Los Angeles River Watershed Bacteria Total Maximum Daily Load

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California Regional Water Quality Control Board
Los Angeles Region
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Acronyms

303(d) list	State of California Clean Water Act section 303(d) List of Water Quality Limited Segments
BMPs	Best Management Practices
BSI	Bacteria Source Identification Study
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CMP	Coordinated Monitoring Plan
CREST	Cleaner Rivers through Effective Stakeholder-led TMDLs
CWA	Clean Water Act
EO	Executive Officer
HFS	High Flow Suspension
IRP	Integrated Resources Plan
LA	Load Allocation
LACDPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LAX	Los Angeles International Airport
LDC	Load Duration Curve
LFD	Low Flow Diversion
LID	Low Impact Development
LRS	Load Reduction Strategy
mgd	Million Gallons per Day
mL	Milliliter
MOS	Margin of Safety
MPN	Most Probably Number
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OWTS	Onsite Wastewater Treatment Systems
O&M	Operation and Maintenance
SCCWRP	Southern California Coastal Water Research Project
SEA	Significant Ecological Areas
SSO	Sanitary Sewer Overflows
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
USEPA	United States Environmental Protection Agency
WDR	Waste Discharge Requirement
WLA	Waste Load Allocation
WRP	Water Reclamation Plant

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1 INTRODUCTION

The Los Angeles River is unlike any other river. The natural waterway, so greatly altered that it is now sometimes maligned as mere “concrete ditch”, has an important past, present and future. The river is the nearest natural waterbody for many millions of people and the namesake river for the City and County of Los Angeles. Because the mainstem of 55 miles is mostly concrete -and much of the principal tributaries, are concrete- many may see the Los Angeles River only as a flood control channel. And while that use is important, so much more can be, and is, expected from the Los Angeles River. In addition to the beneficial uses identified, below, the River’s potential, as identified in the Los Angeles River Master Plan, as required by the Clean Water Act and Porter Cologne Water Quality Control Act, and as detailed in this and other TMDLs is such that all parties are compelled to take aggressive action to protect and restore this river.

This Staff Report documents the development of a Total Maximum Daily Load (TMDL) to address impairments of water quality standards for bacteria in the Los Angeles River Watershed (see Figure 1-1). The Staff Report describes the water bodies and their beneficial uses, bacteria objectives for supporting the beneficial uses, water quality data documenting impairments, sources of bacteria and their linkage to water quality, waste load and load allocations, and sets forth an implementation plan to attain water quality standards.

This TMDL and Staff Report are based on the original work conducted by the “Cleaner Rivers through Effective Stakeholder-led TMDLs” (CREST) stakeholder group, a stakeholder effort initiated by the City of Los Angeles for the purpose of developing TMDLs to restore and protect water quality in the Los Angeles River. CREST conducted a groundbreaking study of the dry weather storm drain system inputs to the Los Angeles River referred to in these documents as the “Bacteria Source Identification” study (BSI study). This study sampled every storm drain in selected reaches of the Los Angeles River and documented the bacterial inputs and variability from urban areas in the most complete fashion to date. With stakeholders, the City of Los Angeles’s CREST team established reference conditions for dry and wet weather and developed a detailed dry weather implementation plan with a schedule and estimates of costs. CREST held many stakeholder meetings and workshops and wrote a technical report with sections that parallel the TMDL sections upon which most of this staff report depends.

This TMDL considers the entire mainstem of the Los Angeles River from above Sepulveda Basin to the estuary and the tributaries including Bell Creek, Tujunga Wash below Hansen Dam, Verdugo Wash, Arroyo Seco, Rio Hondo, and Compton Creek.

Figure 1-1 Map of the Los Angeles River Watershed

1.1 Regulatory Background

The State of California's principal water quality law is the Porter-Cologne Water Quality Control Act (Porter-Cologne Act). The Porter-Cologne Act is implemented in the Los Angeles Region (i.e., Los Angeles and Ventura Counties) by the California Water Quality Control Plan, Los Angeles Region (Basin Plan). The Basin Plan sets water quality standards for the Los Angeles Region, which includes beneficial uses for surface and ground water with numeric and narrative objectives necessary to support those uses, and the state's antidegradation policy. The Basin Plan also describes implementation programs to protect all waters in the region. The Basin Plan lists numeric water quality objectives for indicator bacteria in fresh waters, which apply to the Los Angeles River and its tributaries. These plans are required to comply with the federal Clean Water Act (CWA). Section 303(d)(1)(A) of the CWA requires each state to conduct a biennial assessment of its waters, and identify those waters that are not achieving water quality standards. The resulting list is referred to as the 303(d) list (LARWQCB, 2006b; 2003a). The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and to develop and implement TMDLs for these waters (40 CFR §130.7).

A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR §130.2) such that the capacity of the water body to assimilate pollutant loads (the loading capacity) is not exceeded. The elements of a TMDL are described in Code of Federal Regulations, title 40, section 130.2 and section 130.7 (40 CFR §130.2 and §130.7) and Section 303(d) of the CWA, as well as in United States Environmental Protection Agency (USEPA) guidance (USEPA, 1991). TMDLs must take into account seasonal variations and include a margin of safety to address uncertainty in the analysis (40 CFR §130.7(c)(1)). A TMDL allocates pollutant loadings to point and nonpoint sources. Finally, TMDLs must be included or referenced in States' water quality management plans (40 CFR §130.6 (c)(1)).

The USEPA has oversight authority for the 303(d) program and is required to review and either approve or reject the State's 303(d) list and each TMDL developed by the state. If the State fails to develop a TMDL in a timely manner or if the USEPA disapproves a TMDL submitted by a state, EPA is required to establish a TMDL for that water body (40 CFR §130.7(d)(2)).

As part of its 1996 and 1998 regional water quality assessments, the Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998b). A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (*Heal the Bay Inc., et al. v. Browner, et al.* C 98-4825 SBA) approved on March 22, 1999. For the purpose of scheduling TMDL development, the consent decree combined the over 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical unit 15 consists of segments of the Los Angeles River and tributaries with impairments related to coliform bacteria.

Bacterial water quality standards protect human health. Monitoring of all potential waterborne pathogens is infeasible, therefore fecal indicator bacteria are used to predict the presence of pathogens and/or fecal sources. Epidemiological studies have been used to develop recreational water quality criteria given an accepted health risk. Recreational water quality criteria are currently based on epidemiological studies that simultaneously measured densities of fecal indicator bacteria (*E. coli*, fecal coliform, total coliform, and/or Enterococcus) and rates of highly-credible gastrointestinal illness and other adverse health effects in swimmers (Cabelli *et al.*, 1981; Dufour, 1984; Haile *et al.*, 1999).

Since the 1950s, numerous epidemiological studies have been conducted around the world to investigate the possible links between swimming in fecal-contaminated waters and health risks. However, as shown in several large-scale epidemiological studies of recreational waters, other health outcomes such as skin rashes, respiratory ailments, and eye and ear infections are also associated with swimming in fecal-contaminated water. Many of these studies have been conducted in areas of known human sewage contamination; others have been conducted in areas where the sources of fecal contamination were unknown. A Santa Monica Bay study (Haile et al., 1999) found swimming in urban runoff-contaminated waters resulted in an increased risk of chills, ear discharge, vomiting, coughing with phlegm and significant respiratory diseases. These studies demonstrate that there is a causal relationship between illness and recreational water quality, as measured by fecal indicator bacteria densities.

Los Angeles Regional Water Quality Control Board Staff (Regional Board Staff) proposes to use the reference system, antidegradation approach for this TMDL. The reference system/antidegradation approach recognizes the fact that there are natural sources of bacteria that may cause or contribute to exceedances of bacteria water quality standards as allowed by the Region's implementation for the REC-1 bacteria objectives. This approach allows a certain number of days when the single sample bacteria objectives may be exceeded. The number is based on historic exceedance levels at local reference sites.

In essence, the reference system approach recognizes natural sources and focuses this TMDL to set waste load allocations and load allocations such that anthropogenic sources of bacteria do not cause or contribute to exceedances of bacteria water quality standards.

The reference system approach ensures water quality comparable to that of reference systems while being consistent with state and federal antidegradation policies. This is accomplished by requiring that, if current water quality is better than that of the reference system, then no degradation of existing water quality is permitted.

1.2 Environmental Setting

The Los Angeles River Watershed has a varied terrain consisting of mountains, low lying foothills, valleys and coastal plains. The area is bounded on the north by the Santa Susanna and San Gabriel Mountains whose hillside slopes exceed 68% and stream gradients range up to 3,000 feet per mile (57%). From the outwash fans at the northern edge of this alluvial plain to the top of the higher peaks there is a difference in elevation of as much as 4,500 feet (County of Los Angeles, 1996).

Due to major flood events at the beginning of the century, most of the Los Angeles River Watershed was lined with concrete between the 1940s to 1950s. The sections lined with concrete include: Arroyo Calabasas from Valley Circle to Los Angeles River, Bell Creek form Highlander Rd. to Los Angeles River, Caballero Creek, Browns Creek, Aliso Canyon Wash, Bull Creek from San Fernando Rd. to the beginning of the Sepulveda Basin, Tujunga Wash from Hansen Dam to Los Angeles River, Pacoima Wash from Lopez Dam to Los Angeles River, Burbank Western Channel, Verdugo Wash and tributaries, Arroyo Seco from Devils Gate Dam to Los Angeles River, Rio Hondo and tributaries (Alhambra Wash, Rubio Wash, Eaton Wash, Arcadia Wash, Santa Anita Wash, Sawpit Wash), and most of Compton Creek (LARWQCB, 1998a). Only three sections of main channel remain soft-bottom. These sections include the Sepulveda Basin, Glendale Narrows, and the lower reaches of the main channel from Willow Street to the estuary, though this portion still retain concrete-lined sides.

1.2.1 Reach Definition

The Los Angeles River flows for 55 miles from the Santa Monica Mountains at the western end of the San Fernando Valley to the Long Beach Harbor and into the Pacific Ocean. The entire watershed includes a total stream length of 837.62 miles and 4.6 square miles of lake area, based on the Regional Board GIS Database (see Figure 1-2 for the detailed reach map).

The headwaters of the Los Angeles River are located in the Santa Monica Mountains at the confluence of Arroyo Calabasas and Bell Creek (LARWQCB, 1998a). From this point the river flows east to the Sepulveda Flood Control Basin at Balboa Blvd and is designated as Los Angeles River Reach 6. Tributaries in this reach include Browns Canyon, Aliso Canyon Wash, and Bull Creek, which drains the Santa Susanna Mountains.

Reach 5 of the Los Angeles River runs from Balboa Blvd through Sepulveda Flood Control Basin to the Sepulveda Dam. The Basin remains one of the few “soft-bottom” portions of the main channel. The Basin is a 2,150-acre open space designed to collect floodwaters during major storms. Because the area is periodically inundated, it remains in natural or semi-natural conditions and supports a variety of low-intensity uses. The U.S. Army Corps of Engineers owns the entire basin and leases most of the area to the City of Los Angeles Department of Recreation and Parks, which has developed a multi-use recreational area that includes a golf course, playing fields, hiking trails and bicycle paths. The Corps has undertaken a riverside re-vegetation program here, and wind-blown seeds have taken root in the river bed sediments and along the stone and mortar banks (LARWQCB, 1998a). The D.C. Tillman Water Reclamation Plant discharges tertiary treated effluent to this section of the watershed.

Reach 4 of the Los Angeles River runs from the Sepulveda Dam to Riverside Drive. Pacoima Wash and Tujunga Wash are the two main tributaries to this reach. Both tributaries drain portions of the Angeles National Forest in the San Gabriel Mountains. Some of the discharge from Hansen Dam is diverted to spreading grounds for groundwater recharge, but most of the flow enters the channelized portion of the stream.

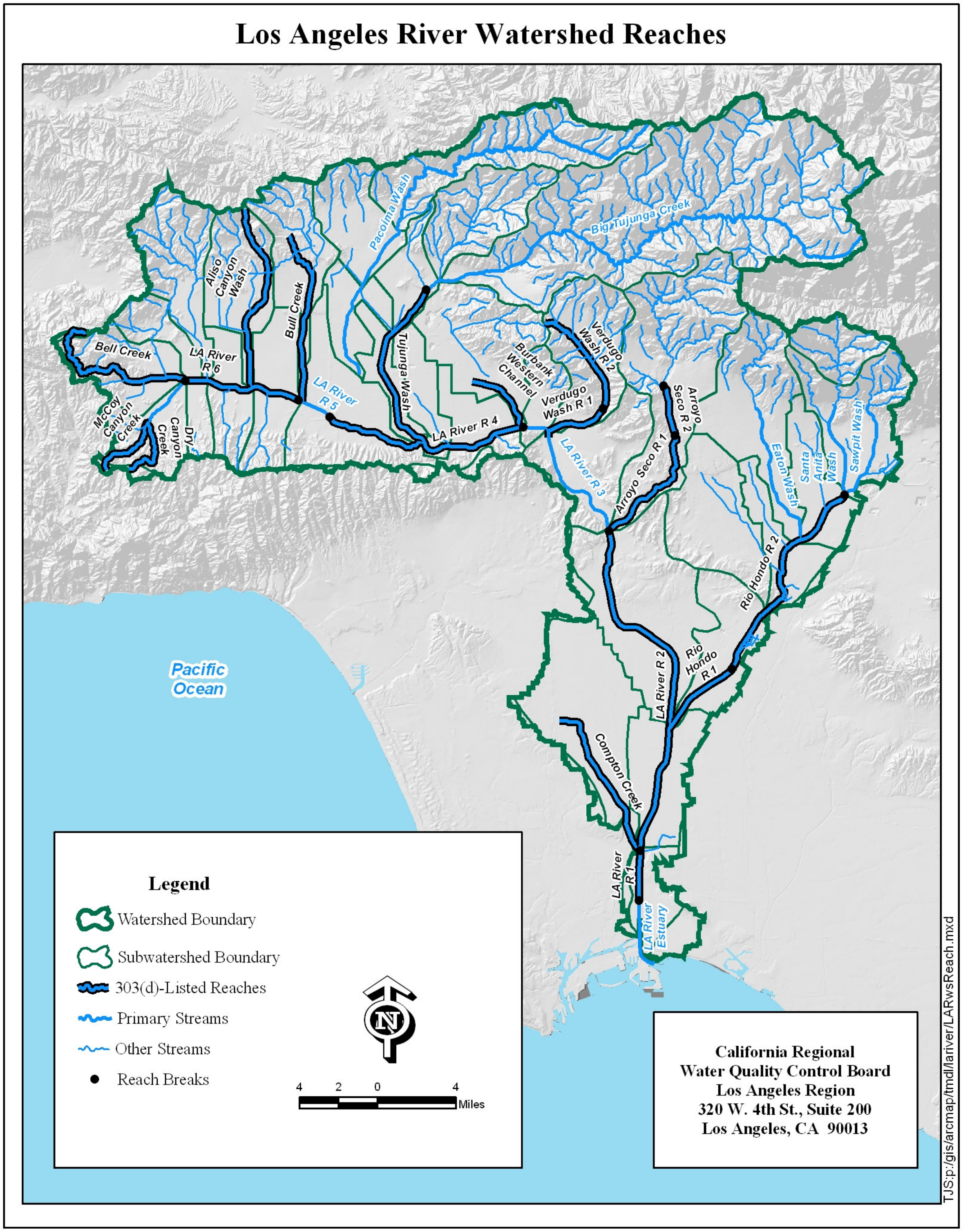
Reach 3 of the Los Angeles River runs from Riverside Drive to Figueroa Street. The two major tributaries to this reach are the Burbank Western Channel and Verdugo Wash, which drains the Verdugo Mountains. Both tributaries are channelized. The Burbank Western Channel receives flow from the Burbank Water Reclamation Plant.

From the eastern end of the San Fernando Valley, the Los Angeles River flows through Griffith Park and Elysian Park, an area known as the Glendale Narrows. This area is fed by natural springs during periods of high groundwater. The river bottom in this area is unlined because historically groundwater routinely discharges into the channel, in varying volumes depending on the height of the water table, maintaining year-long flow at the downstream end of the river. The Los Angeles-Glendale Water Reclamation Plant discharges to the Los Angeles River in the Glendale Narrows.

Reach 2 of the Los Angeles River runs from Figueroa Street to Carson Street. Arroyo Seco is just below Glendale Narrows, which drains areas of Pasadena and portions of the Angeles National Forest in the San Gabriel Mountains. The Rio Hondo and its tributaries drain a large area in the eastern portion of the watershed. At Whittier Narrows, flow from the Rio Hondo can be diverted to the Rio Hondo Spreading Grounds. During dry weather, virtually all the water in the Rio Hondo goes to groundwater recharge, so little or no flow exits the spreading grounds to Reach 1 of the Rio Hondo. During storm events, Rio Hondo flow that is not used for spreading, reaches the Los Angeles River.

Reach 1 of the Los Angeles River, runs from Carson Street to the estuary at Willow St. Major tributaries include Compton Creek. The Los Angeles River Estuary begins at Willow St. where the tidal-influenced portion of the River begins and runs approximately three miles before joining with Queensway Bay located between the Port of Long Beach and the City of Long Beach. In this reach, the channel has a soft bottom with concrete-lined sides. Sandbars accumulate in the portion of the river where tidal influence is limited.

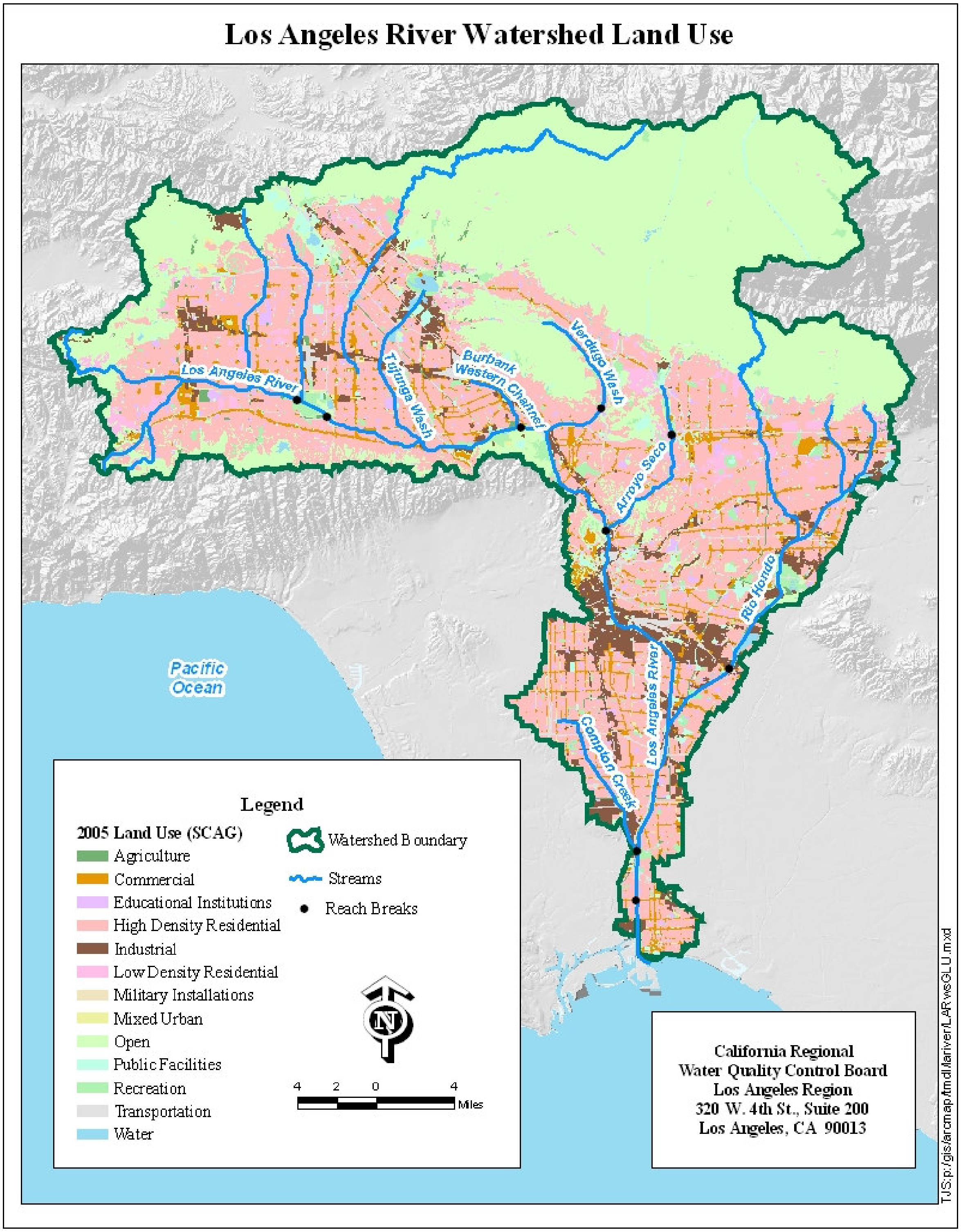
Figure 1-2 Los Angeles River Reach Map



1.2.2 Land Use

The watershed consists of an area of 834 square miles. The foothill and mountainous portions of the Los Angeles River Watershed comprise 363 square miles or about 43 percent of the watershed, and of this area, 272 square miles are within the boundary of the Angeles National Forest (County of Los Angeles, 1996). Approximately 44% of the watershed area can be classified as forest or open space. These areas are primarily within the headwaters of the Los Angeles River in the Santa Monica, Santa Susana, and San Gabriel Mountains, including the Angeles National Forest. Approximately 36% of the land use can be categorized as residential, 10% as industrial, 8% as commercial, and 3% as agriculture, water and other (see Figure 1-3). The more urban uses are found in the lower portions of the watershed.

Figure 1-3 Los Angeles River Watershed Land Use Map



1.2.3 Climate/Rainfall

The Los Angeles watershed has a mild, Mediterranean climate, which is characterized by hot dry summers and cool wet winters. Long-term annual rainfall averages vary from 12.2 inches along the coast, 15.5 inches in downtown Los Angeles, to 27.5 inches in the mountains. The maximum-recorded 24-hour rainfall in the Region was 34 inches in the mountains and 9 inches on the coastal plain (Leadership Committee, 2006).

The City's mean monthly high temperature is 74.1 degrees Fahrenheit with a yearly average of 329 days of sunshine.

1.2.4 Watershed Habitat

Twenty-five different types of habitat in the Los Angeles River watershed were identified by the Natural History Museum of Los Angeles County (LARWQCB, 1998a).

Based on information from the National Wetland Inventory and the Southern California Mapping Project, Regional Board staff has determined that the Los Angeles River Watershed contains approximately 19.82 miles of wetland habitat or roughly12,685 acres.

