.44 million cubic meters of runoff was recorded yielding total storm-born sediment of 2,500 metric tons/year (dry weight).

This value is lower than 7,800 metric tons/year as described in the TMDL and the calculated value of 5,700 metric tons/year in this Implementation Plan. Complete set of data will be included in the Annual Monitoring Report.

5.2.4 Implementation Plan to Address Sediment Toxicity

As described in Section 2, the TIE study concluded that the main cause of toxicity in the Ballona Creek Estuary is due to the presence of pyrethroids in the sediments in the estuary rather than due to the constituents listed in the TMDL. Therefore, to address toxicity listing in the TMDL, the Implementation Plan proposes to reduce the discharge of pyrethroids, which are the primary pesticide currently used to control insects on lawns and in gardens using foggers and underground injection and are transported via urban runoff and sediment to the estuary.

Since no WLA exists for pyrethroids, the load reduction needed to eliminate toxicity in the estuary has not been established. Therefore, the load reduction by the proposed BMPs has also not yet been quantified. Following are the BMPs proposed to reduce the discharge of pyrethroids.

- Institutional and structural BMPs: since pyrethroids bind to sediments, the structural and institutional BMPs proposed in this Toxics TMDL Implementation Plan will also serve to reduce the discharge of pyrethroids;

- Targeted Pesticide Reduction Program:

  - Public education and outreach: this will be done to promote use of non-toxic methods of pest-control and educate the public on proper ways to apply pesticides to keep them from running off of the property; and

  - Product replacement: identification of product replacement options will be done as necessary.

5.2.5 Uncertainty and Limitations of the Quantification Approach

An attempt was made to minimize the statistical bias of the quantification results through the use of data central tendencies (i.e., means and medians) for computing watershed-wide, average annual load estimates. However, as described below, there are several unavoidable sources of uncertainty in the pollutant load reduction estimates for structural and institutional BMPs due to data limitations, unknown future conditions, simplifying assumptions, and site-specific factors.

***Uncertainty #1*: Available BMP Areas and Drainage Areas**

- For regional BMPs, the available areas were estimated based on aerial imagery, land use data, and parcel information. An assessment of conflicting uses or level of use was not conducted and on-site subsurface utilities were not identified. The tributary areas of the proposed BMP sites were approximated based on existing catchment delineations and identified storm drains. Some drainage areas may be larger or smaller than estimated.

- Specific sites for distributed BMPs were not determined. BMPs were assumed to be, on average, sized to capture 0.75 inches of runoff for volume-based BMPs and 0.2 in/hr for flow-based BMPs. Footprint areas and treatment area ratios were based on the SBPAT default values for each modeled BMP type. The actual BMP design capacities, footprints and treatable runoff will vary from site to site. Refer to Section 5.2.6 for the sensitivity analysis of the design parameters.

***Uncertainty #2*: Land Use Imperviousness and Changes to Land Uses over Time**

- Los Angeles County imperviousness estimates were used in the assessment. The imperviousness for specific areas may vary from the average land use value used, which impacts the runoff volume estimated by the hydrologic model.

- 2005 SCAG land use data were used to identify BMP opportunities and estimate runoff concentrations. Land use designations may change in many areas as the watershed is redeveloped over the next 10 years (e.g., conversion from industrial to multifamily residential or commercial land uses). The current assessment assumes land uses will not significantly change due to redevelopment.

<u>Uncertainty #3</u>: Water Quality Modeling and Monitoring Data for TSS

- Water quality modeling of TSS loading and structural BMP treatment relying heavily on limited datasets was carried out to aid the use of integrated water resources approaches to meet multiple TMDLs. Results of Nexus Tool modeling, showing baseline and post-BMP implementation loading of TSS, are intended to be used in high level TMDL implementation planning exercises and provide guidance for the development and subsequent adaptive management of stormwater programs to ensure compliance with WLAs. Estimated TSS load reductions derived from structural BMP treatment will be verified, and revised if necessary, throughout the implementation of stormwater programs as the body of literature regarding TSS loading and treatment unit processes grows.

<u>Uncertainty #4</u>: Institutional BMP Performance Quantification

- Available data on the performance of institutional BMPs is scarce and highly uncertain. Two approaches for quantifying the downstream benefits of institutional BMPs includes reference watersheds or before/after studies. Both of these approaches typically require many years of monitoring to detect statistically significant differences due to natural variability in hydrology and water quality, unknown changes in land uses or activities in the control or target watersheds, and episodic or illicit discharges of pollutants. Due to the lack of statistically conclusive studies, the quantification of potential TSS load reductions from sources controls was based on a combination of data-supported assumptions and best professional judgment.

- The effectiveness of enhanced street sweeping was based on an estimate of the amount of street sediment and the expected performance of high-efficiency sweepers. Sediment volumes would be expected to be highly variable and site specific. In addition, all of the studies base sweeper performance on the quantity of collected sediment rather than changes in downstream water quality. Finally, the proportion of collected sediment that would have reached the receiving water is unknown.

<u>Uncertainty #5</u>: Redevelopment Rate Assumptions

- Redevelopment rates for LAUSD are based on current levels of new school construction for the entire district that have been scaled to the Ballona Creek Watershed. This assumes that the construction rates are approximately evenly distributed across the district and that new construction in the Ballona Creek watershed includes redevelopment of currently developed parcels.

- Redevelopment rates for MFR was estimated to be 200 projects per year with an average project size of two acres based on the number of SUSMP applications for 10+ housing developments from 2003-2008 in the Ballona Creek watershed. Future redevelopment rates may be higher or lower than this amount.

***Uncertainty #6*: Existing Sediment Data**

- In order to perform the compliance analysis, the expected concentration of each constituent in the sediment in the Ballona Creek Watershed was required. Ideally, measured data would have been used from samples of sediment in runoff water in the Ballona Creek Watershed which included the concentration of each constituent in this runoff water. This would have represented the concentration of each constituent in the actual sediment coming from the watershed. However, the only available data was constituent concentrations in the sediment on the bottom of the estuary. The uncertainty associated with this data is that it not possible to know the time frame with which these collected sediments were deposited. Confirmation of sediment bound loading will need to be made as the CMP is implemented and the appropriate data is collected.

5.2.6 Sensitivity Analysis of the Design Parameters

When simulating pollutant removal, SBPAT calculates the standard deviation of the resulting pollutant loading based on the variation of flow and event-mean concentration (EMC) data. However, variation in the design parameters used in the model can also have a significant impact on pollutant removal. A sensitivity analysis was conducted for the SBPAT model to determine how variation in BMP design parameters affects pollutant removal. The distributed BMPs swales, cisterns, bioretention, and permeable pavement were evaluated in this analysis.

The methodology of the sensitivity analysis involves selecting a representative catchment and running the SBPAT model with varying design storm parameters for the distributed BMPs. Sizing parameter for each of the BMPs are different based on the sizing equations, including design storm (as inches of rainfall for the storm), rainfall intensity (as inches per hour of rainfall), and the ratio of the size of the BMP to tributary area. Table 5-10 lists the BMPs and design parameters used for the sensitivity analysis.

A catchment with typical characteristics was selected as the sample catchment to conduct the sensitivity analysis. The selected catchment was one of the distributed catchments discussed in Section 5.1.2.2 and listed in Table 5-2, as catchment number 12, and shown in Appendix G, Figure G-12. This catchment proposes a suite of distributed BMPs, and since each of the BMPs has different design parameters, in order to simultaneously perform the sensitivity analysis on each BMP throughout the catchment, each of the BMP’s design storm parameters was varied by a percent of the baseline value (0.75 in and 0.2 in/hr) used in the analysis. A summary of the parameters used for the sensitivity analysis and values are shown in Table 5-10.