1.2.4.1 Special Habitat Areas

Currently there are no areas within the Los Angeles River Watershed listed in California State Water Resources Control Board (State Board), "Areas of Special Biological Significance," or listed by the California Coastal Commission as a Critical Coastal Area.

In 2003, the Coastal Commission designated the Santa Monica Mountains as an Environmentally Sensitive Habitat Area (ESHA) (Dixon, 2003). In addition, the County of Los Angeles has dedicated Significant Ecological Areas throughout the Greater Los Angeles County Region. The Greater Los Angeles County Integrated Regional Water Management Plan includes the following discussion of Significant Ecological Areas in Los Angeles County (Leadership Committee, 2006).

> Significant Ecological Areas (SEAs) are ecologically important areas that are designated by the County of Los Angeles as having valuable plant or animal communities. Similar to the SEAs are Environmentally Sensitive Habitat Areas which are designated by the Coastal Commission via local coastal programs.

There are a total of 11 designated SEAs in the Los Angeles River watershed. Below is a figure illustrating the location of all the SEAs in the Los Angeles River Watershed.

Figure 1-4 Map of Significant Ecological Areas in the Los Angeles River Watershed

1.2.4.2 Threatened and Endangered Species

The Federal Endangered Species Act of 1973 (FESA) defines a threatened species as one that is likely to become endangered within the foreseeable future and an endangered species is defined as one that is considered in danger of becoming extinct throughout all or a significant portion of its range (17USC §1531–§1544). FESA does not include a formal definition for species of concern, also known as ‘at-risk’ species, however the United States Fish and Wildlife Service maintains a list for these species. Species of concern is typically defined as species that are declining or appear to be in need of conservation. Rare species are defined as species “…existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens …” or…“the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered “threatened” as that term is used in the Federal Endangered Species Act”

The City of Los Angeles Optimization Study lists 8 bird species, 1 amphibian species, 1 fish species, 3 insect species and 2 plant species as endangered, threatened, rare species or as species of concern in the Los Angeles River watershed (City of Los Angeles, 2003).

2 Problem Identification

The Los Angeles River is highly contaminated by fecal pollution. Many reaches and tributaries exceed the bacterial water quality standards 80 or 90 or even 100% of the time, that is, most or all of the time. The reaches or tributaries with better water quality exceed the indicator bacteria water quality standards roughly 50% of the time. This severely limits the potential for recreational uses of the river.

Bacterial concentrations in the Los Angeles River and tributaries exceed water quality standards during both dry and wet weather.

2.1 CWA Section 303(d) Listed reaches and tributaries

At least 127 miles of Los Angeles River mainstem or tributaries have been included on the State of California's CWA Section 303(d) list as impaired for indicator bacteria.

Table 2-1 Miles of Los Angeles River and Tributaries Listed for coliform or fecal coliform Bacteria

Waterbody Segments Listed	Miles Affected
Los Angeles River Reach 1(from the estuary to Carson St.)[1]	2
Los Angeles River Reach 2 (from Carson St. to Figueroa St.)[1]	19
Los Angeles River Reach 4 (from Sepulveda Dam to Sepulveda Dr.)[1]	12
Los Angeles River Reach 6 (above Sepulveda Flood Control Basin)[1]	6
Aliso Canyon Wash[3]	10
Arroyo Seco Reach 1 (LA River to West Holly Ave)[1]	7
Arroyo Seco Reach 2 (Figueroa St. To Riverside Dr.)[1]	3
Bell Creek[1]	10
Bull Creek[4]	2
Burbank Western Channel[4]	13
Compton Creek[1]	9
Dry Canyon Creek[2]	4
McCoy Canyon Creek[2]	4
Rio Hondo Reach 1 (from the Santa Ana Fwy to LA River)[1]	4
Rio Hondo Reach 2 (at spreading grounds)[1]	3
Tujunga Wash (from Hansen Dam to LA River)[1]	10
Verdugo Wash Reach 1 (from LA River to Verdugo Rd)[1]	3
Verdugo Wash Reach 2 (above Verdugo Rd)[1]	6
Total miles affected	127

[1] First listed on the 1998 303(d) and reference Consent Decree thereafter

[2] First listed on the 2002 303(d)

[3] First listed on the 2006 303(d)

[4] Listed in the Regional Board Approved 2008 303(d) List

2.1.1 Beneficial Uses

The Basin Plan for the Los Angeles Region (1994) defines 14 beneficial uses for the Los Angeles River and its tributaries. These uses are summarized in Table 2-2. The Basin Plan identifies beneficial uses as existing (E), potential (P), or intermittent (I) uses.

Existing use designations for warm freshwater, wildlife, wetland, and rare, threatened or endangered species habitats (WARM, WILD, WET, and RARE) apply over much of the mainstem and Compton Creek in the lower part of the watershed. The WARM designation applies as either an intermittent or potential use to the remaining listed tributaries. The WILD designation is for the protection of fish and wildlife. This use applies to much of the mainstem of the Los Angeles River, as an intermittent use in Rio Hondo, and as potential use in the remainder of the tributaries. Water quality objectives developed for the protection of fish and wildlife are applicable to the reaches with the WARM, WILD, WET and RARE designations.

The Shellfish Harvesting use designation (SHELL) is for waters that support habitats suitable for the collection of shellfish for human consumption, commercial or sports purposes. This use applies as an existing use in the estuary and as a potential use in the lower portion of the River.

Table 2-2 Beneficial Uses in Listed Reaches of the Los Angeles River

STREAM REACH	MUN	GWR	REC1	REC2	WILD	WARM	SHELL	RARE	MIGR	SPWN	WET	MAR	IND	PROC
Los Angeles River (Reach 6)	P*	E	E	E	E	E					E		P	
Aliso Canyon Wash	P*	I	I1	I	E	I								
Bell Creek	P*	I	I	I	E	I								
Bull Creek	P*	I	I	I	E	I								
Dry Canyon Creek	P*	I	I1	I	E	I								
McCoy Canyon Creek	P*	I	I	I	E	I								
Los Angeles River (Reach 4)	P*	E	E	E	E	E					E		P	
Tujunga Wash	P*	I	P1	I	P	P								
Verdugo Wash Reach 1	P*	I	I	I	P	P							I	I
Verdugo Wash Reach 2	P*	I	I	I	P	P							I	I
Burbank Western Channel	P*		P1	I	P	P								
Los Angeles River (Reach 2)	P*	E	E1	E	P	E							P	
Arroyo Seco (Reach 1)	E	E	E	E	E						E		E	E
Arroyo Seco (Reach 2)	E	E	E	E	E						E		E	E
Rio Hondo (Reach 1)	P*	I	P1	E	I	P								
Rio Hondo (Reach 2)	P*	I	P1	E	I	P								
Compton Creek	P*	E	E1	E	E	E					E			
Los Angeles River (Reach 1)	P*	E	E1	E	E	E	P1	E	P	P		E	P	P

(LARWQCB, 1994)

*Municipal designations marked with an asterisk are conditional.
E: Existing beneficial use,
P: Potential beneficial use,
I: Intermittent beneficial use,
1: Use restricted by LACDPW

All of the Los Angeles River and its tributaries including all of the Section 303(d) listed waterways have designated recreational beneficial uses which are listed in Table 2-3. While access is prohibited to much of the Los Angeles River and the concrete-channelized areas of Tujunga, Verdugo, Burbank Western Channel, Arroyo Seco, and Rio Hondo, some human use of these reaches does or may exist and the beneficial use is applicable.

Table 2-3 Recreational Uses in Listed Reaches of the Los Angeles River watershed

Stream Reach	REC-1	REC-2
Los Angeles River (Reach 6)	E	E
Aliso Canyon Wash	I1	I
Bell Creek	I	I
Bull Creek	I	I
Dry Canyon Creek	I1	I
McCoy Canyon Creek	I	I
Los Angeles River (Reach 4)	E	E
Tujunga Wash	P1	I
Verdugo Wash Reach 1	I	I
Verdugo Wash Reach 2	I	I
Burbank Western Channel	P1	I
Los Angeles River (Reach 2)	E1	E
Arroyo Seco (Reach 1)	E	E
Arroyo Seco (Reach 2)	E	E
Rio Hondo (Reach 1)	P1	E
Rio Hondo (Reach 2)	P1	E
Compton Creek	E1	E
Los Angeles River (Reach 1)	E1	E

E: Existing beneficial use
P: Potential beneficial use,
I: Intermittent beneficial use,
$_1$: Access may be restricted in part by LACDPW

2.2 Water Quality Objectives

The Basin Plan contains bacteria water quality objectives to protect the REC-1 and REC-2 beneficial uses. The objectives include geometric mean limits and single sample bacteria indicator limits for fresh waters: including fecal coliform and *E. coli*.

1. Geometric Mean Limits
    1. *E. coli* density shall not exceed 126/100 mL.
    2. Fecal coliform density shall not exceed 200/100 mL.

2. Single Sample Limits
    1. *E. coli* density shall not exceed 235/100 mL.
    2. Fecal coliform density shall not exceed 400/100 mL.

Regional Board staff is in the process of updating the bacteria objectives for freshwaters designated as REC-1 to remove redundancy and maintain consistency with U.S. EPA's recommended criteria. The update of bacteria objectives will remove the fecal coliform objectives and use *E. coli* objectives as the sole objective for freshwaters. To be consistent with the update of bacteria objectives, the numeric targets will be only the adopted Basin Plan objectives for *E. coli* for REC-1 in freshwaters.

Single sample bacteria exceedances are used to determine impairments. Geometric mean limits are also used to determine impairments. Protecting REC-1 beneficial uses will result in the protection of REC-2 beneficial uses because REC-1 bacteria objectives are more stringent than REC-2 bacteria objectives.

Implementation provisions for the water contact recreation bacteria objectives, defined in the Basin Plan Resolution 2001-018, are listed below (LARWQCB, 2001).

> The geometric mean values should be calculated based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period).
>
> If any of the single sample limits are exceeded, the Regional Board may require repeat sampling on a daily basis until the sample falls below the single sample limit or for five days, which ever is less, in order to determine the persistence of the exceedance.
>
> When repeat sampling is required because of an exceedance of any one single sample limit, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

Implementation provisions for the water contact recreation bacteria objectives, defined in the Basin Plan Resolution 2002-22 are listed below (LARWQCB, 2001).

> The single sample bacteriological objectives shall be strictly applied except when provided for in a Total Maximum Daily Load (TMDL). In all circumstances, including in the context of a TMDL, the geometric mean objectives shall be strictly applied. In the context of a TMDL, the Regional Board may implement the single sample objectives in fresh and marine waters by using a 'reference system/antidegradation approach' or

> ‘natural sources exclusion’ approach subject to the antidegradation policies as discussed below. A reference system is defined as an area and associated monitoring point that is not impacted by human activities that potentially affect bacteria densities in the receiving water body.
>
> These approaches recognize that there are natural sources of bacteria, which may cause or contribute to exceedances of the single sample objectives for bacterial indicators. They also acknowledge that it is not the intent of the Regional Board to require treatment or diversion of natural water bodies or to require treatment of natural sources of bacteria from undeveloped areas. Such requirements, if imposed by the Regional Board, could adversely affect valuable aquatic life and wildlife beneficial uses supported by natural water bodies in the Region.
>
> Under the reference system/antidegradation implementation procedure, a certain frequency of exceedance of the single sample objectives shall be permitted on the basis of the observed exceedance frequency in the selected reference system(s) or the targeted water body. The reference system/antidegradation approach ensures that bacteriological water quality is at least as good as that of a reference system and that no degradation of existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of the selected reference system(s).
>
> Under the natural sources exclusion implementation procedure, after all anthropogenic sources of bacteria have been controlled such that they do not cause or contribute to an exceedance of the single sample objectives and natural sources have been identified and quantified, a certain frequency of exceedance of the single sample objectives shall be permitted based on the residual exceedance frequency in the specific water body. The residual exceedance frequency shall define the background level of exceedance due to natural sources. The ‘natural sources exclusion approach subject to the antidegradation policies may be used if an appropriate reference system cannot be identified due to unique characteristics of the target water body. These approaches are consistent with the State Antidegradation Policy (State Board Resolution No. 68-16) and with federal antidegradation requirements (40 CFR 131.12).”

2.2.1 Antidegradation

Both the State of California and the federal government have antidegradation policies for water quality. The State policy is formally referred to as the “Statement of Policy with Respect to Maintaining High Quality Waters in California” (State Board Resolution No. 68-16). This policy restricts degradation of surface or ground waters and protects water bodies where existing quality is higher than is necessary for the protection of beneficial uses. The federal Antidegradation Policy (40 CFR §131.12) was developed under the

Clean Water Act. This TMDL complies with antidegradation policies by requiring water quality adequate to support beneficial uses and by not setting any waste load allocations and load allocations above existing numbers of exceedance days.

2.3 Review of data

The majority of the available bacteria data were collected as part of the City of Los Angeles' Status and Trends monitoring program in the Los Angeles River Watershed. In addition to this data set, receiving water data collected as part of the Monitoring and Reporting Programs for the City of Los Angeles' LA-Glendale and D.C. Tillman Water Reclamation Plants and the Burbank Water Reclamation Plant were also analyzed as well as data from the mass emission and tributary instream monitoring stations under the Monitoring and Reporting Program of the County of Los Angeles' Municipal Separate Storm Sewer System Permit. The data that were analyzed covered the period from November 1997 to February 2008.

The data are expressed in terms of exceedance days of the Basin Plan REC-1 water quality objectives. Exceedance days are days on which sample bacteria densities exceed bacteria water quality objectives for the REC-1 beneficial use.

The data are further separated into wet and dry weather and summer and winter seasons for single sample limits. Summer months cover the months of April through October. Winter months cover the months of November through March. Wet weather days are defined as those days that experience 0.1 inch of rain or more and the three following days (LARWQCB, 2002b).

The Basin Plan implementation provisions for the bacteria objectives do not differentiate between wet and dry weather when applying the geometric mean objectives. As a result, dry and wet weather exceedances were not separately tallied for geometric means.

The calculation of the rolling 30-day geometric mean requires a statistically sufficient number of samples (generally, at least five equally spaced samples) (LARWQCB, 2001).

These data are summarized in terms of exceedance percentages, which are calculated as the sample exceedance count divided by the sample count. The exceedance count and sample count are also listed next to the exceedance percentage in parentheses (see Table 2-4).

Table 2-4 Los Angeles River Watershed Bacteria Exceedances

		Los Angeles River Reach 1	Los Angeles River Reach 2	Los Angeles River Reach 4	Los Angeles River Reach 6
		November 1997 - February 2008	January 2001 - February 2008	October 1998 - February 2008	October 1998 - February 2008
		Exceedance %	Exceedance %	Exceedance %	Exceedance %
Single Sample	Fecal Coliform	86.2% (50/58)	80.0% (4/5)	58.1% (209/360)	75.5% (542/718)
	E. coli	83.1% (226/272)	81.9% (443/541)	52.8% (267/506)	88.6% (304/343)
	Exceedance Days	84.4% (276/327)	82.3% (445/541)	55.0% (476/866)	79.7% (846/1061)
	Dry weather	79.4% (189/238)	79.3% (345/435)	47.9% (373/779)	78.3% (717/916)
	Wet weather	91.6% (87/95)	88.5% (100/113)	72.0% (103/143)	88.4% (129/146)
	Summer	77.0% (134/174)	79.2% (244/313)	57.4% (290/505)	84.0% (524/624)
	Winter	89.3% (142/159)	87.7% (201/229)	51.2% (186/363)	73.5% (322/438)
Geometric Means	Fecal Coliform	100.0% (11/11)	N/A	95.5% (592/620)	98.7% 1233/1249)
	E. coli	100.0% (22/22)	100.0% (59/59)	100.0% (71/71)	100.0% (35/35)
	Exceedance Days	100.0% (33/33)	100.0% (59/59)	95.9% (663/691)	98.8% (1268/1284)
	Summer	100.0% (3/3)	100.0% (6/6)	99.8% (432/433)	99.5% (849/853)
	Winter	100.0% (30/30)	100.0% (53/53)	88.8% (231/260)	97.2% (419/431)

		Aliso Canyon	Arroyo Seco Reach 1	Bull Creek	Burbank Western Channel
		January 2002 - February 2008	January 2002 - February 2008	January 2002 - February 2008	January 2002 - February 2008
		Exceedance %	Exceedance %	Exceedance %	Exceedance %
Single Sample	Fecal Coliform	80.0% (4/5)	100.0% (10/10)	100.0% (10/10)	87.5% (14/16)
	E. coli	91.5% (65/71)	69.5% (66/95)	64.6% (51/79)	53.3% (48/90)
	Exceedance Days	86.8% (66/76)	72.5% (74/102)	67.4% (58/86)	57.3% (59/103)
	Dry weather	86.2% (56/65)	73.0% (65/89)	65.3% (47/72)	58.7% (54/92)
	Wet weather	90.9% (10/11)	69.2% (9/13)	78.6% (11/14)	45.5% (5/11)
	Summer	86.0% (37/43)	76.9% (50/65)	77.6% (38/49)	67.9% (38/56)
	Winter	87.8% (29/33)	64.9% (24/37)	54.1% (20/37)	44.7% (21/47)
Geometric Means	Fecal Coliform	N/A	N/A	N/A	N/A
	E. coli	N/A	100.0% (64/64)	N/A	N/A
	Exceedance Days	N/A	100.0% (64/64)	N/A	N/A
	Summer	N/A	100.0% (64/64)	N/A	N/A
	Winter	N/A	N/A	N/A	N/A

		Compton Creek	Rio Hondo Reach 1	Tujunga Wash	Verdugo Wash Reach 1
		January 2002 - February 2008	January 2002 - February 2008	January 2002 - February 2007	January 2002 - February 2007
		Exceedance %	Exceedance %	Exceedance %	Exceedance %
Single Sample	Fecal Coliform	87.5% (14/16)	90.9% (10/11)	100.0% (4/4)	100.0% (4/4)
	E. coli	53.3% (48/90)	69.1% (56/81)	75.7% (56/74)	89.9% (71/79)
	Exceedance Days	57.3% (59/103)	79.0% (64/81)	76.0% (57/75)	92.5% (74/80)
	Dry weather	58.7% (54/92)	78.3% (54/69)	77.6% (52/67)	92.8% (64/69)
	Wet weather	45.5% (5/11)	83.3% (10/12)	62.5% (5/8)	90.9% (10/11)
	Summer	90.5% (38/42)	49.2% (38/48)	91.1% (41/45)	95.8% (45/47)
	Winter	63.4% (21/33)	68.8% (22/32)	55.2% (16/29)	87.9% (29/33)
Geometric Means	Fecal Coliform	N/A	N/A	N/A	N/A
	E. coli	N/A	N/A	N/A	N/A
	Exceedance Days	N/A	N/A	N/A	N/A
	Summer	N/A	N/A	N/A	N/A
	Winter	N/A	N/A	N/A	N/A

*Note: Exceedance % = Exceedance Count ÷ Sample Count

3 Numeric Targets

The TMDL includes numeric targets based on the bacteria objectives for fresh waters designated for water contact recreation (REC-1) (LARWQCB, 2001). These objectives are consistent with those recommended by the USEPA in "Ambient Water Quality for Bacteria – 1986" (USEPA, 1986).

The Basin Plan contains bacteria water quality objectives to protect the REC-1 and REC-2 beneficial uses. The objectives include geometric mean and single sample limits for indicator bacteria including fecal coliform and *E. coli* in fresh waters.

1. Geometric Mean Limits
    a. ***E. coli* density shall not exceed 126/100 mL.**
    b. Fecal coliform density shall not exceed 200/100 mL.

2. Single Sample Limits
    a. ***E. coli* density shall not exceed 235/100 mL.**
    b. Fecal coliform density shall not exceed 400/100 mL.

Regional Board staff is in the process of updating the bacteria objectives for freshwaters designated as REC-1 to remove redundancy and maintain consistency with USEPA's recommended criteria. The update of bacteria objectives will remove the fecal coliform objectives and use *E. coli* objectives as the sole indicator bacteria objective for freshwaters. To be consistent with the update of bacteria objectives, the numeric targets for this TMDL will be only the Basin Plan objectives for *E. coli* for REC-1 in freshwaters.

3.1 Alternative Targets Considered

Three alternatives were considered for developing the appropriate numeric targets to achieve the water quality standards:
(1) strict application of the water quality objectives as listed in the Basin Plan with no allowable exceedance, (2) the Natural Sources Exclusion Approach, and (3) the Reference System/Antidegradation Approach with specific exceedance day frequencies. The factors considered when selecting the recommended alternative included:

- Consistency with state and federal water quality laws and policies,
- Level of beneficial use protection,
- Consistency with current science regarding water quality necessary to protect the beneficial uses, and
- Practicability for the Los Angeles River Watershed.

3.2 Recommended Alternative

Some of these alternatives recognize that there are natural sources of bacteria, which may cause or contribute to exceedances of the water quality objectives for bacteria indicators (Schiff *et al.*, 2005). The Regional Board acknowledges in the implementation provisions for the bacteria objectives in the Basin Plan that it is not the intention of the Regional Board to require treatment or diversion of natural water bodies or to require treatment of natural sources of bacteria from undeveloped areas.

For this TMDL, alternative (3) is the recommended alternative because this alternative allows the Regional Board to avoid imposing requirements to divert natural coastal creeks or treat natural sources of bacteria from undeveloped areas. This approach includes allowable exceedance levels during dry weather and wet weather. This approach will be explored in greater detail in latter parts of the Staff Report.

The recommended numeric targets will be assessed as the allowable number of single sample exceedance days for each site because the frequency of single sample exceedances is most relevant to public health. The USEPA allows states to select the most appropriate measure to express the TMDL. Allowable exceedance days are considered an “appropriate measure” consistent with the definition in 40 CFR §130.2(i). The number of allowable exceedance days is calculated from reference reaches while observing strict antidegradation policies. Targets will apply at compliance monitoring locations (17 CCR §7961(b)).

Alternative 1 requires strict application of the water quality objectives as listed in the Basin Plan with no allowable exceedances. This alternative is not recommended. Strict application of objectives would fail to consider natural sources of bacteria and required treatment in excess of natural water quality levels.

Alternative 2 is a natural sources exclusion approach. Based on the implementation provisions for the bacteria objectives contained in the Basin Plan, this approach requires an identification and quantification of naturally-occurring sources of bacteria. Additionally, prior to applying this implementation approach, all anthropogenic sources must be controlled such that they do not cause or contribute to exceedances of the bacteria objectives. Once quantified, natural source levels become the baseline bacteria level. The exceedances caused by natural sources are used to quantify the allowable exceedance frequency and becomes the allowable exceedance frequency. However, information sufficient to quantify all naturally-occurring sources of indicator bacteria does not exist at this time.