Table 5-10
Sensitivity Analysis Design Parameters

BMP	Parameters	Units	Percent Variance from Average Design Storm Parameters								
			-60%	-40%	-20%	0%	20%	40%	60%	80%	100%
Swales	Design Storm intensity	in/hr	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40
Cisterns	Design Storm	in	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50
Bioreten-tion	Design Storm	in	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50
Permea-ble Pavement	Tributary Area ratio	bmp area/(trib + bmp area)	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

A summary of the catchment's landuse is shown in Table 5-11 as well as the average landuse for the Ballona Creek catchments. The table shows the catchment is primarily made up of residential land uses, as is typical in the Ballona Creek watershed. The catchment has a higher percent of agriculture and education landuses, and a lower percent of commercial and industrial landuse. For the purpose of the sensitivity analysis, with the range of BMPs included in the preliminary site layout and the typical high residential land use, this catchment is expected to provide a representative example of the sensitivity to the design parameters in the model.

Table 5-11
Sample Catchment and Average Ballona Creek Landuse Summaries

Landuse Classification	Catchment Area (acres)	% of Total Area within Catchment	Average % for Ballona Creek Catchments
Agriculture	3.4	11.2%	0.04%
Commercial	0.0	0.0%	14.4%
Education	8.1	26.7%	3.0%
Multi-Family Residential	1.7	5.6%	22.8%
Industrial	0.0	0.0%	4.5%
Transportation	0.0	0.0%	2.4%
Single Family Residential	12.6	41.6%	36.8%
Vacant/Open Space	4.5	14.9%	16.0%
Total	30.3	100.0%	100.0%

Figure 5-3 shows the results of the sensitivity analysis for total suspended solids (TSS). The upper and lower boundaries based on standard deviations of the model results are also shown. The variation is due to the storm event precipitation and variations in the EMC data (see Appendix L for additional discussion on the SBPAT model). At 0% variance (0.75 in storm depth, 0.2 in/hr design intensity, and 0.5 area ratio) average TSS loading removal is 0.39 tons/year with upper limit of 0.56 tons/year and lower limit of 0.2 tons/year, approximately +/- 45 percent. As described in Figure 5.3, the load removal variance remains relatively around +/- 45 percent at the planning level. More accurate estimate may be derived during concept design and pre-design phases for individual projects. The figures show that the variation of pollutant removal due to changes in design storm parameters are within range of the variation due to storm events and EMCs. Even if the design storm parameters are reduced by 60 percent or doubled, they are still within bounds of the storm and EMC variation.

Figure 5.3 Sensitivity Analysis for TSS

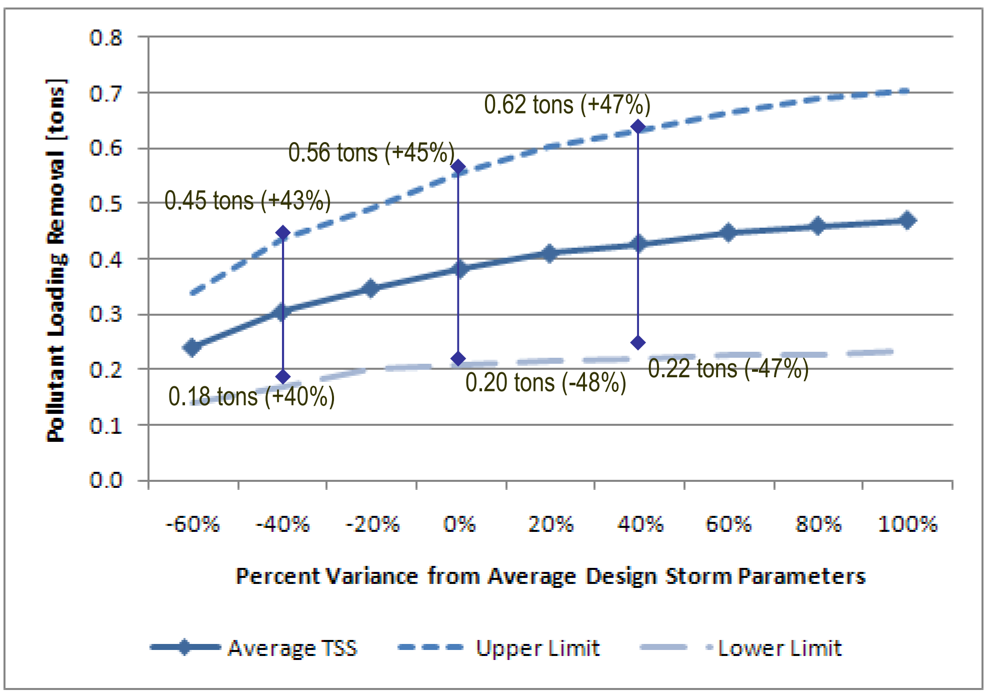
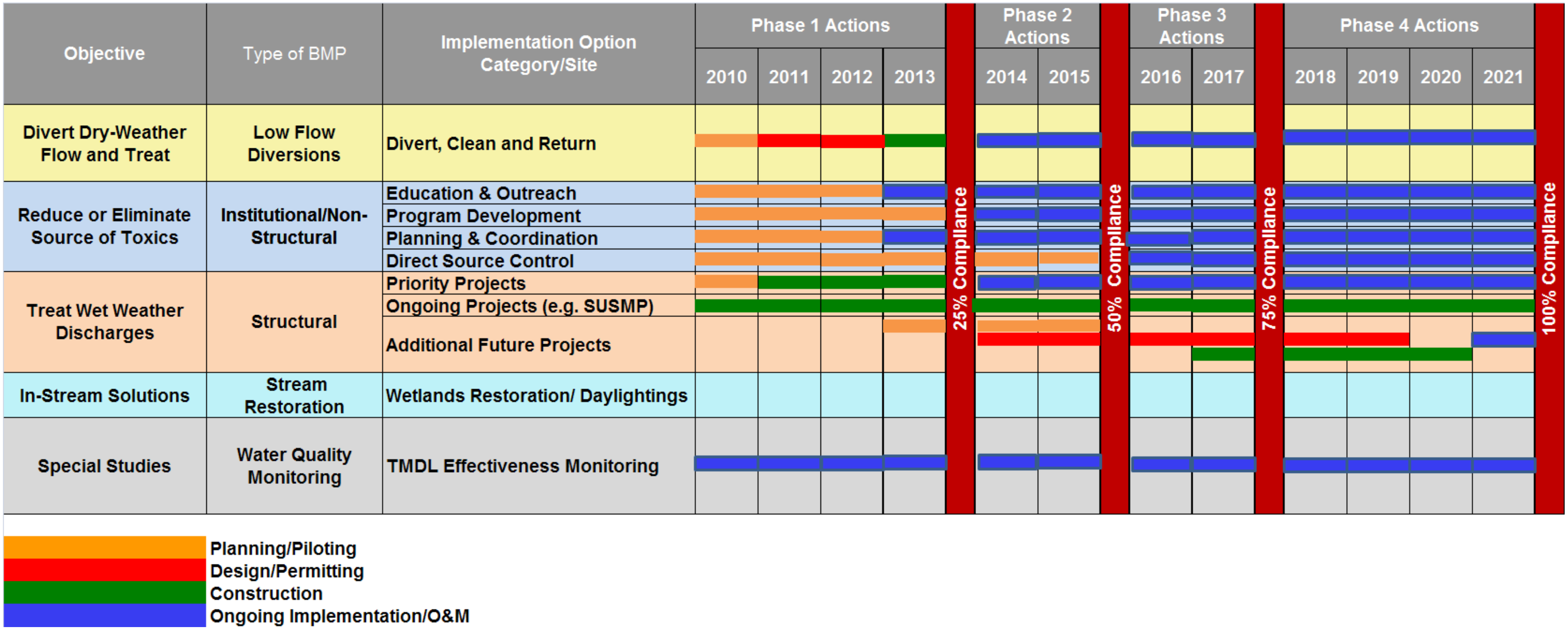


Table 5-12
Ballona Creek Toxic Pollutants TMDL Implementation Schedule and Milestones



5.3 Monitoring and Special Studies

5.3.1 Monitoring

As discussed in Section 1, the Ballona Creek Toxics TMDL requires ongoing baseline and performance monitoring, which is described in the Coordinated Monitoring Plan. These data will provide estimates of current and future metals and organics loadings relative to the TMDL loading targets. Upstream monitoring for these constituents can be used to identify "hot spots" or those areas showing consistent patterns of high concentrations where additional structural controls may be necessary.

5.3.2 Special Studies

Completion of the three Ballona Creek TMDL Implementation Plans, for Toxics, Metals and Bacteria, has identified several data gaps and information needs. Accordingly, the following special studies are recommended for implementation:

5.3.2.1 Source Characterization Studies

Source characterization studies should be implemented in the watershed to identify additional contributing factors to metals and organics loading and estimate their loading rates. Estimates of pollutant emissions can be based on inventories, emissions factors or modeling. Inspections of houses and business facilities can help identify additional sources, as well as studies to identify locations of pollutant "hot spots" within the watershed.

5.3.2.2 Pilot Programs

Small-scale pilot programs can be a cost-effective way to determine what institutional BMPs are effective and should be expanded to a watershed-wide level. Pilot programs can be designed to collect new source data and provide unit area based cost and benefit information for institutional BMPs to determine need and applicability and evaluate effectiveness. If a pilot study identifies that an institutional BMP is costly and provides limited water quality benefits, the responsible jurisdictions should not deploy it across the entire watershed. Pilot programs can include targeted areas for street sweeping or neighborhoods for downspout retrofit programs.

5.3.2.3 Outreach and Education Surveys and Data Collection

As previously described, successful education and outreach programs rely on communities to change their behavior regarding pollution problems. Surveys, formal or informal, are an effective tool to gauge the performance of education and outreach programs by directly asking community members about their knowledge of runoff pollution problems and prevention measures, and what, if any, steps they are taking to reduce polluted runoff. Surveys can occur via mail or in-person by randomly interviewing attendees at a community area or event. Prior to any surveys, the responsible jurisdictions should identify quantifiable, measurable goals for education and outreach programs. Initial surveys can then be performed to help define effective outreach programs. Informal surveys can yield important results, such as existing knowledge and awareness in the watershed and the behaviors that should be target for change. After implementation, surveys can be used to evaluate behavior changes and progress towards goals. Data collection can also be used to indirectly measure baseline behavior and program effectiveness.

5.3.2.4 Monitoring within MS4s

Institutional BMP implementation should include a long-term monitoring and tracking program. Flow and pollutant monitoring within MS4s provide information on runoff pollutants and the impact of BMPs. Additionally, monitoring can be used to find pollutant "hot spots" by identifying sites of high pollutant concentrations and backtracking to their source. Monitoring should be conducted throughout the entire period when the BMPs are being implemented as well as afterwards to measure their impact on pollutant loading.

5.4 Implementation Plan Schedule and Milestones

Sections 5.4.1 summarizes the preliminary schedules and milestones for institutional BMPs, structural BMPs, and LFTF projects for achieving compliance with relevant TMDL limits in the Ballona Creek Watershed. For each BMP, Table 5-12 shows the proposed initiation and duration of: (1) planning/piloting activities, (2) design and permitting, (3) construction, and (4) ongoing implementation/operation & maintenance (O&M). It is assumed that the responsible jurisdictions will continue to act collaboratively and coordinate on scheduling the implementation activities. Caltrans, however reserves the right to proceed independently to address the TMDL goals depending on the specific costs and implementation measures identified during the implementation process.

5.4.1 Interim Compliance

In Section 5.2.2, TSS load reductions from each of the elements of the Implementation Plan scheduled for implementation prior to 2021 were summed. An estimated concentration of each constituent in the sediment was applied to establish the total load reduction. This was removed from the baseline loading to demonstrate compliance with the TMDL for each constituent. The compliance milestones, as discussed in Section 1, include the following:

- January 11, 2013: 25 percent of the total drainage area served by the MS4 system is effectively meeting the waste load allocations for sediment
- January 11, 2015: 50 percent of the total drainage area served by the MS4 system is effectively meeting the waste load allocations for sediment
- January 11, 2017: 75 percent of the total drainage area served by the MS4 system is effectively meeting the waste load allocations for sediment
- January 11, 2021: 100 percent of the total drainage area served by the MS4 system is effectively meeting waste load allocations for sediment

As discussed in Section 5.2.3, copper is the constituent listed in the TMDL that is not currently in compliance and has not been historically banned from use. As such the interim compliance analysis will serve to illustrate how the copper load will be reduced to meet the interim compliance requirements.

Assuming that load reduction is proportional to MS4 drainage area compliance, compliance with interim milestones can be computed without extensive upstream geospatial analysis. For instance, to achieve the first milestone of 25 percent of MS4 drainage area in compliance, 25 percent of the necessary load reduction must be demonstrated. Therefore, the recommended BMP projects in the Toxics TMDL Implementation Plan provide sufficient treatment of urban runoff to achieve interim milestones based on the fraction of necessary load reduction achieved, as presented below. Since the BMPs were selected to target high pollutant loading catchments, distributed throughout the watershed (see Section 4), retrofit of only a fraction of the watershed land area is required to achieve full compliance.

The rate of implementation for each of the BMP categories in this Implementation Plan was established and presented in Table 5-13. The implementation of distributed BMPs is based on a uniform annual rate of implementation, while regional BMPs require more substantial planning and the dates that each of the eight regional BMPs would be completed was estimated separately. To be conservative, it is assumed that the institutional BMPs will not be completed until 2021.

Table 5-13 presents the estimated TSS load reduction expected for by each interim date. As shown, for each BMP type, the expected TSS load reduction is established and summed to arrive at the total pollutant load reduction by each interim compliance date. Using these values, the total copper load reduction was calculated for each interim compliance date as shown in Table 5-14. The results include:

- January 2013: 42 percent of the total load reduction required by 2021 will be achieved, which exceeds the required 25 percent. This is based on a combination of 29 percent of the total required retrofit acres of distributed BMPs.
- January 2015: 89 percent of the total load reduction required by 2021 will be achieved, which exceeds the required 50 percent. This is based on a combination of 60 percent of the total required retrofit acres of distributed BMPs completed, two regional BMPs will be completed.
- January 2017: 123 percent of the total load reduction required by 2021 will be achieved, which exceeds the required 75 percent.
- January 2021: 191 percent of the total load reduction required by 2021 will be achieved.

While the BMPs included in this Toxics TMDL Implementation Plan exceed the requirements of the Toxics TMDL, since the BMPs presented here also serves to meet the requirements of the Metals and Bacteria TMDLs, these additional BMPs are necessary to meet the requirements of those TMDLs.