3.3 Wet Weather

Wet weather is defined as days with 0.1 inch of rain or more plus three days following the rain event. REC-1 uses associated with the “swimmable” goal as expressed in the federal Clean Water Act are suspended through the High Flow Suspension (HFS) Basin Plan Amendment (LARWQCB, 2003b), which is applied to certain reaches and tributaries that are concrete-lined channels during days with greater than or equal to 0.5

inch of rain and the following 24 hours. Table 3-1 includes the waterbodies in the Los Angeles River Watershed that are subject to the HFS.

Table 3-1 Los Angeles River Reaches and Tributaries High Flow Suspension (HFS)

Stream Reach	Hydro Unit
Los Angeles River to Estuary	405.12
Los Angeles River	405.15
Los Angeles River	405.21
Rio Hondo below Spreading Grounds	405.15
Rio Hondo to Spreading Grounds	405.15
Rio Hondo	405.41
Verdugo Wash	405.24
Burbank Western Channel	405.21
Tujunga Wash	405.21

3.4 The Continuing Process

The science of recreational water quality is rapidly advancing. The federal BEACH Act (40 CFR 32.1) requires USEPA to conduct a *Criteria Development Plan* (R/7-097-432). Under the ongoing *Plan*, the USEPA is conducting additional epidemiological studies and quantitative microbial risk assessments (QMRAs) for fresh- and marine waters impacted by point- and nonpoint sources (Boehm *et al.*, 2009). The assays being utilized by USEPA include *Enterococcus*, *E. coli*, and *Bacteroidales*. Under a legal settlement, USEPA is committed to issuing new and/or revised criteria by October 15, 2012. The State will likely have several years to implement these new/revised criteria after promulgation by USEPA. Therefore, during the expected timeframe for implementation of this TMDL, targets, themselves, may change and this TMDL may be revised by the Regional Board through a Basin Plan Amendment, if appropriate.

4 Source Assessment

The challenge of identifying and quantifying potential bacteria sources in the Los Angeles River watershed is large; the watershed includes over 1,000 miles of connected storm drain infrastructure, and a population of more than 10 million people. The sources of bacteria to the Los Angeles River from the 834-square mile watershed are many and possibly include, but are not limited to, domestic pets, horses, direct human inputs all contributing to the bacteria in the urban runoff, leaks and overflows from wastewater collection systems, illicit connections, failing septic systems, and sediments.

A TMDL requires an estimate of loadings from point sources and nonpoint sources. Point sources typically include discharges from a discrete human-engineered point (e.g., a pipe from a wastewater treatment plant or industrial facility). These types of discharges are regulated through a National Pollutant Discharge Elimination System (NPDES) permit, typically issued in the form of Waste Discharge Requirements (WDRs) issued by the Regional Board. These permits along with other permits are summarized in Table 4-1. Nonpoint sources include pollutants that reach waters from a number of diffuse sources.

However, the regulatory distinction between point and nonpoint sources is blurred in the Los Angeles Region. Storm drain system discharges may have elevated levels of indicator bacteria due to sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, pet waste, and illegal discharges from recreational vehicle holding tanks, among others. The indicator bacteria used to assess water quality are not specific to human sewage; therefore, fecal matter from animals and birds can also be a source of elevated levels of bacteria.

A comprehensive analysis of the potential sources of bacteria and pathogens in the watershed was generated by the CREST stakeholder group (CREST Appendix A). Monitoring datasets from various agencies in the watershed were compiled and analyzed as presented in CREST Appendix A. Available information for potential bacteria and pathogen sources in the watershed for which discharges are not well characterized (e.g., industrial discharges, onsite wastewater treatment systems, etc.) were also summarized by CREST.

4.1 Point Sources

Many point sources to the Los Angeles River are permitted by the Regional Board.

Table 4-1 Summary of Permits in the Los Angeles River Watershed

Permit Type	Number of Permits
Municipal Storm Water and Urban Runoff	2
Major NPDES Discharges	5
WRPs	3
Industrial Storm Water	1,384
Construction Storm Water	759
Industrial Waste Water	40
Minor NPDES Discharges	15
General NPDES Discharges	113
Caltrans Storm Water	1

(CREST, 2009a; LARWQCB, 2007)

4.1.1 Municipal Storm Water

There are currently three municipal separate storm sewer system (MS4) NPDES permits that cover discharges in the Los Angeles River Watershed. These include the Los Angeles County Permittees (excluding the City of Long Beach), City of Long Beach, and Caltrans permits, which are listed in Table 4-2. The Caltrans permit is a statewide storm water permit.

Table 4-2 MS4 Permits in the Los Angeles River Watershed

Permit Number	Order Number	Permittee
CAS004001	01-182	Los Angeles County Flood Control District, Los Angeles County, and 84 incorporated cities
CAS004003	99-060	City of Long Beach
CAS000003	99-06 DWQ	Caltrans

The Los Angeles County MS4 permit covers roughly 96% of the total urban watershed, the City of Long Beach permit covers approximately 3%, located in the downstream portion of the river, and the Caltrans permit covers approximately 6,950 acres, which is equivalent to around 1% of the urban watershed (CREST, 2009a; LARWQCB, 2005). The City of Los Angeles has estimated that there may be more than 1,980 storm drain outfalls that discharge to segments and tributaries of the river within the City of Los Angeles along with as many as 1,735 outfalls outside of the City of Los Angeles that discharge to the segments and tributaries (CREST, 2010). Many of these outfalls only flow during wet weather.

Ackerman *et al.* found that storm drains contribute roughly 13% of the flow in the Los Angeles River in dry weather, while WRPs contribute roughly 72% of the flow during dry weather. With this flow, storm drains were contributing almost 90% of the *E. coli* loading (Ackerman *et al.*, 2003). *E. coli* concentrations were found to be as much as four orders of magnitude higher in storm drain discharges than in the WRP discharges.

During dry weather, flows into storm drains consist of residential and commercial runoff from activities such as over-irrigation, car washes, pavement cleaning, etc. Though MS4 permittees are required to have programs to prevent illicit discharges and connections, bacteria loading from these sources may also contribute to loading.

The CREST development team conducted extensive outfall monitoring and sampling in Reaches 2 and 4 of the Los Angeles River mainstem. The results were summarized in the Los Angeles River Bacteria Source Identification Study (BSI) study (CREST, 2008). Flow rates varied widely as well as loading per storm drain varied widely so that some outfalls with very low flows contributed very high loads (CREST, 2009a).

During wet weather, WRP discharges may account for as little as 1% of the total flow in the river (CREST, 2009a). SCCWRP conducted a storm water urban runoff study for the greater Los Angeles area (Stein *et al.*, 2007). The study found bacteria concentrations were typically orders of magnitude higher for highly developed watersheds (i.e., Los Angeles River Watershed) compared to undeveloped watersheds (i.e., Arroyo Sequit Watershed). The study also found that agricultural, industrial, and horse recreational land uses had the highest indicator bacteria concentrations observed though all land uses had concentrations well above the water quality objectives.

While there are many sources of indicator bacteria to the MS4, the MS4 is the principal source of bacteria to the Los Angeles River in both dry weather and wet weather.

4.1.2 Major NPDES Discharges

There are five major NPDES dischargers in the Region. These five dischargers include three WRPs and two other facilities. The permittee descriptions are detailed in Table 4-3.

Table 4-3 Major Dischargers in Los Angeles River Watershed

Permit Number	Order Number	Permittee	Facility
CA0052949	R4-2005-0028	Plains West Coast Terminals	Dominguez Hills Tank Farm
CA0001309	R4-2009-0058	The Boeing Company	Santa Susana Field Lab
CA0056227	R4-2010-0060	City of Los Angeles	Donald C. Tillman Water Reclamation Plant
CA0053953	R4-2006-0092	City of Los Angeles	Los Angeles-Glendale Water Reclamation Plant
CA0055531	R4-2006-0085	City of Burbank	Burbank Water Reclamation Plant

Plains West Coast Terminals, LLC Dominguez Hills Tank Farm has a permitted discharge of up to 4.32 mgd of hydrostatic test water, fuel equipment wash water and storm water runoff to Compton Creek. The Boeing Company Santa Susana Field Lab discharges up to 160 mgd of storm water (based on the 24-hour duration, 10-year return storm event) mixed with industrial wastewater to Bell Creek via two discharge points (LARWQCB, 2005). Neither discharger is required to monitor for bacteria in their current permit and are not known to be a significant source of bacteria to the watershed.

4.1.2.1 Wastewater Reclamation Plants

There are three main Water Reclamation Plants (WRP) that discharge into the Los Angeles River and a tributary, the Burbank Western Wash. These WRPs include the Donald C. Tillman Water Reclamation Plant, Los Angeles-Glendale Water Reclamation Plant, and the Burbank Water Reclamation Plant. During dry weather, effluent discharged from these plants accounts for roughly 72% of the flow in the river (Ackerman *et al.*, 2003). During wet weather, WRPs account for less than 1% of the total flow in the river (CREST, 2009a). These WRPs have a permitted effluent limit of 2.2 MPN/100 mL for bacteria, which is well below the levels necessary to protect the REC-1 beneficial use.

The Tillman plant discharges approximately 53 million gallons per day (mgd) to the Los Angeles River. Most of the flow is discharged directly into the Los Angeles River Reach 4. However, a portion of the flow goes into a recreational lake, which then drains into

Bull Creek and Hayvenhurst Channel and back into the Los Angeles River Reach 5. Another portion of the flow goes to a wildlife lake, which then drains into Haskell Channel and ultimately back into the Los Angeles River Reach 5 (LARWQCB, 2005). Some of the flow is also discharged into the Japanese Garden near the main plant (CREST, 2009a).

The Los Angeles-Glendale plant discharges approximately 13 mgd directly into Reach 3 of the Los Angeles River in the Glendale Narrows downstream from Colorado Boulevard. Approximately four mgd of the treated wastewater is used for irrigation and industrial uses.

The Burbank Plant discharges approximately four mgd directly into the Burbank Western Channel. A significant portion of the effluent is reclaimed for irrigation and treated water is also used as cooling water for the Burbank Steam Power Plant.

Effluent limits in the NPDES permits for the three WRPs require (1) the median number of total coliform organisms in effluent not to exceed 2.2 per 100 milliliters and (2) the number of total coliform organisms cannot exceed 23 per 100 milliliters in more than one sample within any 30-day period. Consequently, the WRP are not considered to be a source of exceedances of the bacteria water quality objectives in the river.

4.1.3 Other Storm Water Permits

As of November 2008, there were approximately 1,384 permits issued under the Statewide Industrial Activities Storm Water General Permit in the watershed (CREST, 2009a) and 759 permits issued under the Statewide Construction Activities Storm Water General Permit (LARWQCB, 2007).

The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP will contain a site map(s) which shows the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography both before and after construction, and drainage patterns across the project. The SWPPP must list Best Management Practices (BMPs) the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment. (SWRCB, 2010a)

The Industrial Storm Water General Permit, Order 97-03-DWQ (General Industrial Permit), is an NPDES permit that regulates discharges associated with 10 broad categories of industrial activities. The General Industrial Permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The General Industrial Permit also requires the development of a SWPPP and a monitoring plan. Through the

SWPPP, sources of pollutants are to be identified and the means to manage the sources to reduce storm water pollution are described. (SWRCB, 2010b).

4.1.4 Other General NPDES Permits, Minor Individual NPDES Permits, and Industrial Waste Water Permits

The Regional Board has issued general NPDES permits for construction dewatering, industrial wastewater, petroleum fuel cleanup sites, volatile organic compounds (VOCs) cleanup sites, potable water, and hydrostatic test water. Currently, there are approximately 113 general NPDES permits, 15 minor individual NPDES permits, and 40 industrial waste water permits issued in watershed (CREST 2009a, LARWQCB, 2007). Discharges associated with non-process wastewater, petroleum fuel cleanup sites, volatile organic compounds (VOCs) cleanup sites, and hydrostatic test water do not typically require monitoring for bacteria and are not considered significant sources of bacteria to the watershed. Construction dewatering, potable water, and industrial waste water typically are required to monitor for bacteria under their permits. However, they are not usually given a permit limit, based on receiving water standards, unless reasonable potential can be established through a review of data. Discharges for all these activities tend to be infrequent.

4.2 Nonpoint Sources

4.2.1 Septic Systems

The majority of sanitary sewer discharges in the watershed are to sanitary sewer collection systems and to a WRP; however onsite wastewater treatment systems (OWTS), also know as septic systems, are also still in use. OWTS are typically designed to treat small quantities of sewage waste typically from a single residence or small business. Many of the septic systems installed today are for parcels where sewer services are not readily available. Correctly sited, operated, and maintained OWTS are highly effective at removing bacteria. However, failure rates have been reported as high as 20% to 30% in the Malibu Creek Watershed (LARWQCB, 2004b). Failures have been attributed to improper siting, design, and maintenance. The City of Los Angeles has estimated that more than 10,000 septic systems are located in the watershed and the County of Los Angeles estimates that 1,200 septic systems may be located on County unincorporated lands (CREST, 2009b). With the current lack of information regarding the exact location and number of operating septic systems, and number of failed of septic systems, it is difficult to quantify the loading associated with septic systems to the watershed.

4.2.2 Sanitary Sewer Overflows

From September 2006 to August 2008, there were a total of 359 Sanitary Sewer Overflows (SSOs) reported in the watershed from which 371,410 gallons of untreated sewage were discharged into surface waters (CREST, 2009a). Based on inlet data from WRPs, this raw sewage has a median concentration in the millions of MPN/100 mL. The BSI study found that *E. coli* loading from an observed SSO was more than 1,000 times greater than the allowable instream loading in Reach 4 (CREST, 2009b). CREST estimated that the total indicator bacteria loading from these SSOs was 1.52×10^{14} MPN/100mL of *E. coli*, which was estimated to be 2% of the total dry weather load and an even smaller percentage of the wet weather load.

4.2.3 Natural Sources

Natural sources of indicator bacteria are accounted for under the reference system approach for bacteria, and the targets for this TMDL allow for occasional exceedances due to natural non-point sources.

The dataset used to develop the targets for this TMDL included data from a Southern California Coastal Water Research Project (SCCWRP) study called *Fecal Indicator Bacteria in Reference Streams* (Technical Report 542; Tiefenthaler *et al.*, 2008). This dataset included sites representing a wide range of geological, hydrological, and biological conditions, and included samples from the headwaters of Arroyo Seco, which drain a portion of the Angeles National Forest. This is the only available data for natural runoff specific to the Los Angeles River watershed. The samples from the Arroyo Seco reference site exhibited a low rate of bacterial exceedance during dry weather - as was also observed in other natural areas in the same study. Dry weather concentrations of *E. coli* at the Arroyo Seco headwater site were orders of magnitude lower than those found in the Los Angeles River mainstem or any of its tributaries. The median *E. coli* concentration from the Arroyo Seco headwaters was non-detect (<10 MPN/100mL). Therefore, runoff from the hills of the watershed likely only contributes a very small portion of the dry weather loading

4.2.4 In-Channel Sources

Inputs from *within* the channels of the Los Angeles River and its tributaries are potential non-point sources of bacteria, including:

- Groundwater discharges
- Homeless Persons
- Illicit/illegal direct discharges
- Wildlife and birds
- Regrowth and/or suspension of sediment-associated bacteria
- Resuscitation of injured bacteria discharged with disinfected wastewater effluent

The cumulative impact of in-channel sources of *E. coli* during dry weather has been analyzed during two studies by the CREST stakeholder group, the Tier 2 Study (CREST, 2006) and the BSI Study (CREST, 2008). Both of these studies focused on Reaches 2 and 4 of the Los Angeles River, and used a mass balance approach to compare dry weather loading from in-channel sources to loading from all storm drains and tributaries. Overall, the BSI Study concluded that dry weather loading of *E. coli* from in-channel sources along Reach 4 was relatively small compared to discharges from tributaries and storm drains. In the case of Reach 2, on the other hand, dry weather loading of *E. coli* from storm drains and tributaries often accounted for a fraction of the *E. coli* in the Los Angeles River.

A variety of analyses were used by the BSI Study to assess and rank the potential causes of in-channel *E. coli* sources along Reach 2, as follows:

- **Groundwater –** Shallow groundwater sampled from multiple "weep holes" that discharge along Reach 2 was found to be non-detect for indicator bacteria, suggesting groundwater is not a significant in-channel source of *E. coli* along Reach 2.

- **Human fecal discharges –** Along the section of Reach 2 where in-channel sources were estimated to be the strongest (the segment between 6th Street and Rosecrans Avenue), measurements of human-specific *Bacteroidales* in the LA River exhibited little or no upstream/downstream increase. The potential effects of *Bacteroidales* decay were incorporated. Thus, it was concluded by the authors of the BSI study that in-channel sources of *E. coli* were non-human. This finding limits the potential for homeless persons, illicit discharges (e.g., from recreational vehicles), or leaking sewer infrastructure to be predominant in-channel sources along Reach 2.

- **Birds –** Birds were commonly observed by field personnel in the Los Angeles River channel between 6th Street and Rosecrans Avenue, and were classified as potentially important in-channel sources of bacteria. The Audubon Society describes the seven-mile lower portion of the River (north Long Beach through Compton and Paramount) as *"one of the most important shorebird stopover sites in southern California. During the summer, a thin sheet of water forms in the river channel, and becomes rich with algae and micro-invertebrates that attract shorebirds. This environment has replaced formerly extensive shorebird habitat once present in the vast marshes along the coast of the Los Angeles Basin (e.g., Long Beach/Wilmington)."*

- **Regrowth and persistence in sediments –** Sediment deposits are relatively uncommon along the concrete-lined Los Angeles River. However, notable exceptions include (1) large swaths of sediment near Washington Boulevard bridge in Reach 2 and (2) at "outlets" along the side of the low-flow channel along the lower portion of Reach 2. The potential for *E. coli* growth in sediment deposits is well documented. During the CREST Tier 2 Study (CREST, 2006), sediment bacteria concentrations were measured, and fecal coliform was two orders of magnitude (100x) more abundant in sediments than in water. In many cases, sediment bacteria are in a slimy matrix and may resuspend easily. Regrowth in sediments was considered to have moderate likelihood of being a significant component of the in-channel *E. coli* loading to Reach 2 by the BSI study.

- **Regrowth or resuscitation in the water column** – Under suitable conditions, traditional indicator bacteria may regrow or resuscitate in the water column. Regrowth occurs when indicator bacteria are generated in the environment. Resuscitation is when indicator bacteria that are initially viable-but-nonculturable become culturable. Resuscitation can occur after injury (but not death) by treatment or environmental stress. Laboratory studies under ideal conditions have highlighted the potential for post-disinfection resuscitation (Bolster et al., 2005; Rockabrand et al., 1999; Dukan et al., 1997), and a field study in Orange County concluded that bacteria were resuscitated to a degree after dry weather runoff was UV-treated (County of Orange, 2004). During the BSI Study, a simple approach was used to determine whether or not regrowth in the water column could be ruled out as an important *E. coli* source to Reach 2. Calculated (potential) in-channel *E. coli* growth rates from *E. coli* concentrations measured in Reach 2 were compared to reported literature values from laboratory studies to evaluate if growth was a potential source. Based on this comparison, regrowth or resuscitation in Reach 2 of the Los Angeles River during dry weather could not be ruled out. These results do not demonstrate that regrowth/resuscitation is occurring; instead, they highlight it as a potential source that could be further evaluated.

5 Linkage Analysis

As discussed in Section 4.1.1, dry weather urban runoff and storm water conveyed by storm drains are the primary sources of elevated bacterial indicator densities to the Los Angeles River Watershed during dry and wet weather. The linkage between the numeric targets and the allocations is supported by the following scientific findings:

1. In Southern California, in dry weather, local sources of bacteria principally drive exceedances (LARWQCB, 2002b; 2003b; 2004a).

2. Tiefenthaler *et al.* found that in natural streams bacteria levels were generally higher during lower flow condition (Tiefenthaler *et al.*, 2008)

3. Ackerman *et al.* found that storm drains contribute roughly 13% of the flow in the Los Angeles River in dry weather, while WRPs account for roughly 72% of the flow in the river during dry weather. With this flow, storm drains were contributing almost 90% of the *E. coli* loading (Ackerman *et al.*, 2003). *E. coli* concentrations were found to be as much as four orders of magnitude higher from storm drains than from the WRP discharges**.**

4. In the BSI study, the CREST team found that approximately 85% of the storm drain samples collected exceeded the *E. coli* objective. In the reaches investigated, *E. coli* loading from storm drains and tributaries greatly exceeded the allowable in-stream loading. The study also found that some of the loading in Reach 2 could not be attributed to the measured storm drain inputs.

5. In Southern California, in wet weather, upstream or watershed sources principally cause the bacteria exceedances (LARWQCB, 2002b; 2003c; 2004a).

6. During wet weather, WRP discharges may account for as little as 1% of the total flow in the river (CREST, 2009a).

7. Based on three experiments conducted by Noble *et al.* (1999) to mimic natural conditions in or near Santa Monica Bay (SMB), two in marine water and one in fresh water, bacteria degradation was shown to range from hours to days (Noble *et al.*, 1999). Based on the results of the marine water experiments, the model assumes a first-order decay rate for bacteria of 0.8 d-1 (or 0.45 per day). Degradation rates were shown to be as high as 1.0 d-1 (Noble *et al.*, 1999). These studies show that bacterial degradation and dilution during transport through the watershed do not significantly affect bacterial indicator densities in receiving waters. Decay is discussed further in Section 6.1 and 7 of the staff report.

Load duration curves for dry weather in the Los Angeles River were generated by CREST and used to develop the interim allocations (see Section 6.1). USEPA and Tetra Tech Inc. have developed a load duration curve for wet weather in the Los Angeles River based on modeled wet weather data. The results are shown here to illustrate the percentage reduction which will be necessary to meet the final allocations listed in Table 6-3. An example load duration curve is also included for Verdugo Wash for illustration.