Table 5-13
Implementation Schedule to Meet the Interim Compliance Dates for Toxics TMDL Numeric Limits

			Through Jan 2013 (3 years)		Through Jan 2015 (5 years)		Through Jan 2017 (7 Years)		Through Jan 2021 (10 Years)	
BMP Type	**Ac/Yr Treated**	**TSS Removed per Year (Tons)**	**Area Retrofit (ac)**	**Load Reduction (tons)**	**Area Retrofit (ac)**	**Load Reduction (tons)**	**Area Retrofit (ac)**	**Load Reduction (tons)**	**Area Retrofit (ac)**	**Load Reduction (tons)**
Distributed BMPs										
Commercial	186	9.4	558	28.2	930	47	1302	65.8	1,861	94
Industrial	21	3.5	63	10.5	105	17.5	147	24.5	214	35
Transportation	0	3	0	0	377	24	402	26	453	30
Private Edu.	1.6	0.1	4.8	0.3	8	0.5	11.2	0.7	16	1
Public Edu.	-	0.7	-	-	92	7	92	7	92	7
MFR	292	6.4	876	19.2	1,460	32	2044	44.8	2,919	64
SFR	568	24.9	1704	74.7	2,840	124.5	3976	174.3	5,683	249
Distributed BMP Total	*1,069*	*48*	3,206	133	*5,812*	*253*	*7974*	*343*	*11,238*	*480*
Regional BMPs					*631*	*28*	*1034*	*46*	*1,840*	81
Enhanced Street Sweeping (watershed wide)										*42*
Total Quantified Load Reduction			**NA**	**133**	**NA**	**281**	**NA**	**389**	**NA**	**603**

Table 5-14
Evaluation of Sediment Bound Copper Load Reduction

Summary of Data				
Current total predicted TSS load	5,712 tons/yr			
Current sediment bound copper load	244.0 kg/yr			
TMDL WLA for sediment bound copper	230.5 kg/yr			
Total copper load reduction required to be in compliance with TMDL WLA	13.5 kg/yr			
Compliance milestone years	**2013**	**2015**	**2017**	**2021**
TMDL interim target requirements	25%	50%	75%	100%
Predicted TSS load reduction by each milestone year	133	280	389	603
Percent reduction from current total predicted TSS load	2%	5%	7%	11%
Resulting copper load at each TMDL milestone year	238.3	232	227.4	218.2
Fraction of total required copper load reduction achieved by each milestone year	42%	89%	123%	191%

5.4.2 Institutional BMPs

Institutional BMPs are anticipated to be implemented under each phase. The responsible jurisdictions have already implemented several of the institutional BMPs that are identified in this Plan. Implementation of these institutional BMPs will generally follow a typical project cycle including planning, preparation of a detailed BMP specific BMP action plan, development of a pilot program, leading into the subsequent implementation phases. Each of these project phases is expected to take approximately one year. Where feasible, the pilot programs will be prioritized to target the higher priority catchments, (i.e., those with a CPI score > 3). A detailed institutional BMP action plan will be developed for each program and will focus on what each specific agency is currently doing, how resources could be shifted to target high priority catchments initially, and what can be done to enhance activities that will be implemented by each jurisdiction within the first three years following approval of this plan, enabling many of these strategies to be fully in effect by the second interim compliance milestone of 2014.

Under the remaining phases, as the institutional BMPs become better defined through the iterative, adaptive approach, specific, quantifiable performance measures will be identified and included in the respective program implementation plans. In addition, as water quality monitoring results are obtained from the CMP, institutional BMPs can be honed to target specific locations where high bacterial contributions are found, and the implementation plan for the affected programs modified accordingly.

5.4.3 Structural BMPs

Regional Structural BMPs

A minimum of eight regional structural BMPs will be implemented by the end of Phase 4. By the end of Phase 2, a small subset of projects will be implemented that equate to approximately 12 percent to the total targeted acres treated. This subset of projects includes the Lemon Grove Recreation Center and the Rancho Cienega Sports Center projects. Three additional projects will be implemented by the end of Phase 3 (2017) and the remaining three projects will be implemented by the end of Phase 4 (2021).

Generally, Phase 1 implementation activities will primarily focus on planning and coordination. This is necessary because the proposed regional structural BMPs must be retrofitted into existing public parks or other open spaces which will require extensive planning and coordination with multiple agencies. In addition, the regional structural BMPs are intended to achieve multiple-objectives and address other Ballona Creek TMDL compliance limits for metals and bacteria. The scheduling of regional BMP projects may be adjusted if necessary pending the results of additional more detailed engineering feasibility studies.

The proposed Implementation Plan will complete construction of all eight regional BMPs by year 2021. Additional regional BMP sites may be investigated for implementation should one or more of the sites be found infeasible. Successful implementation of all of the projects would be contingent on resolution of permitting, right-of-way, and other potential site constraints. Individual project flow rates and treatment levels will depend on the available area and detailed project engineering design. The treatment volumes for pilot projects may fall below the full treatment volumes as necessitated by existing conditions at the sites and subject to the constraints of retrofitting BMPs on developed sites.

Distributed Structural BMPs

Under Phase 1 (through 2013), distributed BMPs that treat approximately 30 percent of the total targeted acreage will be implemented. Implementation of the distributed structural BMPs consists of several steps: (1) planning and coordination; (2) design, permitting/environmental documentation; (3) advertisement/ bid / award/ construction; and (4) long-term operation and maintenance. Following implementation, the effectiveness of representative structural BMP systems will be determined from a combination of baseline and influent/effluent monitoring over the course of approximately one year. Depending on magnitude and complexity of these projects, the overall duration from developing the concept to assessing the project's effectiveness will range from two to five years from inception.

For planning purposes, it is assumed that the distributed structural BMP program will be an ongoing program, implementing projects that treat runoff from 1,069 acres per year as shown in Table 5-13. This assumes that these BMPs will be necessary to achieve TMDL compliance limits for toxics as well as the metals and bacteria TMDLs. Any issues and unexpected conditions during these processes may ultimately impact the scheduled timeline and jurisdictions may need to adjust timeframes as these arise. The LARWQCB will be apprised of any significant impacts to the schedule, as well as project accomplishments, through the responsible jurisdictions annual MS4 permit reports.

Low Flow Treatment Facilities

The primary purpose of the LFTF is to achieve compliance with the Bacteria TMDL 2013 dry weather compliance limits. Accordingly, the responsible jurisdictions plan to implement LFTF-1 and LFTF-2 as a priority projects for completion before 2013.

The responsible jurisdictions understand that water quality standards have to be met throughout reaches and tributaries and that LFTFs will not improve the water quality in the upstream reaches above the diversion points.

As described in Section 5.2.1, using a watershed-wide, multi-benefit approach, this Implementation Plan proposes a suite of BMPs that will be installed throughout the watersheds as a long term solution to improving the water quality.

Because the implementation of projects at a watershed-wide scale is expected to take several years, as shown in Table 5-12, these LFTFs are considered as an important component of the multi pollutant approach.

In-stream Solutions
Several unique projects may be feasible along Ballona Creek. These include various stakeholder identified "stream day-lighting" projects which are intended to restore portions of Ballona Creek and major tributaries into 'natural' stream channels. These projects will be evaluated opportunistically and their implementation schedule is to be determined.

The Ballona Creek Wetlands present another unique opportunity to implement a multi-objective watershed project. Several agencies including the Coastal Conservancy, Department of Fish and Game, State Lands Commission, and Santa Monica Bay Restoration Commission have initiated a project to enhance habitat and public access at the 600-acre property along both sides of Ballona Creek Estuary. The BMPs implemented under this plan will provide upstream water quality treatment for flows into this wetlands area. It may be possible for a portion of the wetlands to provide additional "polishing." Additional distributed structural BMPs implementing within public parking (e.g. porous pavement) and other access areas could be included in the project design to provide additional water quality treatment.

5.5 Quantification of Integrated Water Resources Benefits

One of the goals of the Implementation Plan, as expressed by stakeholders, is to develop an integrated plan. Following is a summary of some of the integrated water resources benefits included in the Implementation Plan.

Reductions in Other Pollutants
The IWRA plan included in the Toxics TMDL Implementation Plan will also address other pollutants of concern in the Ballona Creek watershed. The structural BMPs included in the Implementation Plan are predicted to reduce loads of bacteria by approximately 18 percent. The overall Implementation Plan is predicted to comply with the WLAs in the Ballona Creek Bacteria TMDL and the Ballona Metals TMDL.

Groundwater Recharge
As the Ballona Creek watershed sits above a confined aquifer, it is not known whether the infiltration projects identified in the Implementation Plan will serve to recharge the groundwater basin. However, there are multiple BMPs that include infiltration elements. For the distributed BMPs, assuming that 80 percent of them have an infiltration element, approximately 1.9 MGD of runoff could be infiltrated (50 percent x 10,000 acres x 230 gpd/ac (CREST, 2005)). For Regional BMPs, four of the eight sites include infiltration elements, with a total potential infiltration rate of 0.3 MGD (1,100 acres x 230 gpd/ac). For both regional and distributed BMPs, this results in a total possible infiltration rate of 2.2 MGD.

Multi-use Regional Projects
Of the eight regional project identified, four include multi-use elements. These four projects have a total footprint of approximately 28 acres. Further, during design many

of the distributed BMPs could be coupled with multi-use projects, such as trails and bike paths, based on community needs, project partnerships, and site appropriateness.

Urban Runoff Beneficially Reused

The NOTF facility will provide the option to reuse treated effluent, up to 6.5 MGD. Further, a subset of the distributed BMPs that will be implemented include reuse BMPs such as cisterns. Assuming that only a small portion utilize cisterns, such as 5 percent, this would result in approximately 0.1 MGD of reuse watershed wide (5 percent x 11,200 acres retrofit by 2021 x 230 gpd/ac). Prior to using the runoff for beneficial use, the responsible jurisdictions will coordinate with the Department of Fish and Game regarding minimum flow requirements in the creek.

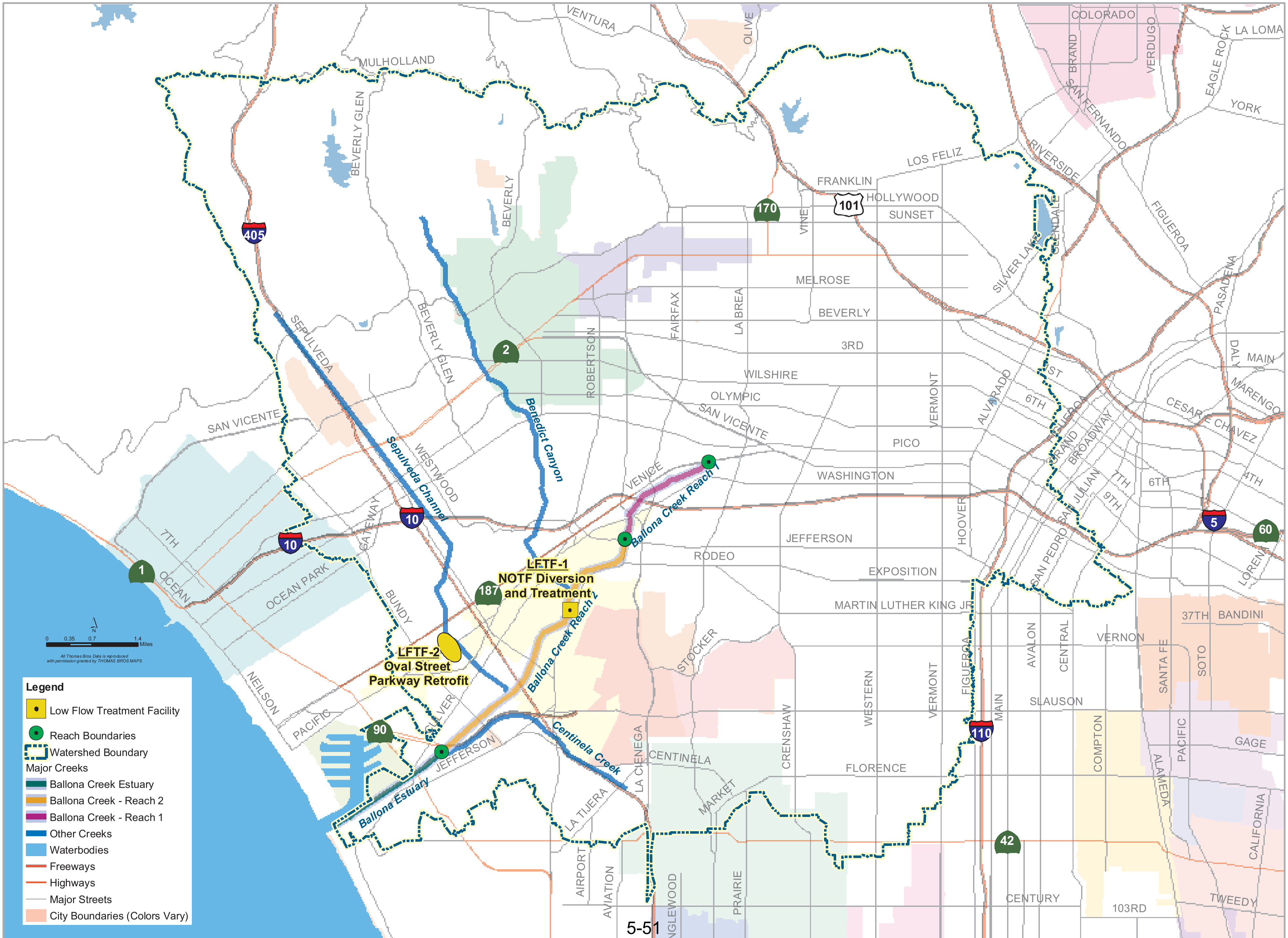


Figure 5-1 Ballona Creek Watershed - Low Flow Treatment Facility (LFTF)