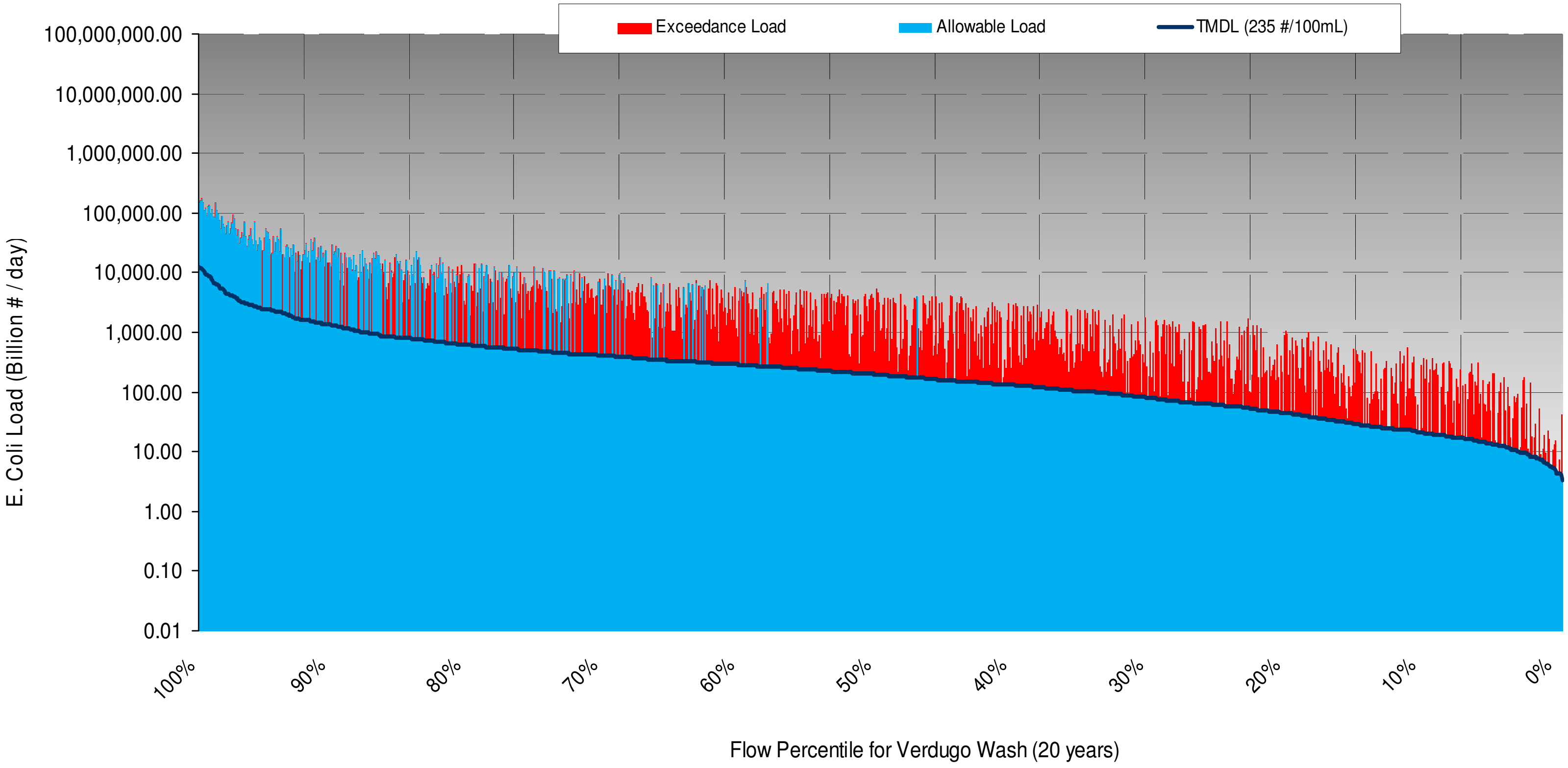
Table 5-1 Estimated Modeled Percentage *E. coli* Load Reduction for Wet Weather

	Average Wet Days	HFS Based Allowable Exceedance Days	Modeled Annual Load	Modeled Annual Wet-Day Load	Adjusted Annual Wet-Day Load	Estimated Reduction Required	Percent Wet-Day Reduction
Los Angeles River (Segment A)	44	15	241,286	235,132	59,617	55,602	93.3%
Los Angeles River (Segment B)	56	15	3,913,215	3,609,176	953,479	893,062	93.7%
Los Angeles River (Segment C)	49	15	1,298,652	1,216,736	362,057	330,161	91.2%
Los Angeles River (Segment D)	60	15	823,497	810,904	165,871	156,458	94.3%
Los Angeles River (Segment E)	56	15	1,240,920	1,187,661	275,675	258,746	93.9%
Compton Creek	45	10	1,144,340	1,057,629	296,285	279,100	94.2%
Rio Hondo	48	15	190,518	183,574	50,607	46,831	92.5%
Arroyo Seco	58	10	723,910	694,094	186,671	166,623	89.3%
Verdugo Wash	61	15	496,081	479,713	122,306	110,019	90.0%
Burbank Western Channel	43	15	96,593	96,139	26,466	25,676	97.0%
Tujunga Wash	58	15	981,052	949,003	211,337	192,725	91.2%
Bull Creek	58	10	347,712	339,556	81,620	72,115	88.4%
Aliso Canyon Wash	46	10	644,682	628,462	178,104	170,221	95.6%
McCoy Canyon	43	10	143,201	142,326	39,399	38,053	96.6%
Dry Canyon	48	10	62,159	61,171	12,245	10,418	85.1%
Bell Creek	44	10	311,487	293,743	68,619	61,714	89.9%

1) Percent reduction express as Estimated Reduction / Modeled Wet Day Load

2) *E. coli* loads expressed as Billion # / year

Figure 5-1 Estimated Modeled Load Reduction Curve for Wet Weather for Verdugo Wash



6 Allocations

Waste Load Allocations (WLAs) are allocations of bacteria loads to point sources and Load Allocations (LAs) are allocations of bacteria loads to nonpoint sources. In this TMDL, WLAs and LAs are set for (1) dry weather and (2) wet weather (defined as days of 0.1 inch of rain or more plus three days following the rain event).

Interim WLAs are set for MS4 dischargers as bacterial loads (MPN/day) and final WLAs and LAs are set for all dischargers as exceedance days - the number of daily or weekly sample days that may exceed single sample limits (see Section 2.2) at the appropriate monitoring sites. Final WLAs and LAs are expressed as allowable exceedance days because the bacteria density and frequency of single sample exceedances are the most relevant to public health protection. Allowable exceedance days are "appropriate measures" consistent with the definition in 40 CFR §130.2(i). Exceedances of the geometric mean limit are not permitted.

6.1 Interim Allocations: MS4 dischargers, dry weather

Interim allocations are set for MS4 dischargers for dry weather.

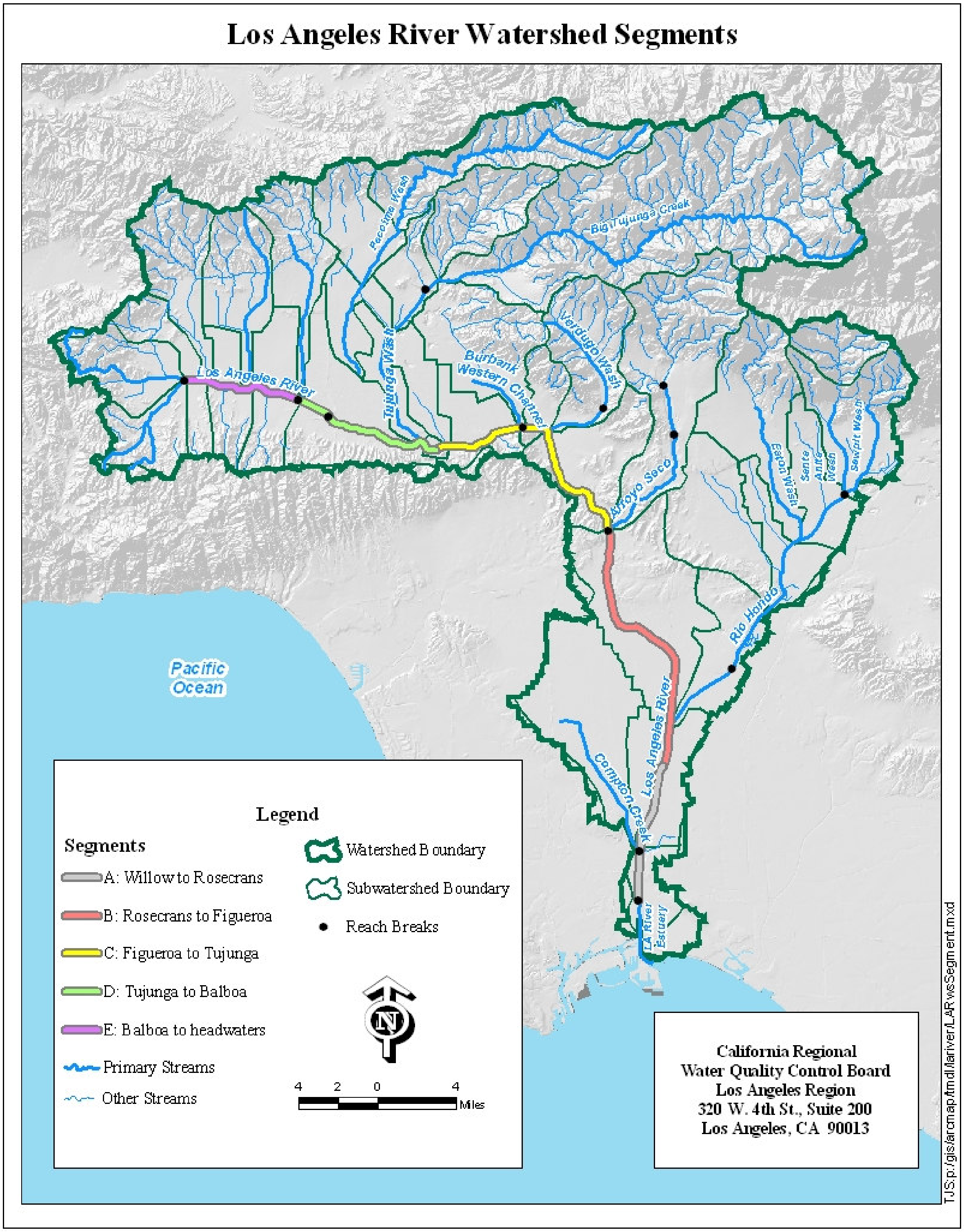
These allocations were generated using a load duration curve (LDC). A LDC is a simple method to calculate TMDLs and allocations. A load duration curve for dry weather used the measured flow rate and a reference concentration to generate a cumulative plot of the values. LDCs have been used in many TMDLs in the Region, including the Malibu Creek Bacteria TMDL.

The loading rate units and allocation units are in the bacterial concentration units of MPN/day.

The main stem of the river was broken down into segments for allocations based on the availability of flow data (see Figure 6-1).

- Segment A includes Reaches 1 and 2
- Segment B includes a portion of Reach 2
- Segment C includes Reaches 3 and 4
- Segment D includes Reaches 4 and 5
- Segment E includes Reach 6

Figure 6-1 Los Angeles River Watershed Segment Map



The average daily flows were calculated using the City of Los Angeles' Status and Trends data and used to plot the flow duration curves. The flow rates from the City of Los Angeles' Status and Trends data are summarized along with travel times in Table 1 of Section 6 of the CREST Technical Report.

The flow duration curve was multiplied by the water quality objective for *E. coli* to calculate the allowable instream loading. The allowable instream loading also considered bacteria decay and travel time in addition to flow rate. For this TMDL, a conservative decay rate of 0.09 hour^{-1} was assumed (CREST, 2009a).

The load duration curve includes separate calculations for upstream reaches and tributaries. There are several reasons for using this strategy. Lower portions of the mainstem receive flow and loading from upper portions of the river. WLAs account for this instream loading. Some of the mainstem portion of the river and one tributary receive large, regular discharges of tertiary treated effluent (Section 4 of the Staff Report). Effluent from WRPs in the watershed must meet the permitted limit of not more than 2.2 per 100 milliliters as the median number of coliform organisms and not more than 23 per 100 milliliters as the maximum number of coliform organisms in not more than one sample within any 30-day period. Due to the large effluent volume and low bacteria limits, this effluent adds to the assimilative capacity of the river downstream from the discharge.

Therefore, the WLAs allocated per segment are essentially the calculated median allowable instream loading minus the allowable upstream loading, the loading from tributaries, and the allowable WRP loading. The resulting loads are the interim WLAs assigned to the Municipal Separate Storm Sewer System (MS4) Permittees within the specific segment or tributary and are summarized in Table 6-1.

Table 6-1 Interim Waste Load Allocation by Segment and Tributary for MS4 Dischargers

River Segment or Tribuary	*E. Coli* Load (10^9 MPN/Day)
Los Angeles River Segment A	274
Los Angeles River Segment B	471
Los Angeles River Segment C	421
Los Angeles River Segment D	413
Los Angeles River Segment E	29
Aliso Canyon Wash	21
Arroyo Seco	22
Bell Creek	13
Bull Creek	8
Burbank Western Channel	78
Compton Creek	6
Dry Canyon	6
McCoy Canyon	6
Rio Hondo	2
Tujunga Wash	9
Verdugo Wash	46

6.2 Final Allocations

6.2.1 Final Load Allocations

Lands not covered by a MS4 permit, such as the US Forest Service lands, California Department of Parks and Recreation lands, or National Park Service lands are assigned LAs. The dry weather LAs and wet weather LAs for single sample limits are listed in Table 6-3.

Onsite Waste Treatment Systems are assigned LAs of zero (0) days of allowable exceedances for both dry and wet weather for the single sample and rolling 30-day geometric mean limits.

In addition, sewer collection systems are assigned LAs of zero (0) days of allowable exceedances for both dry and wet weather for the single sample and rolling 30-day geometric mean limits.

6.2.2 Final Wasteload Allocations

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR permittees in the Los Angeles River Watershed are assigned WLAs of zero (0) days of allowable exceedances for both dry and wet weather and for the single sample limits and the rolling 30-day geometric mean limits.

The three Water Reclamation Plants in the watershed, D.C. Tillman, Los Angeles-Glendale and Burbank, currently have NPDES permits that require (1) the median number of coliform organisms in effluent not to exceed 2.2 per 100 milliliters and (2) the number of coliform organisms not to exceed 23 per 100 milliliters in more than one sample within any 30-day period. The WLAs for WRPs are set equal to 2.2 MPN/100mL of *E. coli* multiplied by the discharge rate at the time of sampling to ensure zero (0) days of allowable exceedances for both dry and wet weather and for the single sample limits and the rolling 30-day geometric mean limits.

For MS4 dischargers, the dry weather and wet weather WLAs are expressed as allowable exceedances, discussed below and listed in Table 6-3.

6.2.3 Allowable Exceedance Days

This TMDL sets the number of allowable exceedance days for each segment or tributary to ensure that two criteria are met (1) bacteriological water quality is at least as good as that of a largely undeveloped system, and (2) there is no degradation of existing bacteriological water quality. The number of allowable exceedance days is based on the single sample exceedance frequency at the reference system.

Regional Board Staff ensures that the two criteria above are met by using the smaller of two exceedance probabilities for any monitoring site multiplied by the number of dry days or wet days for the critical condition (see Section 8). An exceedance probability, P(E), is simply the probability that one or more single sample limits, described in Section 2.2, will be exceeded at a particular monitoring site, based on historical data.

6.2.4 Calculating Dry Weather and Wet Weather Exceedance Probabilities

The dry weather exceedance probability is simply the probability that the sample limit will be exceeded on a dry weather day at a particular location. The wet weather exceedance probability is simply the probability that the sample limit will be exceeded on a wet weather day (see Section 2.4) at a particular location.

Monitoring data from October 2005 to May 2007 were used to determine the exceedance probability of the reference system for dry and wet weather. Samples were identified as dry or wet weather samples using rainfall data from LAX.

6.2.5 Calculating Allowable Exceedance Days at a Targeted Location

As in previous bacterial TMDLs in the Los Angeles Region, allowable exceedance days were calculated with the smaller of the two exceedance probabilities, that of the targeted site or the reference site. In the case of this TMDL, the smaller of the exceedance probabilities for all sites was that of the reference site and that value was used in subsequent calculations, as described below.

To translate the exceedance probabilities into allowable exceedance days and exceedance-day reductions, the number of wet weather days and the number of dry weather days in the 90th percentile storm year, based on rainfall data from the Los Angeles International Airport (LAX) meteorological station, was used.

6.2.6 Reference System

As discussed in sections 1.2 and 3.2, the reference system/antidegradation approach is the recommended alternative; this approach ensures that water quality is at least comparable to that of the reference system and is also consistent with state and federal antidegradation policies. The reference system approach uses both the water quality objective exceedance probability for the reference system and reference dry and wet weather days from the reference year (see section 6.2.7) to determine the allowable number of exceedances days allocated.

Previously adopted bacteria TMDLs in the Region, which include the Santa Monica Bay Bacteria TMDLs among others, have employed Leo Carrillo Beach and its drainage area, Arroyo Sequit subwatershed, as the reference system (LARWQCB, 2002a; 2002b; 2003c; 2004a; 2006a). Early TMDLs developed in freshwater systems (e.g., Malibu Creek Bacteria TMDL and Ballona Creek Bacteria TMDL) also used the marine beach, Leo Carrillo, as the reference site due to the lack of bacteria data from freshwater reference systems in the Los Angeles region. In this TMDL, Regional Board staff proposes the use of freshwater reference data that is now available from southern California freshwater reference monitoring locations for the reference system. This TMDL, and the concurrently developed Santa Clara River Bacteria TMDL, will be the first bacteria TMDLs in the Region to use freshwater reference data to develop exceedance day allocations.

The Southern California Coastal Water Research Program (SCCWRP), a joint powers authority formed to conduct coastal environmental research, has conducted monitoring and analysis of freshwater reference sites throughout southern California. The monitoring was conducted from the fall of 2004 to the spring of 2007. This monitoring was summarized in three studies, which include the Natural Landscapes Study (Stein and Yoon, 2007), the Reference Stream Study (Tiefenthaler *et al.*, 2008), and the Wet Weather Reference Beach Study (Schiff *et al.*, 2006).

SCCWRP's selection of reference sites was based on four criteria. These criteria include sites that: 1) have no less than 95% undeveloped drainage area; 2) possess a "relatively homogeneous setting"; 3) have "year-round or prolonged dry weather flow"; and 4) are located in watersheds that have not experienced fire during the previous three years. Of the sites sampled in the Reference Stream Study, three sites were deemed minimally impacted. As such, data from these three sites were excluded. The resulting data was compiled and used as the basis for determining the reference watershed exceedance probability (see Table 6-2).

Table 6-2 Estimated Exceedance Probabilities for the Reference System

Single Sample *E. coli* Exceedance Probability		
Water Quality Objective	Dry weather exceedance probability	Wet weather exceedance probability
235 MPN/100 mL	0.016	0.19

6.2.7 Critical condition (reference year)

Based on an examination of historical rainfall data from the Los Angeles International Airport (LAX) meteorological station[1], Regional Board Staff propose using the 90th percentile storm year[2] in terms of wet weather days as the critical condition for determining the allowable wet weather exceedance days. The reference year of 1993 was chosen because it is the 90th percentile year in terms of wet weather days, based on 54 storm years (1948-2008) of rainfall data from LAX (see Appendix A). In the 1993 storm year, there were 75 wet weather days; therefore, there were 290 dry days.

6.3 Translating exceedance probabilities into estimated exceedance days during the critical condition

The estimated number of exceedance days during the critical condition (reference year) was calculated for the reference system by multiplying the site-specific exceedance probability by the estimated number of dry or wet days in the reference year. The site-specific exceedance probability is taken directly from the data analysis in Table 6-2. Based on 54 storm years of rainfall data from LAX meteorological station, 1993 is the reference year for both dry and wet weather.

$$E_{CC} = P(E)_i * days_{1993} \qquad \text{(Equation 6.1)}$$

Where E_{CC} is the estimated number of exceedance days under the critical condition and $P(E)_i$ is the average probability of exceedance for any site. The average exceedance probability is appropriate, since the weekly sampling is systematic and the rain events are randomly distributed; therefore, sampling will be evenly spread over the dry weather and wet weather events (i.e., the rain day, day after, 2nd day after, 3rd day after)[3].

To estimate the number of exceedance days during the reference year *given a weekly sampling regime*, the number of days was adjusted by solving for *x* in the following equation:

$$days_{1993} \qquad x$$

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[1] The LAX meteorological station was used, since the station has the longest historical rainfall record in the Los Angeles region.

[2] The "storm year" is defined as November 1 to October 31.

[3] Also, note that the Southern California Coastal Water Research Project found no correlation between the day of the week and the percentage of samples exceeding the single sample objectives (Schiff *et al.*, 2002).

$$\frac{\qquad}{365\ \text{days}} = \frac{\qquad}{52\ \text{weeks}} \qquad \text{(Equation 6.2)}$$

Using Equation 6.1 and Equation 6.2, the exceedance probability of the reference system is translated to exceedance days as follows. Analysis of monitoring data for the reference system shows that the dry weather exceedance probability is 0.016 and the wet weather exceedance probability is 0.19. Per Equation 6.1, the exceedance probability of 0.016, for dry weather, is multiplied by 290 days, the number of dry weather days in the 1993 storm year, resulting in five (5) exceedance days when daily sampling is conducted. The exceedance probability of 0.19 for wet weather is multiplied by 75 days, the number of wet weather days in the 1993 storm year, resulting in 15 exceedance days when daily sampling is conducted.

Regional Board Staff recognizes that the number of dry weather days and wet weather days will change from year to year and, therefore, the exceedance probabilities of 0.016 for dry weather and 0.19 for wet weather will not always equate to 5 or 15 days, respectively. However, Regional Board Staff proposes setting the allowable number of exceedance days based on the reference year rather than adjusting the allowable number of exceedance days annually based on the number of dry or wet days in a particular year. This is because it would be difficult to design capture and/or treatment facilities to address such variability from year to year. Regional Board Staff expects that by designing controls for the 90th percentile storm year, during drier years there will most likely be fewer exceedance days than the maximum allowable.

To estimate the number of exceedance days at the reference system in the reference year under a weekly sampling regime for dry weather and wet weather, the number of days was adjusted by solving for x in Equation 6.2 as follows:

$$\frac{290\ \mathit{days}}{365\ \mathit{days}} = \frac{x}{52\ \mathit{weeks}} \qquad \text{(Equation 6.2 for dry weather)}$$

$$\frac{75\ \mathit{days}}{365\ \mathit{days}} = \frac{x}{52\ \mathit{weeks}} \qquad \text{(Equation 6.2 for wet weather)}$$

For dry weather, solving for x equals 41.9, which is then multiplied by 0.016, resulting in one (1) exceedance day during dry weather when weekly sampling is conducted. For wet weather, x equals 10.7 multiplied by 0.19, results in two (2) exceedance days during wet weather when weekly sampling is conducted. The allowable exceedances based on daily and weekly sampling are summarized in Table 6-3.

6.3.1 High Flow Suspension

Certain reaches and tributaries of the Los Angeles River are subject to a High Flow Suspension (HFS) of the recreational beneficial uses, which is applied to certain reaches and tributaries that are concrete-lined channels during days with greater than or equal to 0.5 inch of rain and the following 24 hours. During this period REC-1 and REC-2 beneficial uses are suspended for the affected reaches and tributaries (see Table 3-1).

For this TMDL, a different number of wet weather days based on the reference year is used in the calculation of allowable exceedance days for the reaches and tributaries subject to the HFS. For the reference year, 75 wet weather days were observed. Of these 75 days, 26 days fall under the definition of a HFS day. These 26 days are excluded from the calculations, since the REC-1 use does not apply on these days in these reaches and tributaries. As such, the remaining number of wet weather days for HFS-affected reaches and tributaries is 49 days. The number dry weather days remains 290 days. With an adjustment to the number of wet weather days, the number of allowable wet weather exceedances for HFS affected reaches and tributaries is also adjusted. The resulting allowable exceedance for wet weather is 10 days based on daily sampling and 2 days based on weekly sampling. The allowable exceedances based on daily and weekly sampling are summarized in Table 6-3.

Table 6-3 Allowable Exceedance Days for Daily and Weekly Sampling based on the Reference Year

Allowable Number of Exceedance Days	**Daily Sampling**	**Weekly Sampling**
Dry Weather	5	1
Non-HFS* Waterbodies Wet Weather	15	2
HFS Waterbodies Wet Weather	10	2

*HFS = High Flow Suspension

7 Margin of Safety

This TMDL applies an implicit margin of safety for interim allocations through the use of conservative assumptions regarding the effect of *E. coli* discharges from storm drains on in-stream water quality and an explicit margin of safety for final waste load allocations.

Decay is almost always assumed in dry weather models used for bacteria TMDLs for storm drain discharge. The conservative assumption of no bacterial decay of storm drain loadings was assumed for this TMDL when determining the assimilative capacity of the river segments and tributaries. Therefore, storm drain discharges of *E. coli* could potentially be higher than the interim MS4 WLAs and the TMDL targets would still be met. By ignoring decay of *E. coli* in storm drains during calculation of the WLAs, an implicit margin of safety (MOS) is applied. While the MOS is implicit, its magnitude can be estimated for the river segments and tributary (see Table 7-1). A more detailed version of the table can be found in Section 6.6 of the Technical Report (CREST, 2009a).

Table 7-1 Los Angeles River Segments and Tributary Margin of Safety

River Segment or Tributary	Margin of Safety in 10^9 MPN/day	% of Allowable Interim Load
Los Angeles River Segment A	71	21%
Los Angeles River Segment B	269	36%
Los Angeles River Segment C	218	34%
Los Angeles River Segment D	149	26%
Los Angeles River Segment E	8	21%
Aliso Canyon Wash	11	35%
Arroyo Seco	7	25%
Bell Creek	4	26%
Bull Creek	8	52%
Burbank Western Channel	42	35%
Compton Creek	4	40%
Dry Canyon	1	12%
McCoy Canyon	1	12%
Rio Hondo	7	82%
Tujunga Wash	3	27%
Verdugo Wash	14	23%

The MOS for interim allocations was calculated by comparing the potential loading without decay against the interim WLA. The difference between the two numbers equates to the MOS. The potential loading without decay is calculated by applying the exponential decay equation (Equation 7.1) listed below.

$$C_f = C_o\, e_{-kt} \qquad \text{(Equation 7.1)}$$

Where C_f is the downstream concentration, C_o is the concentration assumed before decay, k is the exponential decay rate, and t is the travel time (CREST, 2009a).

An explicit margin of safety has been incorporated for final allocations in allowable exceedance days. Exceedances of the single sample objectives are allowed no more than 5% of the time on an annual basis, based on the cumulative allocations for dry and wet weather in Section 6. The Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (SWRCB, 2004) concludes that there are water quality impairments using a binomial distribution method, which lists waterbodies when the exceedances are between approximately 8 and 10 percent.

8 Critical Conditions

The critical condition is wet weather and, in particular, the 90th percentile storm year is the critical wet weather year.

The critical condition in a TMDL defines an extreme condition for the purpose of setting allocations to meet the TMDL numeric targets. The critical condition may also be thought of as an additional margin of safety because the allocations are set to meet the numeric target during an extreme (or above average) condition[4]. Unlike many TMDLs, the critical condition for bacteria loading is not during low-flow conditions or summer months, but rather during wet weather. This is because intermittent loading sources such as surface runoff will have the greatest impacts at high (i.e. storm) flows (USEPA, 2001). As discussed in Section 6.2.4, waters tend to exceed water quality standards more frequently in wet weather compared to dry weather even in systems that are mostly undeveloped.

To identify the critical condition within wet weather, in order to set the allowable number of exceedance days, described in Section 6, staff propose using the 90th percentile storm year in terms of wet days as the reference year. Staff selected the 90th percentile year for several reasons. First, selecting the 90th percentile year avoids an untenable situation where the reference system is frequently out of compliance. Second, selecting the 90th percentile year allows responsible jurisdictions and responsible agencies to plan for a 'worst-case scenario', as a critical condition is intended to allow. Finally, Regional Board Staff expects that there will be fewer exceedance days in drier years, since structural controls will be designed for the 90th percentile year.

The 90th percentile storm year in terms of wet days was identified by constructing a cumulative frequency distribution of annual wet weather days using historical rainfall data from LAX from 1947-2008. This rainfall database was chosen due to the extent of the database and to maintain consistency with the other bacteria TMDLs in the Los Angeles Region. With a 90th percentile storm year, only 10% of years should have more wet days than the 90th percentile year. The 90th percentile year in terms of wet days was 1993, which had 75 wet days. The number of wet days was selected instead of total rainfall because the TMDL's numeric target is based on number of days of exceedance, not on the magnitude of the exceedance.

9 Implementation Strategy

9.1 Introduction

This implementation strategy focuses principally on eliminating or reducing the fecal indicator bacteria-laden runoff entering the river though the MS4 and also on reducing fecal indicator bacteria from entering the MS4. The source assessment and the BSI study support that this approach will be effective and will address human health concerns.

As required by the Federal Clean Water Act, discharges of pollutants to the Los Angeles River from municipal storm water conveyances are prohibited, unless the discharges are in compliance with a NPDES permit. In December 2001, the Los Angeles County Municipal NPDES Storm Water Permit was re-issued jointly to Los Angeles County Flood Control District, Los Angeles County and 84 cities as co-permittees. The Los Angeles County Municipal Storm Water NPDES Permit and the Caltrans Storm Water Permit will be key implementation tools for this TMDL.

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[4] Critical conditions are often defined in terms of flow, such as the seven-day-ten-year low flow (7Q10), but may also be defined in terms of rainfall amount, days of measurable rain, etc.

Future storm water permits will be modified in order to address implementation and monitoring of this TMDL and to be consistent with the waste load allocations of this TMDL.

The Porter Cologne Water Quality Control Act prohibits the Regional Board from prescribing the method of achieving compliance with water quality standards, and likewise TMDLs (Water Code §13360). Below, staff has presented potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the maximum allowable exceedance days are not exceeded. The implementation strategies presented and the implementation schedule are the result of a stakeholder effort facilitated by CREST through which responsible agencies worked together to compile potential implementation scenarios and to provide cost estimates on the selected implementation options.

As a "certified regulatory program," the Regional Board must satisfy the substantive requirements of 23 CCR § 3777(a), which requires a written report that includes a description of the proposed activity, an alternatives analysis, and an identification of mitigation measures to minimize any significant adverse impacts. Mitigation measures and the CEQA checklist are included in the Substitute Environmental Documents of the TMDL.

Over the course of TMDL implementation, the TMDL may be re-considered to incorporate new information from TMDL special studies, or address revisions to water quality standards, such as adoption of revised water quality objectives based on recommendations of USEPA.

The implementation of this TMDL should be coordinated with activities and BMPs that are implemented through other TMDLs that have already been adopted in the watershed (notably, the Los Angeles River Metals TMDL) and other activities including the Integrated Regional Water Management Plan and Los Angeles River Revitalization Plan. Implementation actions for other TMDLs may significantly contribute to the implementation efforts for this TMDL.

9.2 Potential Implementation Actions

A variety of methods exist to reduce bacteria concentrations and loadings. A successful strategy will include a combination of methods to reduce bacteria exceedances to acceptable levels and support beneficial uses.

9.2.1 Structural Implementation Actions

Structural actions or BMPs are designed to target specific land uses, sources, time periods or events.

9.2.1.1 Dry Weather Structural BMPs

Dry weather structural BMPs vary in size and complexity. Several infrastructure improvements have been used, are currently used, and have been proposed as implementation methods.

- Low-flow diversions are designed to divert low flows to the local Water Reclamation Plants for treatment rather than discharging into surface waters. Low-flow diversions will reduce bacteria loading associated with these sources and are currently used to address bacterial impairments at numerous beaches throughout the region including many Santa Monica Bay beaches and Mother's Beach in the Marina del Rey Harbor (LARQWCB 2004a, 2003b, 2002b, 2002a).

- Retention, filtration, bioretention, and biofiltration are also implementation methods for dry weather.

9.2.1.2 Wet Weather Structural BMPs

Storm water washes pollutants off roof-tops, pavement, streets, industrial areas, and lawns. Because of the much higher volume, exceedances of bacterial targets during wet weather will be more difficult to reduce than during dry weather, although many of the dry weather implementation methods will assist with wet weather implementation.

9.2.1.2.1 Sub-Regional Structural BMPs

Sub-regional structural BMPs consist of a single or a series of BMPs designed to treat wet weather flows for limited sub-regions within the subwatershed. Sub-regions can vary in size from a small parking lot to several city blocks. These sub-regional implementation strategies often have multiple pollutant treatment potential. Listed below are a few sub-regional structural BMPs and a brief description of each:

- Vegetated biofiltration systems include swales, filter strips, bioretention areas, and storm water planters (McCoy *et al.*, 2006a). Vegetated systems involve the use of soils and vegetation to filter and treat storm water prior to discharge. Additional bioslopes, infiltration trenches, soil grading alterations, bioretention ponds, and the use of selective vegetation can further increase the efficiency of vegetative biofiltration systems.

- Local retention and infiltration improvements, like porous paving, retention ponds, cisterns, and infiltration pits, can promote retention and added infiltration of storm water rather than run-off over impervious surfaces (McCoy *et al.*, 2006).

9.2.1.2.2 Regional Structural BMPs

Regional structural BMPs contain many similarities to sub-regional structural BMPs but differ in both the scope and scale of the implementation strategy. Treatment areas can range from several sub-regions to the entire subwatershed. Regional structural BMPs retain the multiple treatment potential of sub-regional BMPs. Listed below are a few regional structural BMPs and a brief description of each:

- Regional biofiltration systems, including surface flow and sub-surface flow wetlands, promote hydrolysis, oxidation, rhizodegradation, filtration through the aerobic and anaerobic zones of the soil matrix (Halverson, 2004). These systems can treat a variety of pollutants and can be utilized for flood mitigation.

- Regional infiltration and detention systems, including detention and infiltration basins, help reduce flow volume in lower stream areas and promote sedimentation (McCoy *et al.*, 2006).

9.2.2 Non-structural Best Management Practices

Non-structural BMPs are a broad-based description of implementation strategies not of an extensive structural nature. Non-structural BMPs are further categorized as administrative controls and outreach and education.

9.2.2.1 Administrative Controls

Administrative controls include better enforcement of ordinances, such as pet waste disposal ordinances and litter ordinances; posting additional signage; feral cat population control; proposing stricter penalties for non-compliance; and other actions of an administrative nature for dry weather. Administrative controls require less initial investment of time, compared to structural BMPs, due to the lack of need for planning and capital required for dry weather implementation. However, long-term implementation may be more time intensive.

Wet weather administrative controls tend to be more costly and have a far greater scope and include post-construction storm water BMPs requirements and Low Impact Development (LID) requirements. Sub-regional and Region-wide plans for sheet-flow diversion may need to be developed. A green building program similar to one developed in the City of Santa Monica can help promote sustainability (McCoy and Hartwich, 2006).

9.2.2.2 Outreach and Education

Outreach and education is potentially the most effective long-term implementation strategy for ensuring compliance with bacteria water quality standards. Information regarding the adverse impacts associated with illicit discharges, fishing waste, litter, and feral cat feeding should be made readily available to the general public. Wet weather outreach and education should target local planning groups, community groups, and agricultural organizations due to the region-wide effort necessary to control wet weather bacteria loading.

9.3 Responsible parties

Responsible Parties for each segment and tributary in the Los Angeles River Bacteria TMDL are shown in Table 9-1

Table 9-1 Responsible Parties for Waste Load Allocations Assigned in the Los Angeles River Bacteria TMDL

Responsible Entity	Los Angeles River Segment					Los Angeles River Tributary										
	A	B	C	D	E	Aliso Canyon Wash	Arroyo Seco	Bell Creek	Bull Creek	Burbank Western Channel	Compton Creek	Dry Canyon Creek	McCoy Canyon Creek	Rio Hondo	Tujunga Wash	Verdugo Wash
Alhambra		√												√		
Arcadia														√		
Bell		√														
Bell Gardens		√												√		
Bradbury														√		
Burbank		√	√							√						
Bureau of Land Management					√											
Calabasas					√							√	√			
CA Dept. of Parks and Recreation				√	√											
Caltrans	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Carson	√										√					
Commerce		√												√		
Compton	√	√									√					
Cudahy		√														
Downey		√												√		
Duarte														√		
El Monte														√		
Glendale		√	√				√			√					√	√
Hidden Hills								√					√			
Huntington Park		√									√					
Inglewood											√					

Responsible Entity	Los Angeles River Segment					Los Angeles River Tributary										
	A	B	C	D	E	Aliso Canyon Wash	Arroyo Seco	Bell Creek	Bull Creek	Burbank Western Channel	Compton Creek	Dry Canyon Creek	McCoy Canyon Creek	Rio Hondo	Tujunga Wash	Verdugo Wash
Irwindale														√		
La Cañada Flintridge			√				√									√
Lakewood	√															
Long Beach	√										√					
Los Angeles		√	√	√	√	√	√	√	√	√	√	√	√		√	√
Los Angeles County	√	√	√		√	√	√	√	√		√	√	√	√	√	√
Los Angeles County Flood Control	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Lynwood	√	√									√					
Maywood		√														
Monrovia														√		
Montebello		√												√		
Monterey Park		√												√		
National Park Service				√	√											
Paramount	√	√														
Pasadena		√	√				√							√		√
Pico Rivera														√		
Rosemead														√		
San Fernando															√	
San Gabriel														√		
San Marino														√		
Santa Clarita									√							
Sierra														√		

Responsible Entity	**Los Angeles River Segment**					**Los Angeles River Tributary**										
	A	B	C	D	E	Aliso Canyon Wash	Arroyo Seco	Bell Creek	Bull Creek	Burbank Western Channel	Compton Creek	Dry Canyon Creek	McCoy Canyon Creek	Rio Hondo	Tujunga Wash	Verdugo Wash
Madre																
Signal Hill	√															
South El Monte														√		
South Gate		√									√			√		
South Pasadena		√					√							√		
State Land Commission					√											
Temple City														√		
U.S. Forest Service							√		√					√	√	√
Vernon		√									√					

9.4 Implementation: Dry weather

9.4.1 Dry Weather Implementation for Non-point Sources

Non-point sources in the watershed include onsite wastewater treatment systems (OWTS), in-channel sources, and runoff from the headwaters.

Lands not covered by a MS4 permit, such as the US Forest Service lands, California Department of Parks and Recreation lands, or National Park Service lands are assigned LAs equal to the number of allowable exceedances based on the reference system, as shown in Table 6-3. Discharges from the headwaters and natural land sources are accounted for with the exceedance day approach, which accounts for natural sources of bacteria from undeveloped areas. Thus the discharges of *E. coli* from these natural/non-point sources are "allocated" as LAs using allowable exceedance days. Responsible parties who are land owners or managers and not Permittees under an MS4 permit, such as the US Forest Service (US Department of Agriculture), California Department of Parks and Recreation, or National Park Service (US Department of Interior) are required to not cause or contribute to exceedances of bacterial standards in the Los Angeles River or its tributaries beyond the allowable number of exceedance days and, if necessary, deploy appropriate BMPs to ensure compliance.

Bacteria discharges from Onsite Wastewater Treatment Systems (OWTS) are assigned a Load Allocation (LA) of zero days of allowable exceedances of the *E. coli* targets. In some cases, municipalities are responsible for their own OWTS including permitting under a waiver of waste discharge requirements from the Regional Board. In some cases the Regional Board is responsible for permitting via waste discharge requirements. The LA is reasonable because OWTS Waste Discharge Requirements require compliance with groundwater objectives for bacteria.

Sanitary sewer collection systems are assigned a Load Allocation (LA) of zero allowable exceedances. Discharges of untreated wastewater are illegal (i.e., sanitary sewer overflows). Sanitary sewer collection systems are often managed by multiple agencies and are covered under the Statewide General Waste Discharge Requirements for sanitary sewer overflows (SSOs) (WQO No. 2006-0003-DWA). Enrollees in this permit are required to report all SSOs for which their agency has responsibility to the State Water Resources Control Board's (SWRCB) SSO database and must develop and implement a system-specific Sewer System Management Plan which will serve to implement this TMDL.

9.4.2 Dry Weather Implementation for Point Sources

Point sources include water reclamation plants, general and individual industrial stormwater dischargers, individual wastewater dischargers, Municipal Separate Storm Sewer System (MS4) dischargers, and among other dischargers.

9.4.3 Water Reclamation Plants

Dry weather WLAs established for the three Water Reclamation Plans (WRP) in this TMDL (Donald C. Tillman, Los Angeles-Glendale, and Burbank) will be implemented through NPDES permits as end-of-pipe effluent limitations. Effluent limitations in the NPDES permits for the three WRPs currently require (1) the median number of total coliform organisms in effluent not to exceed 2.2 per 100 milliliters and (2) the number of total coliform organisms no to exceed 23 per 100 milliliters in more than one sample within any 30-day period. The current coliform limits for these WRPs are sufficient, and no revisions to the WRP NPDES permits are necessary based on this TMDL. No additional actions are expected to be necessary for WRPs to be in compliance with the TMDL allocations.

9.4.4 General and Individual Industrial Stormwater NPDES Dischargers

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR permittees in the Los Angeles River Watershed are assigned WLAs of zero (0) days of allowable exceedances for both dry and wet weather and for the single sample and the rolling 30-day geometric mean limits. To comply with the allocation, these dischargers will demonstrate compliance with the target concentration of 235 MPN *E. coli*/100mL. This allocation will be included in NPDES permits and WDRs.

9.4.5 MS4 Dry Weather Implementation

For each Los Angeles River segment and tributary addressed under this TMDL, group interim and final WLAs have been developed for the MS4 Permittees in the watershed including Caltrans. The group allocations will apply to all NPDES-regulated MS4 Permittees in the Los Angeles River watershed (MS4 Permittees in the watershed are Los Angeles County Flood Control District, Los Angeles County, and co-Permittees that discharge to the watershed, the City of Long Beach, and Caltrans).

The interim WLA are expressed as the maximum *E. coli* load in MPN per day. The final WLAs are expressed as exceedance days of the numeric targets measured in the receiving water (i.e. river segment or tributary).

While MS4 Permittees can achieve WLAs by employing any viable and legal implementation strategy, a recommended implementation approach is presented below, called “MS4 Load Reduction Strategy” (LRS) and requires coordinated effort by all MS4 Permittees within a segment or tributary. However, if individual MS4 Permittees or subgroups of MS4 Permittees choose to develop and implement an alternative implementation strategy, then the group-based WLAs may be distributed based on proportional drainage area, upon approval of the Executive Officer. In this case, the implementation approaches herein can still be followed based on the proportional WLAs.

For MS4 Permittees that choose to *not* follow an MS4 Load Reduction Strategy, there is no specific process to be followed, but the compliance schedule for attainment of final

WLAs is shorter as a second implementation phase is not included in the schedule. Overall, MS4 Permittees who follow a LRS approach accept a tradeoff between a longer timeframe for compliance with final WLAs, but a more rigorous process by which Permittees must determine and document necessary implementation activities.

The LRS MS4 dry weather implementation strategy as described in the following establishes a stepwise and iterative process. This strategy establishes phases for implementation, both by prioritizing different segments of the river for implementation actions before others, as discussed below, and by allowing two full phases of implementation per segment.

In the first phase of implementation, a segment must meet the interim WLA expressed as *E. coli* loading and the LRS must be designed to meet the final WLA expressed as exceedance days of the numeric targets in the river segment or tributary, but due to the highly variable nature of bacterial sources, a full second phase of implementation is scheduled to ensure achievement of final WLAs.

A MS4 Load Reduction Strategy (LRS) is both [1] a suite of actions performed by MS4 Permittees along a Los Angeles River segment or tributary and [2] a document submitted to the Regional Board Executive Officer for approval. The document must describe the suite of actions that will be performed and demonstrate reasonable assurance of interim and final WLA attainment. A LRS may include 1) outfall methods such as structural methods like dry weather diversions, 2) source control and, in appropriate circumstances, 3) downstream methods to treat waters at the end of tributaries.

1) Structural methods are usually directed at specific outfalls. Dry weather diversions of storm drains to wastewater treatment plants or localized infiltration projects are structural methods.

2) Source control - Any approach to reduce bacteria in the MS4 will necessarily include some source control. Source control may be less costly and/or more reliable than the outfall-based approach while still attaining the WLAs. Source control relies heavily on “sustainable” types of actions that may be preferred by stakeholders including dry weather runoff management, low impact development, and sanitary surveys. Source control methods may include development of comprehensive, system-wide actions to reduce the volume of dry weather runoff discharged from MS4 outfalls. These flow rate reductions could potentially be achieved using non-structural controls/programs that reduce or eliminate dry weather runoff. Such programs may include enforced municipal ordinances regarding landscape irrigation (limiting excessive overflow and/or the types of plants that are allowed), low impact development ordinances that capture runoff from development/redevelopment, etc. A major challenge will be quantification of the effectiveness of non-structural controls/programs; the collected outfall monitoring data could be used in conjunction with pilot studies to quantify effectiveness before and after implementation. Source control methods could also include targeted investigations and abatement efforts (e.g., sanitary surveys) of

problematic dry weather storm drain discharges. Human-specific bacterial indicators (e.g., *Bacteroidales*) data could be used in conjunction with *E. coli* data to target problematic discharges.

3) The downstream methods use a single structural control to directly reduce bacteria concentrations in receiving waters (e.g., constructing a treatment control at the mouth of a tributary just upstream of its confluence with the Los Angeles River), as opposed to constructing multiple controls at storm drain outfalls along the segment or tributary. A downstream method will necessarily require a Use Attainability Analysis (UAA) to be a viable implementation approach.