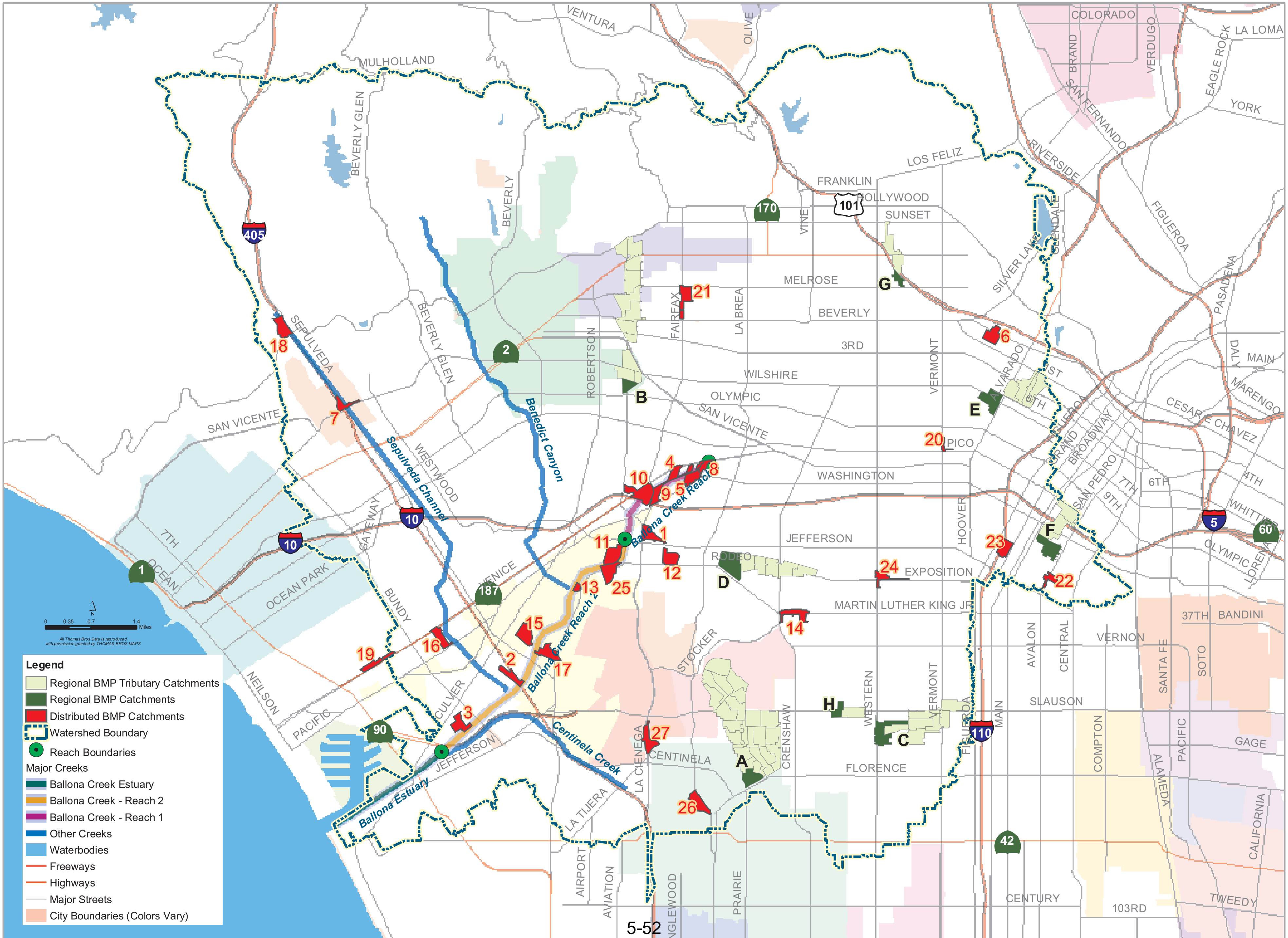


Figure 5-2 Ballona Creek Watershed - Priority Distributed and Regional BMP Sites

Section 6
Program Cost and Budget

6.1 Introduction

Planning-level (order-of-magnitude) capital and O&M budgets and staff resources estimates were developed based on the preliminary project and program concepts presented in Section 5. These estimates are intended to provide decision-makers with an order-of-magnitude sense of what expenditures and staff resources may be anticipated over the 12-year implementation schedule.

This Toxics TMDL Implementation Plan was developed in combination with the Ballona Creek Bacteria TMDL and Ballona Creek Metals TMDL. The Bacteria TMDL Implementation Plan was due to the Regional Board first– and was submitted in November 2009, and the Metals TMDL Implementation Plan was first submitted in January of 2010. These documents also included a program cost and budget section. Since the planning process involved identification of BMPs for both bacteria, metals, and sediment bound toxics, the majority of the BMPs identified and cost estimated in the Bacteria and Metals TMDL Implementation Plans will treat both metals, bacteria and sediment bound toxics. As such, to implement the Toxics TMDL Implementation Plan, the Responsible Agencies will incur only a slight increase from the costs previously presented in the Bacteria and Metals TMDL Implementation Plans. This incremental cost is related to the implementation of the institutional BMPs specific to managing pesticides as described in Section 5.

Given the iterative and adaptive nature of the implementation plan, and the many uncertainties associated with a lot of the projects and programs, the budget forecasts, especially for later phases, should be considered relatively speculative. The cost estimate is for the Implementation Plan as a whole; the allocation of costs to specific jurisdictional agencies is not addressed.

6.2 Structural BMPs

The Water Environment Research Federation (WERF) Whole Life Cycle cost spreadsheets provide the basis for developing the cost estimates for structural BMPs. (http://www.werf.org/bmpcost). The Whole Life Cycle costing approach was applied to five selected distributed BMP sites and four selected regional BMP sites. Cost estimates for construction of these facilities were prepared using construction cost data prepared for other City of Los Angeles Proposition O projects, revised as necessary from other sources (such as bid tabulations and contacts with venders and contractors to incorporate features not previously included in Proposition O construction cost estimates). Whole life costs (regular operations and maintenance costs prorated over the expected useful life of the project) were calculated using the spreadsheet model included in the 2005 WERF final report: *Performance and Whole Life Costs of Best Management Practices and Sustainable Urban Drainage Systems*.

Appendix K presents the detailed results of the structural BMP cost estimates for each of the selected distributed and regional BMPs. The detailed cost estimates include the present value estimated for the whole life-cycle costs for a 50 year service period.

6.2.1 Structural BMP Capital Costs

Summaries of the structural BMP cost estimate tables are presented in Tables 6-1 for the distributed BMPs and Table 6-2 for the regional BMPs which are planned to address multiple pollutants, including bacteria, metals and toxics. Total facility capital costs and annual O&M costs are provided. The upstream drainage area treated by each BMP project is also presented. The total capital and O&M costs are divided by the treated areas to provide "per acre" costs that can be extrapolated to the remainder of the watershed. The implementation of these BMPs will treat both metals, bacteria and sediment bound toxics, and these costs were included in the Bacteria TMDL Implementation Plan. As such, they are not additional costs specific to the Toxics TMDL Implementation Plan.

Table 6-1
Summary of Cost Estimates for Selected Distributed BMPs in Ballona Creek Watershed[1]

Site #[2]	Total Facility Capital Cost	Total Annual O&M Costs	Acres Treated	Capital Cost per Treated Acre	Maintenance Cost per Treated Acre
1	$830,000	$35,200	19.6	$40,000	$1,800
2	$630,000	$34,800	13.7	$50,000	$2,500
3	$1,600,000	$35,200	12.3	$130,000	$2,900
4	$600,000	$34,300	11.5	$50,000	$3,000
5	$700,000	$35,600	9.8	$70,000	$3,600
		Total Acres:	66.9		
			Average Cost per Treated Acre	$68,000	$2,800

[1] These BMPs will treat both metals, bacteria and toxics, to meet the Metals TMDL and Bacteria TMDL and Toxics WLAs, and as such the costs of these BMPs have previously been presented in the Bacteria and Metals TMDL Implementation Plans and are not to be considered additional costs.
[2] The Site Number corresponds to the sites listed in Section 5, Figure 5-2 and in Appendix G (as Figure G-1 for Site 1, G-2 for Site 2, etc.).