The downstream-based method is included because it has the potential to lead to more reliable, faster, and less-expensive solutions for protection of recreational users when compared to a structural approach. Downstream-based approaches may be less expensive and require a shorter timeline because a single (though larger) solution can be installed within or adjacent to the segment/tributary as opposed to multiple projects at upstream outfalls. Downstream-based approaches may be more reliable and protective because they collect and treat all water (including MS4 runoff) at a single location upstream of potential recreational areas.

The downstream-based approach poses significant challenges, and may in fact not be feasible for any of the Los Angeles River segments or tributaries due to regulatory and/or engineering constraints, as described below.

- **In-stream project** – Create an in-stream project immediately upstream of a compliance point that provides in-stream treatment for bacteria reduction and perhaps has multiple benefits.
- **Treatment and discharge/reuse** – Divert flow immediately upstream of a TMDL compliance point (immediately prior to confluence with the Los Angeles River), treat and return to waterbody and/or reuse dry weather flow to supplement irrigation water supplies.
- **Divert and infiltrate** – Divert flow immediately upstream of a TMDL compliance point, and infiltrate diverted flow at a nearby site.
- **Diversion to WRP** – Divert all or a portion of a tributary or segment's surface runoff to the sanitary sewer for treatment by a WRP.

An evaluation of the feasibility of a downstream approach would include the following components:

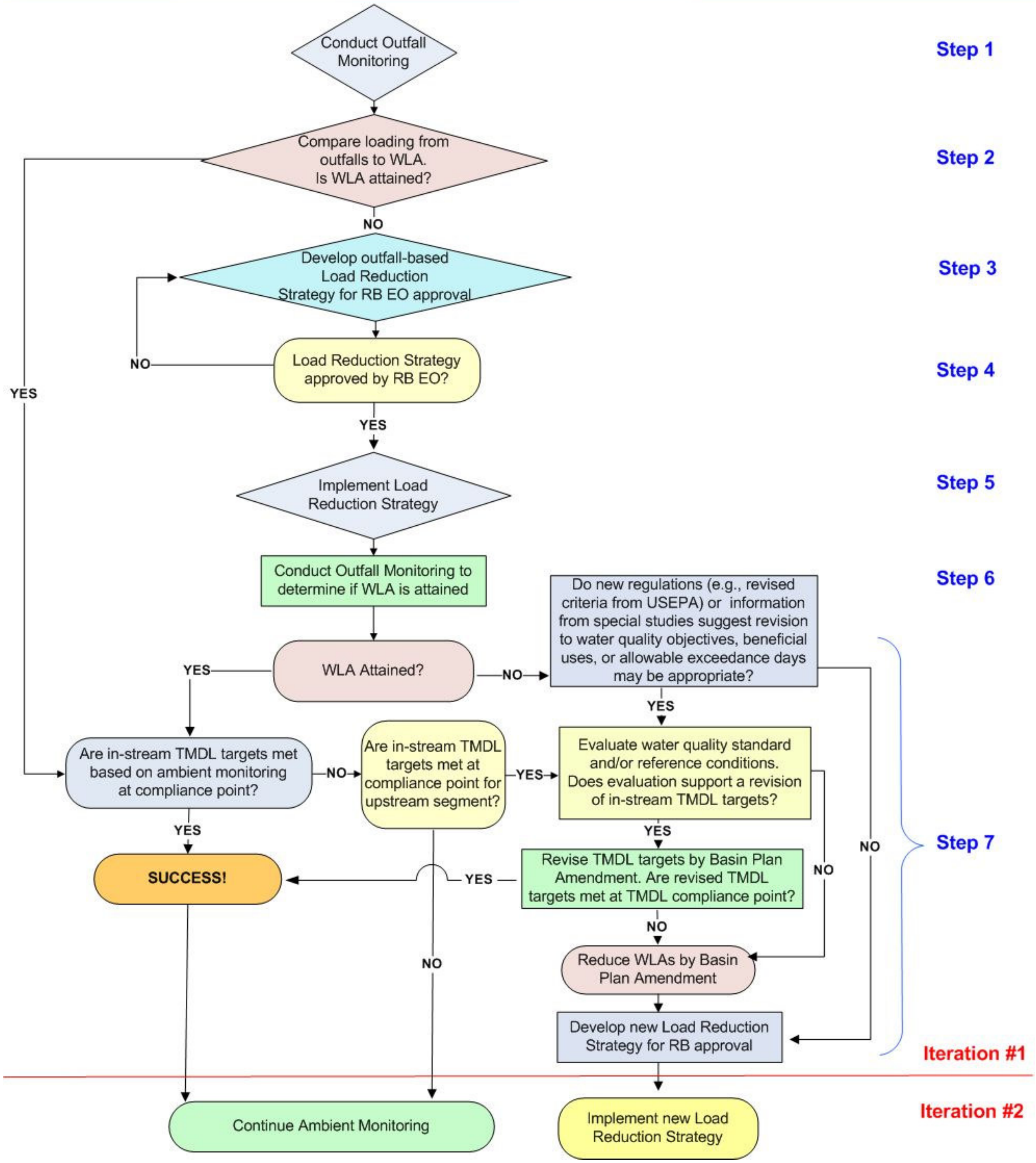
- Technical feasibility
- Economic feasibility
- Regulatory acceptability under federal and state laws
- Environmental impacts
- Public acceptability

> A downstream-based approach could be considered “infeasible” according to any of the above criteria. The regulatory and public acceptability components are likely the biggest hurdles for MS4s permittees that would pursue a downstream-based approach. In particular, the downstream-based approach will likely require the performance of a Use Attainability Analysis (UAA) to evaluate whether the upstream recreational uses are existing and/or attainable per 40 CFR§131.10(g). Otherwise, the portion of the segment or tributary that is just upstream of the downstream solution would remain out of compliance with the TMDL target (and Basin Plan water quality objectives), potentially requiring additional actions in the future.

The MS4 Load Reduction Strategy to be submitted to the Regional Board Executive Officer for approval shall specify the proposed number, types and locations of actions that will be implemented to attain the MS4 WLA for a mainstem Los Angeles River segment or tributary. MS4 Permittees may use any combination of actions in a LRS as long as it is sufficiently demonstrated that the proposed suite of actions are expected to result in WLA attainment.

There are seven steps in using an LRS plan for a mainstem Los Angeles River segment or tributary. After outfall monitoring (Step 1) and comparison of existing *E. coli* loading to the WLA (Step 2), a LRS plan for attaining the WLA is developed (Step 3). Executive Officer approval is Step 4 and implementation of the plan is Step 5. Outfall monitoring and determination of success is Step 6. Step 7 identifies next steps. See Figure 7-1. All of the steps are described in greater detail in the CREST-developed Appendix 1.

Figure 9-1 Los Angeles River Bacteria TMDL Outfall-based LRS Approach Flow Diagram



WLA = Wasteload Allocation RB EO = Regional Board Executive Officer

The MS4 LRS approach requires a significant investment in collection and analysis of outfall water quality data to develop the plan. Step 1 is the collection of that data, as described in more detail in the monitoring subsection, below. Essentially, every outfall in a segment or tributary is characterized so that the outfalls contributing the most to the exceedances and the health risk can be identified for priority action. The early investment in data collection and the evaluation of the data (Step 2) makes it more likely for the plan to succeed.

The LRS plan, itself (Step 3), includes several components:

- **Step 3, Part 1: Review of the data collected for the subject segment or tributary.**

- **Step 3, Part 2: Prioritization of storm drain outfalls for implementation actions.** The prioritization process uses the data collected in the outfall monitoring of Step 1. With these data, an evaluation is conducted to determine the most useful storm drains to target for dry weather diversions or other methods of reduction. The mathematical method used to make the prioritization is a Monte Carlo simulation [or equivalent] to (1) evaluate both the individual and cumulative *E. coli* loading rates from outfalls along a segment or tributary and (2) prioritize implementation actions based on these *E. coli* loading rates and, if desired, data for other indicators including source identification data (e.g., human *Bacteroidales*, human-specific viruses, etc.). Two categories of outfalls are identified:

  - ***Priority Outfalls:*** These are outfalls with relatively consistent, problematic discharges that both drive storm drain loading rates above the WLA and are considered to likely pose the highest risk to human health. As such, Priority Outfalls are the highest priority for source investigation and targeted implementation actions (i.e., structural controls).

  - ***Outlier Outfalls:*** These are outfalls that exhibit episodically high loading rates of *E. coli.* Outlier Outfalls are initially subject to follow-up investigations to identify the sources that could be leading the elevated loading rates.

  The detailed process for identifying Priority Outfalls and Outlier Outfalls is presented in CREST Appendix 1, using the Monte Carlo method and, using as an example, data collected from Segment B during the BSI Study (CREST, 2008).

- **Step 3, Part 3: Field assessment of feasibility of potential implementation actions and investigation of potential sources to Priority Outfalls** – Once priority outfalls are identified, a field assessment will be necessary to evaluate the feasibility of potential actions to provide assurance that proposed actions are implementable. Potential site constraints could include, but are not limited to, availability of land to construct a project, access to utilities, and proximity to wastewater infrastructure with available capacity. The additional purpose of a field assessment would be to conduct more detailed investigation of potential sources to determine if source elimination (e.g., from an illicit sanitary sewer connection), rather than a structural BMP to divert or manage the runoff, is required. Details regarding the actions that could be performed during the field assessment are provided in CREST Appendix 1.

- **Step 3, Part 4: Summarize field assessment and identify load reduction actions to be implemented –** This part of the LRS identifies proposed actions at Priority Outfalls and Outlier Outfalls and provides reasonable assurance that WLAs will be attained after the LRS is completed as follows:

    - ***Summarize results of field assessment at the Priority Outfalls:*** If a bacteria source was identified and abated, and therefore expected to reduce the loading of *E. coli* from a Priority Outfall (and eliminate the corresponding need for structural controls), then supporting field data shall be provided.

    - ***Identify proposed actions for Priority Outfalls:*** Permittees may choose whichever implementation actions are preferred to reduce or eliminate the *E. coli* loading from Priority Outfalls. The range of actions could include but are not limited to source control BMPs, low flow diversions, infiltration BMPs, and treatment BMPs as described in Appendix 1.

    - ***Demonstrate that implementation of actions at the Priority Outfalls will result in attainment of WLA:*** This component of the LRS provides reasonable assurance to the Regional Board Executive Officer that proposed implementation actions at the Priority Outfalls will result in attainment of the WLAs. Monte Carlo simulations similar to those utilized to identify Priority Outfalls could be used to demonstrate that implementation actions proposed for the Priority Outfalls will result in attainment of the WLAs. The expected performance (i.e., expected *E. coli* density and associated load from storm drain effluent) after a proposed BMP is installed could be input into the already-constructed Monte Carlo model. For proposed BMPs that do not completely eliminate the discharge, reliable data must be used to estimate expected BMP performance. If non-structural BMPs are a component of the Outfall-based LRS, then it may be necessary to perform pilot studies to sufficiently estimate expected effectiveness. Table 7.1 shows a hypothetical example of an LRS approach to Priority Outfalls for Segment B, based on data collected during the BSI Study (CREST, 2008). Appendix 1 provides additional details and hypothetical LRSs.

    - ***Establish timeline for implementation of actions at Priority Outfalls:*** A timeline for implementing the specific actions at Priority Outfalls must be provided in the LRS, including milestones during the course of LRS implementation. The proposed timeline for an LRS must be in accordance with the TMDL Implementation Schedule.

    - ***Identify proposed follow-up/investigation efforts at Outlier Outfalls:*** Outlier Outfalls and their corresponding drainage areas and storm drain networks shall be investigated to determine potential sources of *E. coli*, particularly human fecal sources that could have led to the episodic elevated bacteria loading rates. The proposed timeline for Outlier Outfall investigations in the LRS must be in accordance with the TMDL Implementation Schedule. A list of Outlier Outfalls along Segment B based on BSI Study data are presented in CREST Appendix 1.

Table 9-2 Hypothetical LRS Approach to Priority Outfalls for Segment B based on Incorporating Treatment BMPs[1]

Priority Outfall	**Current Expected *E. coli* Loading Rate[2]** (10^9 MPN/day)	**Proposed LRS Action[1]**	**Expected *E. coli* Loading Rate after Proposed LRS Actions** (10^9 MPN/day) (% Reduction)	**Expected *E. coli* Loading Rate from all Segment B Outfalls after Proposed LRS Actions[3]** (10^9 MPN/day)
R2-A	140	Diversion	0 (100%)	883
R2-K	78	Diversion	0 (100%)	742
R2-02	31	Wetland [4]	15 (50%)	694
R2-06	29	Media filter [5]	10 (65%)	637
R2-J	20	Wetland [4]	9 (50%)	597
R2-G	15	Diversion	0 (100%)	508
R2-E	12	Diversion	0 (100%)	446

(see Appendix 1 for additional details)

1 – These actions are completely hypothetical for demonstration purposes only and have not been assessed for feasibility or desirability.
2 – Expected values are based on Monte Carlo simulation medians using data collected from the BSI Study.
3 – The expected *E. coli* loading from all outfalls *prior* to action is 1,431 x 10^9 MPN per day. The expected post-action loading rates are cumulative based on employed BMPs, starting with a low flow diversion (LFD) at R2-A and ending with an LFD at R2-E. The MS4 WLA for Segment B is 472 x 10^9 MPN per day.
4 – Median of 4 values reported by Clary *et al.* (2008) from the International Stormwater BMP Database (www.bmpdatabase.org). Reductions ranged from 0 to 98.5%. The average reduction was 38.4%.
5– Median of 12 values reported by Clary *et al.* (2008) from the International Stormwater BMP Database. Reductions ranged from 0 to 94.8%. The average reduction was 40.6%.

Following development, the LRS shall be submitted for Regional Board Executive Officer approval (Step 4). The EO will approve LRSs that follow the step-wise approaches, which are designed to provide reasonable assurance of WLA attainment.

Implementation of actions in the LRS (Step 5) will be initiated according to the schedule in the LRS.

Upon completion of the implementation actions identified in the LRS, outfall monitoring (Step 6) must be conducted to evaluate whether the LRS resulted in attainment of the WLAs. The goal of this monitoring is to characterize the *E. coli* loading from all flowing storm drain outfalls (Priority Outfalls, Outlier Outfalls, and all other outfalls) and determine if WLAs were attained after the LRS was implemented. The monitoring will be conducted in the same manner as under Step 1, as described below.

An evaluation of attainment of the WLAs and numeric targets is Step 7. Three scenarios are possible after Step 7.

- Scenario 1: MS4 interim WLA attained and numeric targets met (final WLAs)
  Under Scenario 1, the TMDL has been achieved for that segment and ambient monitoring continues.

- Scenario 2: MS4 WLA attained but in-stream targets are not met
  Under Scenario 2, the discharges and WLAs are re-evaluated and a second phase of implementation within the segment/tributary is undertaken, if necessary, and ambient monitoring continues.

- Scenario 3: MS4 WLA not attained and in-stream targets are not met
  Under Scenario 3, the discharges and WLAs are re-evaluated and a second phase of implementation is undertaken, and ambient monitoring continues.

9.4.6 Prioritization of segments; MS4 dry weather implementation

The MS4 LRS strategy establishes phases for implementation, both by allowing two full phases of implementation per segment and by setting different segments of the river to be implemented before others. This section describes the process used to prioritize MS4 implementation on five specific mainstem LA River segments and 11 tributaries. The concepts used in prioritization of TMDL implementation segments were evaluated during a September 2009 CREST stakeholder workshop. Through extensive discussions involving a broad spectrum of stakeholders, four primary locations where water contact activities are known or likely to occur were categorized as the highest priority.

- **Long Beach beaches:** Downstream of the extent of this TMDL, the beaches of Long Beach, are adjacent to the mouth of the Los Angeles River, and are subject to water contact by thousands of individuals each year.

- **Segment A and B of the Los Angeles River:** Much of this portion of the Los Angeles River has a path on the bank of the River[5], and while entering the channel is not permitted, water contact has been observed in these segments.

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[5] The Los Angeles River is a trapezoidal channel along Segment A and B (from Figueroa Street [upstream] to the mouth [downstream]). The walking/bike path is adjacent to the Los Angeles River, several hundred feet from the low-flow channel. Unlike other

- **Glendale Narrows:** The Narrows is a stretch of soft-bottom channel at the downstream end of Segment C. Horse riding and sunbathing are common in this portion of the LA River, and there are access points where individuals can get near or into the river.

- **Sepulveda Basin:** The Sepulveda Basin is another soft-bottom portion of the Los Angeles River, and adjacent to the Basin are recreational areas (Balboa Lake Park) and trails that provide access to the river.

Table 9-3 presents a conceptual timeline of prioritization of TMDL implementation for the mainstem Los Angeles River segments and tributaries. The order in which the segments and tributaries of the Los Angeles River were prioritized over time was based on (1) the relative level of risk to recreational users given perceived differences in frequency of recreational activities[6] and (2) the extent of currently available water quality information that could expedite implementation actions to meet WLAs.

An important consideration for the timeline is the order of implementation actions in Los Angeles River segments versus tributaries. To allow for attainment of TMDL targets in the mainstem Los Angeles River earlier during the TMDL implementation timeline, implementation activities on tributaries are proposed to follow completion of initial work on the corresponding mainstem Los Angeles River segments. In other words, all Los Angeles River segments could have been addressed prior to any tributaries, but the loading from tributaries might have prevented attainment of TMDL targets in the mainstem Los Angeles River until later in the schedule. Thus, the proposed order for the implementation timeline is segment-tributary, segment-tributary instead of segment, segment, tributary, tributary.

While this prioritization shows a stepwise progression of BMP implementation through the various Los Angeles River segments and tributaries, MS4 Permittees may implement system-wide source control BMPs during all phases of implementation. In this manner, loading to some Los Angeles River segments or tributaries would be reduced prior to being addressed by structural BMPs, and in fact, system-wide source control efforts should ultimately reduce the effort for structural implementation actions. In addition, implementation of other TMDLs currently in effect in the Los Angeles River Watershed, in particular the Metals TMDL, will assist with achieving the targets and allocations of this TMDL.

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portions of the Los Angeles River, there is no fence between the path and the water along Segment A and B.

[6] The relative magnitude of recreational activities was based on discussions with stakeholders including non-governmental organizations. It was presumed that the lower reaches of the LA River (Reach 1 and Reach 2) are subject to the most frequent activity. It is noted that some of this user access is prohibited by Los Angeles County DPW. See http://ladpw.org/services/water/nowayout.pdf.

The following describes the reasoning for prioritizing the segments, and corresponding tributaries, as presented in **Table 9-3** (see Figure 6-1 for the extent and location of Los Angeles River segments and tributaries):

- **Priority 1:** Segment B: upper and middle Reach 2 – Figueroa Street to Rosecrans Avenue. Tributaries to Segment B include Rio Hondo and Arroyo Seco. Segment B was selected as the first priority for compliance efforts for three reasons:

  1) The availability of data to support a relatively rapid initiation of implementation actions. There is a large data set on the bacteria and virus loading from the storm drain outfalls collected by the recently completed Los Angeles River Bacteria Source Identification (BSI) Study (CREST, 2008). This dataset is essentially the Step 1 data collection of an MS4 LRS and will allow the MS4 Permittees to move forward with implementation efforts to reduce bacterial loads from priority storm drain outfalls to the main channel.

  2) Elevated recreational use compared to other Los Angeles River segments.

  3) Proximity to the downstream estuary, San Pedro Bay and Long Beach beaches. Reduction of bacterial loads to Segment B would not only be beneficial to recreational users within the Los Angeles River but would also be beneficial to recreational users of the Bay and Long Beach beaches.

  In addition, early reduction of MS4 bacteria discharges to segment B/Reach 2 will provide a better starting point for concurrently conducting optional special studies to more fully characterize all sources within this segment.

  Priority 2: Segment A: lower Reach 2 and Reach 1 – Rosecrans Avenue to Willow Street. Compton Creek is the only tributary to Segment A. Segment A, which is downstream of Segment B, was the next highest priority reach for compliance efforts due to its close proximity to the downstream estuary and beaches. As with Segment B, reduction of bacterial loads to Segment A would not only be beneficial to recreational users within the Los Angeles River but would also be beneficial to recreational users of the bay and Long Beach beaches.

- **Priority 3:** Segment E: Reach 6 – Los Angeles River headwaters to Balboa Boulevard. Tributaries to Segment E include McCoy Canyon, Dry Canyon, Bell Creek, and Aliso Canyon Wash. Segment E was chosen as the next priority because it is directly upstream of the Sepulveda Basin (Reach 5), which is a recreational area with water contact activities. Bacterial load reductions in Segment E are expected to result in improved water quality at the downstream Sepulveda Basin recreational area.

- **Priority 4:** Segment C: lower Reach 4 and Reach 3 – Tujunga Avenue to Figueroa Street. Tributaries to Segment C include Tujunga Wash, Burbank Western Channel, and Verdugo Wash. Segment C was selected as the next priority because of the potential for recreational use in the lower portion of the segment, the Glendale Narrows in Reach 3. Due to its soft bottom and ease of accessibility to the public, Glendale Narrows is a popular recreational area.

- **Priority 5:** Segment D: Reach 5 and upper Reach 4 – Balboa Boulevard to Tujunga Avenue. Bull Creek is the only tributary to Segment D. Segment D was placed as the final priority for implementation efforts because much of this the segment is the least accessible (due to the fenced, vertical concrete channel). While Reach 5 is contained in Segment D and provides recreational use opportunities, it was not prioritized earlier for implementation efforts because (1) it is anticipated that reductions in loadings that occur as a result of addressing Segment E (Reach 6) will also result in supporting attainment of in-stream targets in Reach 5 and (2) there are relatively few MS4 discharges to Reach 5.

Table 9-3 Conceptual Schematic of Los Angeles River Bacteria TMDL Prioritized and Iterative Implementation Process for MS4 Permittees

Timeline	**Immediate Ongoing Actions**	**Implementation of LRS**		**Implementation of Second LRS (if necessary) ***	
	Watershed-Wide Actions	Los Angeles River Mainstem	Tributaries	Los Angeles River Mainstem	Tributaries
Adoption of TMDL	LA River Watershed	Segment B	▨	▨	▨
		Segment A	Segment B	Segment B	▨
		Segment E	Segment A	Segment A	Segment B
↓		Segment C	Segment E	Segment E	Segment A
		Segment D	Segment C	Segment C	Segment E
		▨	Segment D	Segment D	Segment C
Completion of TMDL		▨	▨		Segment D

* – Implementation of additional BMPs as necessary to achieve WLA for each individual segment and/or tributary. If the WLA is achieved, then no additional actions are required for that segment or tributary.