Table 6-2
Summary of Cost Estimates for Selected Regional BMPs in Ballona Creek Watershed[1]

Regional BMP Site	Total Facility Capital Cost	Total Annual O&M Costs	Acres Treated	Capital Cost per Treated Acre	Maintenance Cost per Treated Acre
MacArthur Park	$6,570,000	$187,100	136	$50,000	$1,400
Lemon Grove[2]	$870,000	$38,500	63	$10,000	$600
Jim Gilliam Park[3]	$1,460,000	$37,200	171	$10,000	$200
Centinela Park	$12,890,000	$81,800	736	$20,000	$100
Total Acres			1,106		
Average Cost per Treated Acre				$22,500	$600

[1] The se BMPs will treat both metals bacteria and toxics, to meet the Metals TMDL, Bacteria TMDL and Toxics TMDL WLAs, and as such the costs of these BMPs have previously been presented in the Bacteria and Metals TMDL Implementation Plans and are not to be considered additional costs.
[2] The layout for the Lemon Grove site has been modified since this cost estimate was prepared. However, as this cost estimate was used to determine the cost per treated acre, the costs presented here combined with the treated acres shown here are valid as part of the unit cost calculation.
[3]The regional site Jim Gilliam Park is not included in the final list of eight priority regional projects identified, but could be implemented in the future. However, as the cost estimate was developed for this site, it is presented here as an appropriate factor in determining the cost per treated acre.

The facility costs were determined through two steps. First, an assumed unit cost was applied to each estimated conceptual BMP identified for each distributed catchment or regional site in order to calculate the facility base costs. Second, the facility base costs were scaled up to account for the following additional capital costs, which were applied as a percent of the total facility base cost:

- Project Management (15 percent) includes Engineering: Preliminary and Final Design, Topographic Survey, Geotechnical, and Landscape Design,
- Utility Relocation (2percent),
- Legal Services (2 percent),
- Permitting & Construction Inspection (3 percent),
- Contingency (35 percent).

Land acquisition costs (site, easements, etc.) were not included in the cost estimates because the facility sites were selected to be on public property or will be implemented as part of a public/private partnership.

Tables 6-1 and 6-2 present the average per acre capital cost for distributed BMPs, $68,000/acre and regional BMPs, $22,500/acre, respectively. These average costs were applied across the watershed to estimate overall structural BMP costs for the Implementation Plan (Section 6.5).

6.2.2 Structural BMP O&M Costs

Costs for routine maintenance activities include:

- Inspections,
- Reporting & information management,
- Vegetation management with trash and minor debris removal,
- Vector control.

Corrective and infrequent maintenance activities (e.g., unplanned and assumed to be every three years or more) include:

- Intermittent facility maintenance, and
- Sediment removal.

Similar to the capital cost estimate, in order to extrapolate O&M costs to watershed wide implementation, "per acre" O&M costs were calculated. Tables 6-1 and 6-2 present the average per acre O&M cost for distributed BMPs ($2,800/acre) and regional BMPs ($600/acre), respectively. These average costs were applied to estimate overall structural BMP O&M costs for the Implementation Plan (Section 6.5).

6.3 Low Flow Treatment Facilities

Planning level costs for the two low flow treatment facilities are presented in this section. While these LFTFs are designed to reduce bacteria, they will also provide water quality benefits by reducing total recoverable metals loads and sediment loads.

LFTF-1/North Outfall Treatment Facility

For LFTF-1, the costs are estimated for the diversion, treatment and discharge to Ballona Creek of water meeting REC-1 water quality objectives. This cost considers (1) the construction, operation and maintenance of low flow diversions upstream of the NOTF; (2) conveyance of dry weather flows to the NOTF; and (3) start-up requirements, operation and maintenance at the NOTF. The total estimated cost of implementation of LFTF-1 is $10.6 million (these costs were included in the Bacteria and Metals TMDL Implementation Plans and are not additional costs specific to the Toxics TMDL Implementation Plan):

- The base facility costs are $4.9 million. These costs assume a maximum dry weather runoff of 23 cfs. The runoff collection system costs assume use of an inflatable dam to retain dry weather flows only. The facility processes would include an influent channel, influent pumping/screening, oil and grease removal, filtration, chlorine disinfection, and dechlorination. Costs also include necessary site work and odor control.

- Estimated costs for optional implementation activities were also included (i.e., upgrading NOTF treatment capabilities to meet Title 22 reuse standards, and/or operating the facilities to capture and treat a portion of wet weather flows). Based on estimates previously developed as part of the Ballona Creek Treatment Facility Feasibility Study and Preliminary Design, and adjusted to August 2009 dollars (Los Angeles, 1996), the estimated cost of upgrading the NOTF to treat a portion of wet weather flows and have the capability of treating a portion of diverted flows to Title 22 reuse standards (up to 6.5 MGD) is $5.7 million.

- Average annual operating and maintenance costs are estimated at $1.06 million/year.

LFTF-2/Sepulveda Channel Diversion to Oval Streets

LFTF-2 will be constructed at a location along Sepulveda Channel to treat flows prior to discharge to Ballona Creek. The captured dry weather flow will be diverted to a double infiltration basin with irrigation. Estimated capital costs are $14.7 million, and include the following:

- Dry weather flow from Sepulveda Channel to be pumped using a solar powered pump,

- The new curb and gutter with curb cuts every 10-feet,

- Two 4-foot silty sand filled trench at each side of parkway,

- A flow buffer island with moving water friendly vegetation before water flows into the swales,

- 8-inch HDPE pipes will be used under driveways to connect two parkways. Lateral trench across the parkway will be added to provide adequate soil moisture for the plants throughout the year. Lateral trench will be at least 10-feet away from the Palm trees root system.

LFTF-2 Operations and Maintenance Costs: Costs include plant maintenance, sediment removal, vector control, and pumping. O&M costs are estimated to be 10% of the total capital costs, or $1.5 million.

These costs were included in the Bacteria and Metals TMDL Implementation Plans and are not additional costs specific to the Toxics TMDL Implementation Plan.

6.4 Institutional BMPs

The cost estimate for three of the institutional BMPs listed below (enhanced street sweeping, education program, and downspout disconnection) are all also included in the Bacteria and Metals TMDL Implementation Plan. As such, these are not additional costs beyond what is presented in the Bacteria TMDL Implementation Plan. The two institutional BMPs that are specifically included to treat metals are the targeted zinc reduction program and the product replacement program. The cost for these two

BMPs is an additional cost included in the Metals TMDL Implementation Plan that is beyond the cost presented in the Bacteria TMDL Implementation Plan. Finally, the BMPs listed to treat pesticides are specific to the Toxics TMDL Implementation Plan and were not included in the Metals or Bacteria TMDL Implementation Plans. This represents the incremental cost increase associated with the implementation of the Toxics TMDL Implementation Plan beyond the cost already presented in the Metals and Bacteria TMLD Implementation Plans.

Enhanced Street Sweeping

Expanding the City of Los Angeles Bureau of Street Services (BOSS) program to achieve an additional 15 percent load reduction provided the basis for estimating the cost of an enhanced street sweeping program. BOSS already has an aggressive sweeping program which includes both weekly and monthly sweeping of most of the streets in the City. The additional load reduction may be achieved by expanding the sweeping program incrementally to increase total annual number of curb-miles swept within the Ballona Creek Watershed through increasing the frequency of sweeping on streets that are currently swept monthly. The primary capital costs associated with an enhanced street sweeping program is the equipment procurement. Either mechanical or more efficient vacuum sweepers could be used to expand the sweeping program. Street sweeper equipment can range from $140,000 to $280,000 per unit (SCVURPPP 2005 adjusted to 2008 dollars). As shown in Appendix J, the City would need to purchase additional sweepers to sweep these additional curb-miles. Based on the calculations, an estimated three to four new sweepers would be required in the Ballona Creek watershed to sweep these additional curb-miles and achieve a 15% increase in sediment load removal.