9.5 Wet Weather Implementation

Grouped final WLAs for the MS4 Permittees in the watershed, including Caltrans, for wet weather are expressed as the allowable number of exceedance days. The group allocation applies to all MS4 Permittees in the Los Angeles River watershed (Los Angeles County Flood Control District, Los Angeles County and co-MS4 Permittees that discharge to the watershed, including the City of Long Beach, and Caltrans).

Because compliance with wet weather WLAs will depend upon BMPs designed to meet dry weather targets and because the wet weather WLAs for the entire stretch of river will not be achievable until after full implementation of the dry weather phases, wet weather compliance is required at the end of the implementation schedule for all segments and tributaries.

MS4 Permittees can achieve wet weather WLAs by employing any viable and legal implementation strategy.

As in other bacterial TMDLs developed in this Region, responsible jurisdictions and agencies must provide an Implementation Plan to the Regional Board outlining how each intends to cooperatively achieve compliance with the wet weather WLAs. The report shall include implementation methods, an implementation schedule, and proposed milestones. The plan shall include a technically defensible quantitative linkage to the final wet weather WLAs. The linkage should include target reductions in stormwater runoff and/or *E. coli* bacteria. The plan shall include quantitative estimates of the water quality benefits provided by the proposed structural and non-structural BMPs.

9.6 Implementation Schedule

Within 25 years of the effective date of the TMDL, compliance with the allowable number of exceedance days at all locations during dry weather and wet weather is required.

The longer schedule, as compared to that provided for in the Santa Monica Bay Beaches Bacteria TMDLs, and the Ballona Creek Bacteria TMDL, is warranted due to the number and scale of the foreseeable implementation measures. In the case of the Santa Monica Bay Beaches Bacteria TMDLs, responsible agencies had initiated dry weather implementation measures prior to TMDL adoption for many beaches, therefore a three-year schedule for summer dry weather was feasible for those beaches. The Ballona Creek watershed compliance periods are also much shorter than this TMDL's compliance periods, but the number of stream miles and the size of the watershed to be brought into compliance is also much smaller, see Table 9-4. The final compliance dates for this TMDL are based on foreseeable implementation and are reasonably consistent with the Ballona Creek Bacteria TMDL.

Table 9-4 Comparison of the Size of the Ballona Creek and Los Angeles River Watersheds and the Corresponding TMDL Compliance Dates.

Watershed	Miles of Listed Stream in TMDL	Urbanized Watershed	Dry Weather Implementation Years	Wet Weather Implementation Years
Ballona Creek	10 miles	130 sq mi	6	14
Los Angeles River	127 (55 mainstem miles plus tributaries)	599 sq mi	25	25

The schedule is sufficiently long to allow MS4 Permittees to use any of the compliance methods discussed, including outfall-directed actions, source control actions and if conditions warrant, downstream approaches. The time allowed for specific actions in the schedule – i.e., planning, implementing an estimated number of actions, assessing - is based on the experience of the MS4 Permittees in implementing other TMDLs.

The implementation schedule is phased both in terms of the segment-by-segment approach, as discussed above, and also within each segment by allowing two phases of implementation to achieve full compliance with the WLAs. The interim WLAs, based on bacterial loads (rather than exceedance days), have been developed to bring the River into compliance with the final exceedance day WLAs. A second phase is included in the schedule to allow for the high variability of bacterial loads and potentially changing conditions in the River over time; however, it is expected that the River will be largely in compliance by the time the first phase of implementation is complete.

The TMDL schedule requires completion of the first LRS phase and attainment of the interim WLA on all mainstem Los Angeles River segments and tributaries within 15.5 years, and a total timeline of 25 years to complete a second phase on the final segments addressed (Segments C and D and tributaries).

Implementation for Segments A and B, identified as the highest priority because of the potential influence on the beaches located in Long Beach, will be completed within 8 years of the effective date of the TMDL. Therefore, significantly improved water quality is expected at Long Beach beaches well before the complete implementation of the TMDL.

This schedule is based on the CREST-developed schedule. The time allotted for planning, implementing, and assessing are as determined by the CREST stakeholder group and the schedule includes a full second phase of implementation for all segments. This schedule differs from the CREST-developed schedule in four ways: 1) this schedule provides no gap between first and second phases for “reconsideration” of the TMDL because implementation does not need to stop if the TMDL is re-considered 2) only 3 years is provided for the second phase of implementation (versus 4 years) because it is expected that the river will largely be in compliance as a result of actions in the first phase, and any watershed-wide BMPs will be beginning to have effect, 3) only 2 years for the second evaluation (versus 3 years) because planning for the second evaluation can take place during implementation, 4) the final three segments (Segment C tributaries, Segment D and Segment D tributaries) have been moved up parallel in time to Segment C because watershed-wide BMPs will be beginning to have effect and BMPs implemented for the Los Angeles River Watershed Metals TMDL, which are designed to address multiple pollutants, will have effect.

Responsible parties in the Los Angeles River Watershed are currently implementing the Los Angeles River Watershed Metals TMDL, which requires compliance with wet weather metal targets by 2028 (within 22 years of the TMDL effective date). Interim goals were also established for the metals TMDL. Implementation plans developed for these TMDLs by the City of Los Angeles and County of Los Angeles include BMPs to address multiple pollutants including bacteria. Implementation of the metals TMDL will be complete before the bacterial TMDL and will address much of the bacterial impairment. So, it is expected that the segments scheduled for later implementation under this schedule will experience bacteria water quality improvements prior to the scheduled implementation phase.

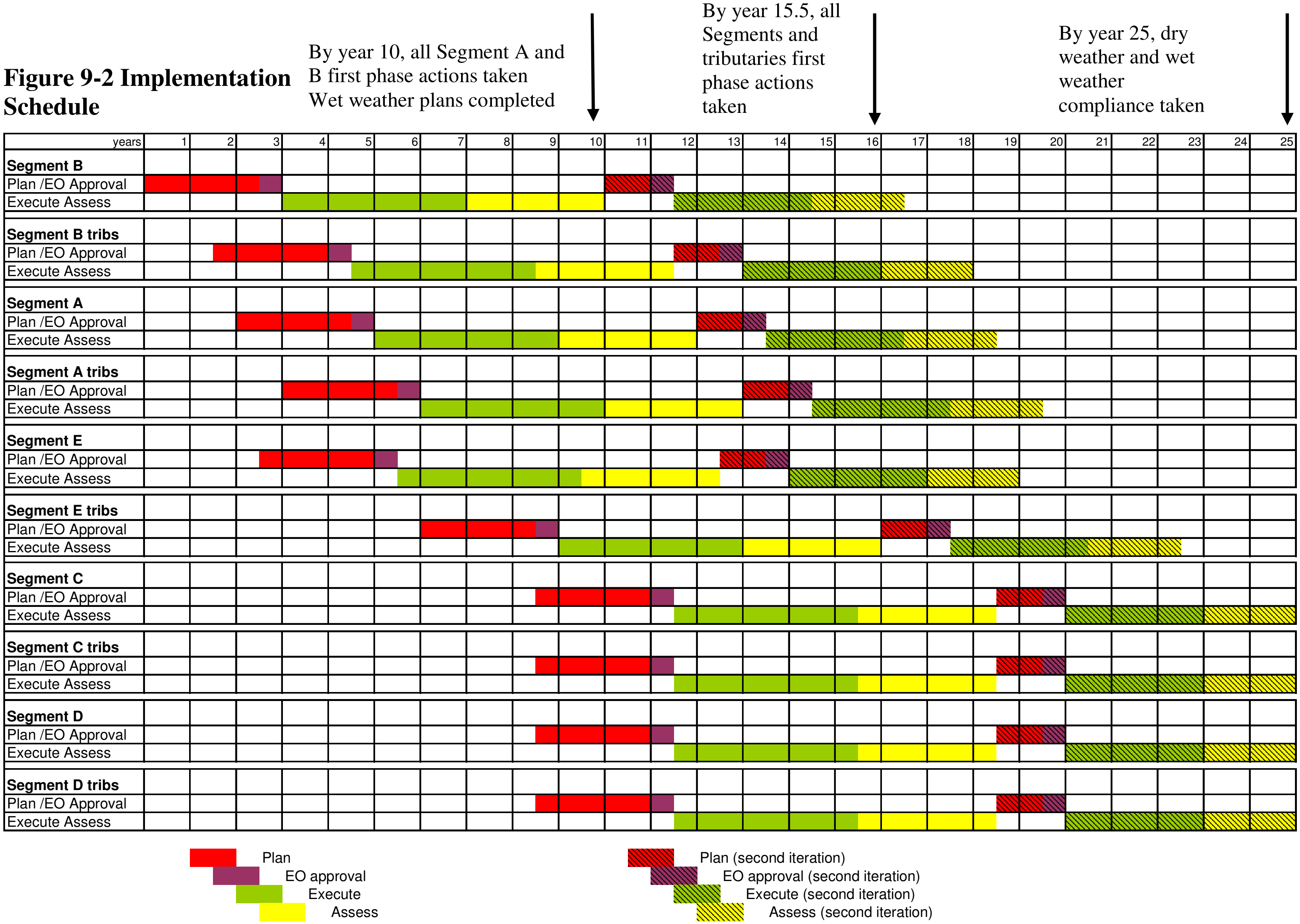
This schedule for dry weather, including interim allocations, is very detailed and phased due to the work of CREST which provided the significant scientific work and stakeholder input to support the detailed, phased, approach. For wet weather, the schedule is based on the Regional Board and stakeholder experiences in developing other bacterial TMDLs. The Ballona Creek Bacteria TMDL, Malibu Creek Bacteria TMDL and Santa Monica Bay Beaches Bacteria TMDL schedules allow approximately 15 to 18 years for wet weather compliance when following an Integrated Water Resources Approach to address multiple pollutants. For this TMDL, the very long time allowed for complete dry weather compliance due to the phased approach, itself, allows sufficient time for responsible parties to pursue and succeed with an integrated approach to achieve wet weather WLAs throughout the watershed. Therefore, the wet weather compliance schedule is set at 25 years.

Figure 9-2 Implementation Schedule

By year 10, all Segment A and B first phase actions taken Wet weather plans completed

By year 15.5, all Segments and tributaries first phase actions taken

By year 25, dry weather and wet weather compliance taken



Note 1: The interim allocations based on bacterial loads (versus exceedance days) have been developed to bring the River in compliance with the exceedance day targets. A second phase is included in the schedule to allow for the high variability of bacterial loads and potentially changing conditions in the River; however, it is expected that the River will be largely in compliance by the time the first phase of implementation is complete.

Table 9-5 Implementation Schedule for Los Angeles River Bacteria TMDL (watershed wide actions at are the end of the table)

Implementation Action	Responsible Parties	Deadline
SEGMENT B (upper and middle Reach 2 – Figueroa Street to Rosecrans Avenue)		
First phase – Segment B		
Submit a Load Reduction Strategy (LRS) for Segment B *(or submit an alternative compliance plan)*	MS4 and Caltrans NPDES Permittees discharging to Segment B	2.5 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B, if using LRS	7 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B, if using LRS	10 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment B, if using alternative compliance plan*	*10 years after effective date of the TMDL*
Second phase, if necessary – Segment B (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B	11 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B, if using LRS	14.5 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B, if using LRS	16.5 years after effective date of the TMDL
Achieve final WLAs in Segment B or demonstrate that non-compliance is only due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment B, if using LRS	16.5 years after effective date of the TMDL
SEGMENT B TRIBUTARIES (Rio Hondo and Arroyo Seco)		
First phase – Segment B Tributaries (Rio Hondo and Arroyo Seco)		
Submit a Load Reduction Strategy (LRS) for Segment B tributaries *(or submit an alternative compliance plan)*	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries	4 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using LRS	8.5 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using LRS	11.5 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is only due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using alternative compliance plan*	*11.5 years after effective date of the TMDL*
Second phase, if necessary – SEGMENT B TRIBUTARIES (Rio Hondo and Arroyo Seco) (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries	12.5 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS

Implementation Action	Responsible Parties	Deadline
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using LRS	16 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using LRS	18 years after effective date of the TMDL
Achieve final WLAs Segment B tributaries or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment B tributaries, if using LRS	18 years after effective date of the TMDL
SEGMENT A (lower Reach 2 and Reach 1 – Rosecrans Avenue to Willow Street)		
First phase – Segment A		
Submit a Load Reduction Strategy (LRS) for Segment A (or submit an alternative compliance plan)	MS4 and Caltrans NPDES Permittees discharging to Segment A	4.5 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A, if using LRS	9 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A, if using LRS	12 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment A, if using alternative compliance plan*	*12 years after effective date of the TMDL*
Second phase, if necessary – Segment A (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A	13 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A, if using LRS	17.5 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A, if using LRS	19.5 years after effective date of the TMDL
Achieve final WLAs in Segment A or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment A, if using LRS	19.5 years after effective date of the TMDL
SEGMENT A TRIBUTARY (Compton Creek)		
First phase – Segment A Tributary		
Submit a Load Reduction Strategy (LRS) for Segment A tributary (or submit an alternative compliance plan)	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary	6 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary if using LRS	10.5 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary if using LRS	13.5 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment A tributary, if using alternative compliance plan*	*13.5 years after effective date of the TMDL*
Second phase, if necessary – Segment A tributary (LRS only)		

Implementation Action	**Responsible Parties**	**Deadline**
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary	14.5 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary, if using LRS	18 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary, if using LRS	20 years after effective date of the TMDL
Achieve final WLAs in Segment A tributary or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment A tributary, if using LRS	20 years after effective date of the TMDL
SEGMENT E (Reach 6 – LA River headwaters [confluence with Bell Creek and Calabasas Creek] to Balboa Boulevard)		
First phase – Segment E		
Submit a Load Reduction Strategy (LRS) for Segment E *(or submit an alternative compliance plan)*	MS4 and Caltrans NPDES Permittees discharging to Segment E	5.5 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E, if using LRS	10 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E, if using LRS	13 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment E, if using alternative compliance plan*	*13 years after effective date of the TMDL*
Second phase, if necessary –Segment E, (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E	14 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E, if using LRS	17.5 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E, if using LRS	19.5 years after effective date of the TMDL
Achieve final WLAs in Segment E or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment E, if using LRS	19.5 years after effective date of the TMDL
SEGMENT E TRIBUTARIES (Dry Canyon Creek, McCoy Creek, Bell Creek, and Aliso Canyon Wash)		
First phase – Segment E Tributaries		
Submit a Load Reduction Strategy (LRS) for Segment E tributaries (or submit an alternative compliance plan)	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries	9.5 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries if using LRS	14 years after effective date of the TMDL

Implementation Action	Responsible Parties	Deadline
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries, if using LRS	17 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries, if using alternative compliance plan*	*17 years after effective date of the TMDL*
Second phase, if necessary – Segment E tributaries (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries	18 years after effective date of the TMDL
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries, if using LRS	21.5 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries, if using LRS	23.5 years after effective date of the TMDL
Achieve final WLAs in Segment E tributaries or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment E tributaries, if using LRS	23.5 years after effective date of the TMDL
Segment C (lower Reach 4 and Reach 3 – Tujunga Avenue to Figueroa Street) **Segment C Tributaries (Tujunga Wash, Burbank Western Channel, and Verdugo Wash)** **Segment D (Reach 5 and upper Reach 4 – Balboa Boulevard to Tujunga Avenue)** **Segment D Tributaries (Bull Creek)**		
First phase – Segment C, Segment C Tributaries, Segment D, Segment D tributaries		
Submit a Load Reduction Strategies (LRS) for Segment C, Segment C tributaries, Segment D, Segment D tributaries *(or submit an alternative compliance plan)*	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries	11 years after effective date of the TMDL
Approve LRS (or alternative compliance plan)	Regional Board, Executive Officer	6 months after submittal of LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries, if using LRS	15.5 years after effective date of the TMDL
Achieve interim WLA and demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries, if using LRS	18.5 years after effective date of the TMDL
Achieve final WLA or demonstrate that non-compliance is due to upstream contributions	*MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries, if using alternative compliance plan*	*18.5 years after effective date of the TMDL*
Second phase, if necessary - Segment C, Segment C Tributaries, Segment D, Segment D Tributaries (LRS only)		
Submit a new LRS	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries	19.5 years after effective date of the TMDL

Implementation Action	Responsible Parties	Deadline
Approve LRS	Regional Board, Executive Officer	6 months after submittal of a second LRS
Complete implementation of LRS	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries if using LRS	23 years after effective date of the TMDL
Demonstrate compliance with LRS	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries, if using LRS	25 years after effective date of the TMDL
Achieve final WLAs in Segment C, Segment C tributaries, Segment D, Segment D tributaries or demonstrate that non-compliance is due to upstream contributions	MS4 and Caltrans NPDES Permittees discharging to Segment C, Segment C tributaries, Segment D, Segment D tributaries if using LRS	25 years after effective date of the TMDL
All Los Angeles River Segments and Tributaries		
Submit implementation plan for wet weather with interim milestones	All responsible parties	Within 10 years of the effective date of the TMDL
Achieve final dry weather WLAs and LAs	All responsible parties	25 years after effective date of the TMDL
Achieve final wet weather WLAs and LAs	All responsible parties	25 years after effective date of the TMDL

9.7 Monitoring

A monitoring program is necessary to determine compliance with the TMDL and to assess attainment of beneficial uses.

The monitoring will be conducted by the responsible MS4 Permittees. There are two types of monitoring:

- **Compliance Monitoring** to assess attainment of WLAs and to assess waterbody conditions in the Watershed, overall
- **Monitoring** in support of Load Reduction Strategies and Wet Weather Implementation Plans.

9.7.1 Compliance Monitoring

The details of the ambient water monitoring program will be provided by the responsible parties in a Bacteria Coordinated Monitoring Plan (CMP), which must be submitted per the TMDL implementation schedule.

- **Number of sites**: The CMP shall include at least one monitoring station in each Los Angeles River segment, reach and tributary addressed under this TMDL.

- **Measurements**: *E. coli* using USEPA-approved methods. Stakeholders may choose to monitor additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus), but these are not required.
- **Sample Collection Methods**: All samples shall be collected as grab samples.
- **Monitoring frequency**: Segments, reaches and tributaries addressed under this TMDL shall be monitored monthly until the subject segment, reach or tributary is at the end of its first implementation phase. Monthly monitoring is sufficient to determine, minimally, if the segment, reach or tributary is in compliance with interim WLA (expressed as loads in MPN/day). Also, monthly monitoring will provide sufficient data to assess changes in bacteria concentrations over the course of the initial implementation time period.

  After the first implementation phase, monitoring must be conducted weekly or more often to determine compliance with the in-stream targets (expressed in allowable number of exceedance days).

Over the course of TMDL implementation, it may be necessary to update or modify the CMP. Responsible parties may request changes via a letter to the Regional Board Executive Officer, and the Executive Officer may approve such changes.

Monitoring for dischargers other than MS4 permittees to determine compliance with WLAs and LAs shall be established through monitoring and reporting programs conducted as part of the discharger's permit/waste discharge/waiver requirements.\

9.7.2 Load Reduction Strategy Monitoring

For MS4 Permittees that choose to comply with the dry weather components of this TMDL through implementation of an LRS, monitoring is also necessary for implementation planning purposes (e.g., to determine the locations and numbers of BMPs) and for assessment of compliance with the interim WLAs.

Implementation of an LRS requires dry weather outfall monitoring both before and after implementation of the LRS. Pre-LRS monitoring is used to estimate the *E. coli* loading from MS4 outfalls to the Los Angeles River segment or tributary, and determine the location and number of Priority Outfalls as well as to support the identification of the types of implementation actions that are expected to be necessary to attain the MS4 WLAs. Post-LRS monitoring is used to evaluate the effectiveness of the implementation actions (i.e., determine if the interim WLA is attained) and to plan and design for additional implementation actions to meet the interim or final WLAs, if necessary.

For each LRS, an outfall monitoring program with the following characteristics would be considered sufficient for development of an LRS:

- **Number of sites**: Outfall monitoring for each LRS shall take place at *all* MS4 outfalls that are discharging to a segment or tributary during a given monitoring event. For reference, Segment B, which is 13.7 miles long, had a maximum of 39 outfalls that were flowing during the BSI Study during one event. A total of 51 outfalls were observed to be flowing over the course of all monitoring events (i.e., some outfall discharges were intermittent). To avoid overwhelming laboratories and field staff, it is acceptable for a single snapshot of a Los Angeles River segment or tributary to be spread out over several days (i.e., all samples do not have to be collected one the same day).

- **Measurements**: *E. coli* by USEPA-approved methods and flow rate. Sufficient dilutions should be used to avoid "greater than" results for *E. coli*. During the BSI Study, greater than ten million (10^7) MPN per 100 mL were measured in a few dry weather discharges. Measurements of volumetric flow rate (e.g., in units of cubic feet per second) of the discharge from each outfall shall be conducted using methods similar to those of the BSI Study (CREST, 2008). Monitoring of additional analytes such as human-specific indicators (e.g., human *Bacteroidales*) and pathogens (e.g., adenovirus) is encouraged but not required.
- **Sample Collection Methods**: All samples shall be collected as grab samples or instantaneous measurements.
- **Monitoring frequency**: For each LRS, at least six (6) snapshots shall be conducted for pre-LRS monitoring, and at least three (3) snapshots shall be conducted for post-LRS monitoring. To the extent practicable, given the TMDL implementation schedule, the dry weather snapshots shall be spread out over at least two seasons (e.g., summer and winter of the same year or multiple years). Note that six (6) pre-LRS snapshots plus three (3) post-LRS snapshots produces a total of nine (9) samples from all outfalls for each LRS, which would be available to assess attainment of the MS4 WLA. If the WLA is not attained, and follow-up actions are necessary under a new LRS, the three post-LRS snapshots provide additional information to develop the new LRS.
- **Period of monitoring**: Pre-LRS outfall monitoring should be initiated with sufficient time to incorporate results into the LRS for BMP planning. Initiation of outfall monitoring two years prior to submittal of the LRS should provide sufficient time to collect samples and utilize results for development of the LRS.

9.8 Special Studies

No special studies are required by the Basin Plan amendment for this TMDL.

10 Cost Considerations

This cost section includes a discussion of the costs in comparison to the costs associated with the Ballona Creek Watershed Bacteria TMDL including both dry and we weather implementation, specific project-type cost estimates, and a summary of the CREST-developed cost estimates for dry weather.

This section takes into account a reasonable range of economic factors in estimating potential costs associated with this TMDL. This analysis, together with the other sections of this staff report, CEQA checklist, response to comments, Basin Plan amendment and supporting documents, were completed in fulfillment of the applicable provisions of the California Environmental Quality Act (Public Resources Code Section 21159).[7]

This cost analysis focuses on compliance with the grouped waste load allocation by the MS4 and Caltrans stormwater permittees in the urbanized portion of the watershed. For the purposes of the cost analysis, the urbanized portion of the watershed is assumed to be 56% of the watershed or 467 square miles.

As implementation of projects and programs progresses, it is anticipated that the responsible parties will focus on the projects with the highest potential return first wherever possible, evaluate results and attempt to optimize the overall program effectiveness and costs. Therefore, it is possible that the TMDL could be achieved with substantially less capital and associated operation and maintenance costs than presented here. Conversely, there are a number of assumptions contained in the cost estimates that could ultimately result in greater capital or operation and maintenance costs for other components to achieve full compliance.

Most of the implementation components would be effective at helping reduce multiple pollutants, in particular metals and possibly trace toxic substances. Therefore, as implementation plans progress for all TMDLs in the watershed, close coordination between efforts is warranted, and the total cost of compliance with all TMDLs has the potential to be significantly less than the sum of the individual costs estimated for each TMDL.

10.1 Implementation Cost in Comparison to Ballona Creek Bacteria TMDL

The City of Los Angeles and County of Los Angeles have prepared implementation plans for the Ballona Creek Bacteria TMDL and have included estimated costs (City of Los Angeles, 2009; County of Los Angeles, 2009).

Cities and agencies (including the Beverly Hills, Caltrans, Culver City, City of Los Angeles, Inglewood, Santa Monica, and West Hollywood) estimated $840,000,000 in TMDL implementation costs for total capital costs, including both structural and institutional BMPs, and $22,600,000 annually for operations and maintenance. These cities also calculated an additional 20 % for program management, administration and monitoring (for a total capital cost of $1,010,000,000 and $27,100,000 in operations and maintenance) and a 30% program contingency.

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[7] Because this TMDL implements existing water quality objectives, it does not “establish” water quality objectives and no further analysis of the factors identified in Water Code section 13241 is required. However, the staff notes that its CEQA analysis provides the necessary information to properly “consider” the factors specified in Water Code section 13241. As a result, the section 13241 analysis would at best be redundant.

The County of Los Angeles prepared a separate implementation plan for unincorporated County areas. The County estimated total implementation costs for unincorporated County areas of $46,600,000.

In total, therefore, over the implementation schedule for the Ballona Creek Watershed Bacteria TMDL, the implementation could equal as much as $1.5 billion. The urbanized portion of the Los Angeles River Watershed is 3.59 times the size of the Ballona Creek Watershed (467 mi^2 vs. 130 mi^2). If costs of implementation are proportionally larger, costs for the Los Angeles River Watershed Bacteria TMDL could range up to $5.4 billion for full, inclusive, implementation costs. This is an elevated approximation as it does not include amortization over the long implementation period (or inflation) or discounting due to duplicity with other TMDLs or water conservation programs.

In the following descriptions, a summary of the costs for various components are presented. In reviewing these cost estimates, it should be noted that there are multiple additional benefits associated with the implementation. Many of the BMPs (both source control and treatment approaches) would also have the ability to reduce the amount of other contaminants in the runoff, which could assist in meeting the requirements of other Los Angeles River TMDLs, such as the metals TMDL, and other programs such as water conservation programs.

10.2 Implementation Costs by Project Types

10.2.1 Institutional Bacteria Source Control

Institutional source controls are measures that seek to reduce either the total flow or the amount of bacteria entering Los Angeles River. As these source controls are on an institutional level, the actual volume or concentration of bacteria that will be reduced cannot be precisely quantified.

Although not designed for bacteria, a number of similar source control measures were identified in the Ballona Creek Metals TMDL, with costs based on the entire Los Angeles Region, which has an area of 3,100 square miles. As the urbanized portion of the Los Angeles River Watershed is 467 square miles, the control measure costs were scaled down proportionally. The following represent the approximate values for the Los Angeles River Watershed for these source control measures:

- Enforcement of litter ordinances - $1.5 million per year;
- Public education - $0.7 million per year;
- Improved street cleaning - $1.1 million per year;
- Increased Storm Drain Cleaning - $4.0 million per year.

In addition to these source controls identified in the Metals TMDL, an estimated $3.6 million per year was added for additional for bacteria source control measures such as finding and eliminating hot spots, sewer overflows and other sources of elevated bacteria that may affect either dry or wet weather flows. Together this equals a total estimated annual cost of $10.9 million per year much of which can be shared with other TMDL implementation requirements.

Summary:
- Capital costs – NA;
- Operation and Maintenance Costs - $10.9 million (M)/yr.

10.2.2 Structural Flow Source Control Costs

Structural Flow Source Controls could include cisterns and rain barrels.

Cisterns
For developing a cost estimate for cisterns, it is assumed that cisterns will be installed only at schools and government facilities, since these types of controls are more easily implemented on these land uses, as opposed to at private homes, or commercial sites.

For the Ballona Creek Bacteria TMDL up to 2,260 cisterns to treat 2,500 acres were estimated; in the proportionally larger urbanized portion of the Los Angeles River Watershed, this translates to 8,140 cisterns to treat 9,000 acres. So, up to 8,140 cisterns could be installed in the Los Angeles River Watershed to manage the flow from all schools and government facilities. With a unit cost of $1/gallon as estimated in the City of Los Angeles Integrated Resources Plan (IRP), for the 10,000 gallon cisterns the total cost would be: $1/gallon * 10,000 gallons/cistern * 8,140 cisterns = $81.4 million.

Operation and maintenance costs for cisterns are based on the amount of water pumped. In order to estimate these costs, the volume of water, size of pump, and energy costs were assumed. In addition to determining that the 10,000 gallon cistern would, on average, be the appropriate size, it was determined that approximately 70,000 gallons per year of runoff would be captured by each cistern. Additional assumptions include:

- 3 horsepower pump;
- Flow rate of 10 gallons per minute;
- Unit energy cost of $0.10 per kilowatt-hour.

Using the standard equation of W=Power*Volume/Flow, which for these assumptions is: W = (3hp) * (.745kW/hp) * (70,000gal/yr/cistern) / ((10gal/min) * (60min/hr)) = 261 kW-hr/cistern/yr. For 8,140 cisterns and using an energy cost of $0.10 per kilowatt-hour, the total operation and maintenance cost for electrical power is $0.06 M/yr. A total O&M cost of $0.8 per year was estimated to allow for other operation, maintenance and replacement costs.

Summary:
- Capital costs – $81.4M;
- Operation and Maintenance Costs - $0.8 M/yr.

Where M/yr is million per year.

Rain Barrels
Rain barrels are a structural flow source control appropriate for residences.

The City of Los Angeles, Bureau of Sanitation, Watershed Protection Division (Stormwater Program) initiated a pilot program for free rainwater harvesting rain barrels for the Ballona Creek Watershed in July 2009 (City of Los Angeles, 2010). This program provided free 55 gallon rain barrels. The City received over 3,000 applications for 600 rain barrels. The cost of the barrel and installation was estimated at $250 a piece.

The program was funded by the Safe Neighborhood Parks, Clean Water, Clean Air and Coastal Protection Bond Act of 2000 (Proposition 12) through the Santa Monica Bay Restoration Commission (SMBRC) and the California Coastal Conservancy. The City has estimated 584,100 gallons can be collected from the 590 barrel pilot program. The City continues to develop its plans for expansion to other watersheds and to develop materials to support homeowners in installing their own rain barrels but no costs are available for watershed-wide implementation.

10.2.3 Subwatershed Infiltration Projects Costs

Local, on-site or subwatershed-based projects may be placed in parks, public land, vacant property, and other open spaces within the Los Angeles River Watershed. Assuming the urbanized portion of the Los Angeles River Watershed has a similar proportion of open space as the Ballona Creek watershed, the open space area, which might be available for available for infiltration projects is estimated at 51,000 acres. Although substantial portions of the 51,000 acres of the watershed may include areas where soils are poor for infiltration, where land use is not compatible or otherwise committed to other uses, or areas are unsuitable for other reasons, it was estimated that up to 5 percent of the open space might be suitable for neighborhood recharge. This results in the potential to develop up to 2,500 acres of land for some form of infiltration or recharge. The types of projects could vary significantly, but would generally focus on multiple benefits including water quality improvements, water conservation (either reduced water use or local recharge), and potentially recreation or aesthetic benefits.

In the areas where neighborhood recharge would be installed, a relatively moderate infiltration rate of 0.5 ft/day could be achieved since the soils in much of the coastal area are much less suitable for significant infiltration (per Los Angeles County DPW Hydrology Manual). Using this infiltration rate and the 2,500 acres of land, an estimated 406 mgd could be managed by implementation of infiltration projects.

A unit cost of $0.65 M/ac was assumed based on data developed under the Sun Valley Project as discussed in the IRP. Therefore, the total estimated capital cost for full implementation of this concept could be as high as $1.6 billion.

For operation and maintenance costs, information from the Sun Valley project was used to develop an average operation and maintenance cost for similar local/neighborhood recharge facilities of approximately $3,000/acre/yr. This would result in approximately

$7.5 M/yr in operation and maintenance costs for 2,500 acres of neighborhood recharge facilities.

Summary:

- Capital Costs - $1.6 B;
- Operation and Maintenance Costs - $7.5 M/yr.

10.2.4 Sand Filters and Infiltration Trenches Costs

Sand filters or infiltration trenches in local watersheds are being considered for implementation of the Los Angeles River Metals TMDL, but would also contribute to bacteria removal. This section reviews the cost analysis conducted for the Los Angeles River Watershed Metals TMDL.

Sand filters are specifically designed to treat urban runoff in high density areas. These BMPs can also remove bacteria. USEPA reports that sand filters have a 76 percent removal rate for fecal coliform and infiltration trenches have a 90% removal rate for fecal coliform (USEPA, 1999). These BMPs can be designed to capture and treat at least 0.5 to 1 inch of runoff. The device could be designed to manage the entire dry weather flow. Additional flow exceeding the design capacity would be allowed to bypass the device and enter the storm drain untreated.

The Metals TMDL cost analysis assumed that 20% of the Los Angeles River Watershed would be treated by infiltration trenches and 20% of the watershed would be treated by sand filters.

Table 10-1 Estimated Costs for Infiltration

	Construction Costs ($ million)	**Maintenance Costs ($ million/year)**
Based on USEPA estimate (1997 dollars)	544	109
Based on FHWA estimate (1996 dollars)	519	Not reported

(LARWQCB, 2005)

Table 10-2 Estimated Costs for Austin and Delaware Sand

	Austin Sand Filter Construction Costs ($ million)	**Austin Sand Filter Maintenance Costs ($ million/year)**	**Delaware Sand Filter Construction Costs ($ million)**	**Delaware Sand Filter Maintenance Costs ($ million/year)**
Based on USEPA estimate (1997 dollars)	553	28	329	16
Based on FHWA estimate (1994 dollars)	102	Not reported	418	Not reported

(LARWQCB, 2005)

10.2.5 Dry Weather Diversion Costs

This component involves diverting any remaining dry weather runoff that has reached the storm drain system to the wastewater collection system for treatment at the City of Los Angeles' Hyperion Treatment Plant or a County Sanitation District treatment plant. The Cities of Los Angeles and Santa Monica have already initiated diversion programs on many of the storm drains discharging to the Santa Monica Bay beaches. Based on the actual costs associated with these diversions, a unit cost per mgd of diversion capacity was estimated to be approximately $1.2 million. Adding on 30 percent to account for non-construction costs, including project management, design, construction management, startup, etc., a unit capital cost of $1.6 million per mgd was assumed.

The CREST Draft Dry Weather Implementation Plan estimates that as many as 122 storm drains will need to be diverted (if dry weather diversion is the only structural control used, with no reliance on source control), with an average flow of 0.15 cfs (about 100,000 gallons per day) per diversion, for a total flow of 12 mgd. This results in a capital cost of approximately $19.2 million.

The CREST hypothetical example developed for Segment B includes 4 dry weather diversions for the segment. If each segment and segment tributaries required a similar number of diversions, the total would be 40 diversions or as much as 6 mgd (stormdrains in tributaries carry much less flow, so this is a conservative assumption). This results in a capital cost of approximately $9.6 million.

Operation and maintenance costs were estimated from the constructed dry weather low flow diversions as presented in the IRP, using a unit operation and maintenance cost of about $34,000/mgd/yr. Using the figures of 12 mgd and 6 mgd of diverted flow, the total operation and maintenance cost estimate is $0.2- 0.4 M/yr.

Summary:

- Capital Costs - $9.6 - 19.2 M;

- Operation and Maintenance Costs - $0.2 - 0.4 M/yr.

10.2.6 Construct Urban Runoff Treatment Plant

The Ballona Creek Bacteria TMDL cost estimates included three cost estimates for urban runoff treatment plants. The implementation strategy for this TMDL does not require any such plant, but during implementation it is possible that responsible parties will consider addressing loads in this manner.

Table 10-3 Example Urban Runoff Treatment Plant Costs

Example Project	Capacity	Capital Costs - M;	Operation and Maintenance Costs -M/yr.
NOTF *(*City of Los Angeles Bureau of Engineering 1995 *Ballona Creek Treatment Facility Feasibility Study and Preliminary Design)*	440 cfs with storage Average flow of approximately 250 cfs for a duration of 2 hours.	$512	$0.53
West Los Angeles Subwatershed (*City of Los Angeles Ballona Creek Treatment Facility Feasibility Study and Preliminary Design)*	100 cfs with storage Average flow of 175 cfs, with a duration of 2 hours	$343	$0.35
Windsow Hills	25 cfs with storage Average flow of 40 cfs and a duration of 2 hours	$82	$0.09

10.3 CREST Dry Weather Implementation Costs

The CREST development team in the Draft Dry Weather Implementation Plan for the TMDL presented a thorough cost analysis for dry weather, which is summarized here. CREST did not include costs of monitoring, but did include operation and maintenance costs over the TMDL implementation period.

CREST considered costs for implementation in three different ways:

1. Costs for an implementation strategy that focused on outfalls and the Load Reduction Strategies - CREST called this a “Conventional Strategy.” ‘Downstream’ solutions and source controls were not included in this analysis.

2. Costs for an implementation strategy focused on both outfall and downstream approaches – referred to as an “Alternative Strategy”. Source controls were not included in this analysis.

3. Costs for an implementation strategy focused on source controls – referred to as an "Integrated Strategy". This included aggressive non-structural source control programs.

10.3.1 "Conventional Strategy"

The process and assumptions CREST used to estimate cost for the outfall-based LRS approach for all Los Angeles River segments and tributaries are listed below.

1. **Estimate the number of outfalls** – the total estimated number of outfalls in the watershed is approximately 3,700.

2. **Estimate the number of outfalls that flow during dry weather** – the estimated number of flowing outfalls is as follows:

- Mainstem Los Angeles River – approximately 280 flowing outfalls during dry weather
- Tributaries – approximately 330 flowing outfalls during dry weather

3. **Estimate the number of outfalls that may require *initial* actions/structural controls along the mainstem Los Angeles River –** using information generated during the BSI Study (CREST, 2008) in combination with a Monte Carlo analysis for Segment B, the number of outfalls along the mainstem Los Angeles River that would require elimination of flow and/or bacteria is estimated to be a minimum of 10%, or approximately 28 outfalls. A similar approach was used for Outlier Outfalls, leading to an estimate of 28 Outlier Outfall investigations over the course of TMDL implementation.

4. **Estimate the number of outfalls that will require *follow-up* actions/structural controls along the mainstem Los Angeles River** – for estimating purposes, it was assumed that after the initial projects were completed in accordance with an LRS, an additional 100% more controls would be needed for an ultimate total of 20% of outfalls (1 in 5) or approximately 28 additional.

5. **Estimate the total number of outfalls that will require structural controls along tributaries** – A minimum of approximately 33 outfalls to the tributaries of the Los Angeles River are estimated to require initial projects, and an additional 100% for follow-up projects for a total of 66 projects.

6. **Establish representative storm drain outfall flow rate** – a representative flow rate for storm drain outfalls of 0.15 cfs for each of the Priority Outfalls was estimated.

7. **Establish representative water quality conditions** – Representative values for Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD) in dry weather storm drain discharges were established at 10 mg/L as these are also used to estimate treatment plant capacity costs.

8. **Create "typical" LFD design** – a "typical" LFD facility design for was created based on prior projects planned and designed by the City of Los Angeles BOS/BOE.

9. **Estimate distances from outfalls to wastewater infrastructure** – an average distance between major outfalls to the river and wastewater infrastructure within the vicinity of the river was estimated at an average distance of 300 feet.

10. **Conveyance and treatment capacity** – a cost basis was developed for acquiring incremental interceptor capacity and incremental treatment plant capacity for the dry weather flows based on the following factors: conveyance, treatment flow, BOD, and TSS.

11. **Develop overall capital costs** –The unit capital costs for a single LFD project in current (2009) dollars was estimated to be $1.7M not including conveyance and treatment capacity allowances (these were categorized as operation and maintenance costs). Costs for Outlier Outfall investigations were estimated as $100,000 per Outlier Outfall.

12. **Develop operation and maintenance costs** – once LFDs are on line, operation and maintenance costs (O&M) were assumed to begin starting with the completion of each LFD and continue through the end of the overall TMDL implementation period. Utilized factors included diversion flow rate, pumping and operation and maintenance costs, collection system maintenance costs, and treatment plant operation and maintenance costs.

13. **Compile costs** – the combination of capital cost and operation and maintenance costs were complied on an annual basis over the entire TMDL implementation time period based on the estimated timeline.

Table 10-4 CREST "Conventional Strategy" – Estimated Total Costs (Capital and O&M, 2009 Dollars) for Treatment Facilities to Implement the Dry Weather Los Angeles River Bacteria TMDL

Type of Implementation Cost	**2009 dollars**
Diversion Facilities and Outlier Outfall Investigations (Capital Cost)	$217,000,000
Conveyance Facilities (Capital Cost)	$30,000,000
Treatment Capacity Cost (Capital Cost)	$21,000,000
Total Capital Costs	$268,000,000
Operation & Maintenance a	$320,000,000
Total TMDL Cost a	**$588,000,000**

a - The estimated total O&M cost is for the TMDL implementation period only. Efforts for O&M costs will likely continue indefinitely, with estimated annual costs exceeding $22,600,000 per year after the TMDL implementation period.

10.3.2 "Alternative Strategy"

The process and assumptions CREST used to estimate costs for the Alternative Strategy, which combines Outfall- and Downstream-based LRS approaches for all Los Angeles River segments and tributaries are listed below.

1. Outfall-based actions would be implemented for the following segments and tributaries:

Segment A, Segment B, Segment C, Segment D and Compton Creek

2. Downstream solutions would be implemented near the downstream end of the following tributaries just prior to the confluence with the mainstem Los Angeles River:

Rio Hondo
Arroyo Seco
Verdugo Wash
Burbank Western Channel (potentially implement upstream of the Burbank WRP discharge)
Tujunga Wash
Bull Creek

3. A Downstream Solution would also be implemented in Segment E of the mainstem Los Angeles River just upstream of the Sepulveda Basin, and no additional projects would be required on the tributaries to Segment E.

4. To develop an order-of-magnitude cost estimate for each Downstream Solution, the assumption was made that some type of off-line diversion and treatment facility would be constructed in the general vicinity of the diversion location, potentially on publicly owned land. A unit cost of these projects per mgd of flow capacity was developed for the Integrated Resources Plan (IRP) for both capital and operation and maintenance costs.

5. The assumed dry weather flow rates for each of the locations listed above, the estimated capital costs of each project, and the estimated operation and maintenance costs once the project was on-line are summarized in Table 10-5.

Table 10-5 Locations, Sizes, and Costs for Downstream Solutions

Location of Project	**Flow Rate/Capacity** (mgd)	**Estimated Capital Cost** ($M 2009)	**Estimated Annual Operation and Maintenance Costs** ($/yr 2009)
Arroyo Seco	2.50	18.0	875,000
Rio Hondo	0.16	1.2	56,000
Verdugo Wash	5.2	37.5	1,820,000
Burbank Western Channel	2.6	18.7	910,000
Tujunga Wash	1.0	7.2	350,000
Bull Creek	2.40	17.3	840,000
LAR Segment E	5.80	41.8	2,030,000

Total capital costs based on the Downstream Solutions identified in Table 10-5, plus the number of projects along the segments/tributaries subject to an Outfall-based approach, which includes 26 initial and 14 follow-up projects in Segments A, B, C, and D and Compton Creek are shown in Table 10-6.

Table 10-6 Alternative Strategy – Estimated Total Costs (Capital and O&M, 2009 Dollars) for Treatment Facilities for Implementation of the Dry Weather Los Angeles River Bacteria TMDL

Type of Implementation Cost	**2009 dollars**
Diversion Facilities and Outlier Outfall Investigations (Capital Cost)	$93,000,000
Downstream Facilities (Capital Cost)	$141,000,000
Conveyance Facilities (Capital Cost)	$13,000,000
Treatment Capacity Cost (Capital Cost)	$9,000,000
Total Capital Costs	$256,000,000
Operation & Maintenance a	$335,000,000
Total TMDL Cost a	**$591,000,000**

a – The estimated total O&M cost is for the TMDL implementation period only. Efforts for O&M costs will likely continue indefinitely, with estimated annual costs exceeding $23,400,000 per year after the TMDL implementation period.

10.3.3 "Integrated Strategy"

Detailed cost estimates were not developed for the Integrated Strategy. The Integrated Strategy was assumed to cost less than the Conventional and Alternative Strategies, because a greater proportion of problematic discharges would be eliminated using less expensive non-structural efforts (e.g., cross connection elimination, repair of sanitary sewer lines, etc.) instead of structural controls at the outfalls (e.g., low flow diversions), which require long-term operation and maintenance.

The components of the Integrated Strategy that would drive costs include, but are not limited to, the following:

1. Sanitary surveys and other *E. coli* source identification efforts;

2. Efforts to eliminate *E. coli* and human-specific sources (cross connections, sewer line repairs, etc.);

3. Capital and O&M costs for structural controls at outfalls with problematic discharges that could not be eliminated using non-structural controls;

4. Efforts to develop and adopt non-structural programs; and

5. Salaries and benefits for municipal staff to implement non-structural programs, including enforcement actions.

10.3.4 CREST Cost Summary

CREST dry weather cost estimates did not include costs of monitoring, but did include operation and maintenance costs over the TMDL implementation period.

In summary, CREST found that the estimated total capital costs for the Alternative Strategy were slightly lower than those estimated for the Conventional Strategy. The total capital cost for the Alternative Strategy was estimated to be $12,000,000 (5%) less than the Conventional Strategy. Assuming a 3% cost escalation (inflation), because the distribution of capital costs over time was different in the two strategies, the total capital cost for the Alternative Strategy was estimated to be $69,000,000 (15%) less than the Conventional Strategy.

Conventional Strategy	$588,000,000
Alternative Strategy	$591,000,000

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