Operation and maintenance costs include labor costs for additional operators and ongoing operation and maintenance of the equipment as well as transportation and disposal costs of the materials collected.

The estimated cost for an enhanced street sweeping program in the Ballona Creek Watershed is: $560,000 - $840,000 capital costs for new equipment and $600,000 per year in additional O&M costs. Appendix J presents a detailed worksheet of the enhanced street sweeping program cost estimate assumptions and calculations.

These costs were included in the Bacteria and Metals TMDL Implementation Plans and are not additional costs specific to the Toxics TMDL Implementation Plan.

Education and Outreach

Cost estimates for an expanded education and outreach program may include the production and distribution communication materials (signs, ads, brochures). The cost estimate for the Education and Outreach program is $2,000,000, and this is expected to cover both metals, bacteria toxic pollutants related education. The operation and maintenance cost is assumed to be 10 percent of this, or $200,000. Since these costs were also included in the Bacteria and Metals TMDL Implementation Plans they are not additional costs specific to the Toxics TMDL Implementation Plan.

Downspout Retrofit Program

The Implementation Plan includes costs associated with the downspout retrofit program. Approximately one-third of the single family homes in Ballona Creek Watershed will be part of the downspout retrofit program, which equates to the 2,600 acres of runoff managed by this program, as shown in Section 5). The average roof area was estimated to be 2,100 square feet, or 0.05 acres. Therefore, there are approximately 52,000 single family homes that will be part of the downspout retrofit program.

Based on the cost estimate for the City WPD downspout retrofit pilot program (City of Los Angeles, 2008), which involved downspout disconnection at 600 properties and had a total cost of $1 million, a unit cost per downspout disconnection is estimated to be $1,700 per property.

Based on 52,000 homes being retrofit, the total capital cost is estimated to be $88.4 million. It is assumed that there will be no operation and maintenance cost for the responsible agencies as the retrofit downspouts will be the responsibility of the property owners.

Since this cost was also included in the Bacteria and Metals TMDL Implementation Plans it is not an additional costs specific to the Toxics TMDL Implementation Plan.

Targeted Pesticide Reduction Program

The Targeted Pesticide Reduction Program is an institutional BMP that involves generally identifying potential significant sources of pesticide loading in the watershed, conducting additional targeted education and outreach efforts to reduce the use of pesticides, encourage alternative less toxic products and find alternaites to using pesticides, and potentially modify existing ordinances if enforcement is necessary. The cost associated with this BMP has been estimated to be $1 million per year. This BMP is specific to the Toxics TMDL Implementation Plan and is an incremental cost that is to be considered in addition to the costs presented in the Bacteria and Metals TMDL Implementation Plans.

6.5 Implementation Plan Costs

As stated, this Toxics TMDL Implementation Plan was developed in combination with the Ballona Creek Bacteria and Metals TMDL Implementation Plans. The costs presented in Table 6-3 represent the cost already included in the Bacteriaand Metals TMDL Implementation Plans for the distributed BMPs, regional BMPs, LFTFs, and institutional BMPs. Based on information provided in previous sections, average "per acre" costs were calculated and applied to estimate the overall costs of the structural BMP program when applied across the Ballona Creek Watershed.

The increase in cost for implementation of the Toxics TMDL Implementation Plan is the O&M cost of $1 million per year, as presented in Table 6-4. This represents the cost for the toxic specific BMP, which are the "Target Pesticide Reduction Program."

The total capital cost is estimated to be $1.3 billion, with $38 million in O&M costs.

Implementation of this plan is subject to the availability of the necessary funding. Currently none of the BMPs and projects identified in this plan are funded, except for some of the institutional measures. Responsible jurisdictions continue to pursue funding alternatives in partnership with each other.

Table 6-3
Total Costs from the Ballona Creek Bacteria and Metals TMDL Implementation Plans[1]

Ballona Creek Watershed BMPs	Treated Acres [2]	Capital Cost per Treated Acre	Total Capital Cost	O&M Costs per acre	Annual O&M
Structural BMPs					
Distributed BMPs	*10,100*[3]	$68,000	$686,800,000	*$2,800*	$18,180,000
Regional BMPs	*1,840*	$22,500	$41,400,000	*$600*	$1,100,000
Low Flow Treatment Facility-1 (NOTF)			$10,600,000		$1,060,000
Low Flow Treatment Facility-2 (Oval St)			$14,700,000		$1,470,000
Institutional BMPs					
Enhanced Street Sweeping			$840,000		$600,000
Downspout Disconnection			$88,400,000		$0
Enhance Pet Waste Pickup and Education Program			$2,000,000		$200,000
Target Zinc Reduction Program					$1,000,000
Copper Brake Pad Product Replacement Program					$100,000
Subtotal			**$840,000,000**		**$23,700,000**
Program Management, Engineering, Administration, and Monitoring (20% of capital cost)[4]			$170,000,000		$4,700,000
Program Contingency (30%)			$250,000,000		$7,100,000
Total Cost			**$1,260,000,000**		**$36,000,000**

[1] Selected BMPs will address multiple pollutants including bacteria, metals and toxicity.
[2] Treated Acres based on draft Implementation Plan selected scenario assuming distributed BMP deployment as required to meet Bacteria, Metals and Toxics TMDL load reduction target and 8 Regional BMP facilities. See Section 5.
[3] Excludes the acres that will be retrofit through the SUSMP program, as these costs would not be the responsibility of the responsible jurisdictions.
[4]The responsible agencies will require additional resources in order to manage the BMPs implementation described in this Implementation Plan. The costs associated with this include administration, engineering, and ongoing monitoring of the program. The costs are estimated to be 20% of the total capital costs, or $160,000,000 through 2021. This cost would include increased staff for oversight of the design and implementation of the structural BMPs as well as implementation of the institutional BMPs (reviewing and enhancing existing policies, etc, as listed in Appendix G).

Table 6-4
Total Costs for Bacteria, Metals and Toxics TMDL Implementation Plans[1]

Ballona Creek Watershed BMPs	Total Capital Cost	Annual O&M
Additional Institutional BMPs for Toxics TMDL Compliance		
Target Toxics Reduction Program		$1,000,000
Subtotal for Additional Institutional BMPs for Toxics TMDL Compliance		**$1,000,000**
Additional Program Management, Engineering, Administration, and Monitoring (20% of capital cost)[2]		$200,000
Additional Program Contingency (30%)		$300,000
Total Increase for Toxics TMDL Compliance		**$1,500,000**
Total Cost from Bacteria and Metals TMDL Implementation Plans	$1,260,000,000	$36,000,000
Total Cost for Implementation of Metals, Bacteria and Toxics TMDL Implementation Plans	**$1,260,000,000**	**$38,000,000**

[1] Included are the costs estimated to implement both the Bacteria, Metals and Toxics TMDL Implementation Plans.
[2]The responsible agencies will require additional resources in order to manage the BMPs implementation described in this Implementation Plan. The costs associated with this include administration, engineering, and ongoing monitoring of the program. The costs are estimated to be 20% of the total capital costs. This cost would include increased staff for oversight of the design and implementation of the structural BMPs as well as implementation of the institutional BMPs (reviewing and enhancing existing policies, etc, as listed in Appendix G).

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