TOTAL MAXIMUM DAILY LOADS FOR BACTERIAL INDICATOR DENSITIES IN BALLONA CREEK, BALLONA ESTUARY, & SEPULVEDA CHANNEL

Photo Courtesy of the UCLA Marine Aquatics Center

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LIST OF ACRONYMS

BMPs	Best Management Practices
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CREST	Cleaner Rivers through Effective Stakeholder-led TMDLs
CWA	Clean Water Act
HDSFR	High-Density Single Family Residence
HTP	Hyperion Treatment Plant
LARWQCB	Los Angeles Regional Water Quality Control Board
LAs	Load Allocations
LAX	Los Angeles International Airport
MFR	Multiple Family Residence
MGD	Million Gallons per Day
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OAL	Office of Administrative Law
REC-1	Water Contact Recreation
REC-2	Non-contact Recreational Use
SCCWRP	Southern California Coastal Water Research Project
SMB	Santa Monica Bay
SMBK	Santa Monica BayKeeper
TMDL	Total Maximum Daily Load
USEPA	Unites States Environmental Protection Agency
WDRs	Waste Discharge Requirements
WLAs	Waste Load Allocations
WQA	Water Quality Assessment

1 Introduction

This document covers the required elements of the Total Maximum Daily Load (TMDL) for the bacteria water quality impairments in the Ballona Creek Watershed, as well as providing the supporting technical analysis used in the development of the TMDL by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). The goal of this TMDL is to determine and set forth measures needed to prevent impairment of water quality due to elevated bacteria densities in Ballona Creek, Ballona Estuary, and their tributaries. The target bacteria indicators addressed are fecal coliform, total coliform, E. coli, and enterococcus.

Ballona Creek, Sepulveda Channel, and Ballona Estuary were listed on the state's 1998 303(d) list as impaired due to exceedances of total and/or fecal coliform water quality standards. The impairment was determined during the 1996 regional water quality assessment (WQA), and was based on the fecal coliform standard of 400 organisms per 100 ml (MPN/100 ml), and the total coliform standard of 10,000 MPN/100 ml. Since then, the bacteria water quality objectives have been updated to include standards for E. coli and enterococcus, and the designated beneficial uses within the creek have been amended. However, these changes do not significantly affect the 1998 findings of impairment.

This TMDL complies with 40 CFR 130.2 and 130.7, Section 303(d) of the Clean Water Act and U.S. Environmental Protection Agency (EPA) guidance for developing TMDLs in California (U.S. EPA, 2000). It is based on information provided by other entities concerning bacteriological water quality in Ballona Creek and Estuary, including sampling efforts undertaken specifically to support the development of this and other TMDLs.

1.1 Regulatory Background

The California Water Quality Control Plan, Los Angeles Region (Basin Plan) sets water quality standards for the Los Angeles Region, which include beneficial uses for surface and ground water, numeric and narrative objectives necessary to support beneficial uses, and the state's antidegradation policy; and describes implementation programs to protect all waters in the region. The Basin Plan establishes water quality control plans and policies for the implementation of the Porter-Cologne Water Quality Act within the Los Angeles Region and, along with the Water Quality Control Plan for Ocean Waters of California (California Ocean Plan), serves as the State Water Quality Control Plan applicable to regulating bacteria in Ballona Creek, Estuary, and their tributaries, as required pursuant to 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. 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.

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates the pollutant loadings to point and nonpoint sources. The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in U.S. Environmental Protection Agency guidance (U.S. EPA, 1991). 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 waterbody to assimilate pollutant loads (the loading capacity) is not exceeded. The Regional Board is also required to develop a TMDL taking into account seasonal variations and including a margin of safety to address uncertainty in the analysis (40 CFR 130.7(c)(1)). Finally, states must develop water quality management plans to implement the TMDL (40 CFR 130.6).

The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove 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 U.S. EPA disapproves a TMDL submitted by a state, EPA is required to establish a TMDL for that waterbody (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, 1998). 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 decree combined the over 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical Unit 49 lists Ballona Creek and Ballona Estuary with impairments related to coliform bacteria. Analytical Unit 48 lists Sepulveda Canyon Channel (Sepulveda Channel) with similar impairments. The consent decree also prescribed schedules for certain TMDLs, and according to this timeline, a bacteria TMDL for the Ballona Creek Watershed should be completed by March 2006. Under the terms of the consent decree, U.S. EPA must either approve a state TMDL or establish its own, by Mach 22, 2007.

On June 12, 2003, the Regional Board held a California Environmental Quality Act (CEQA) scoping meeting to solicit input from the public and interested stakeholders in determining the appropriate scope, content and implementation options of the proposed TMDL for bacteria in Ballona Creek and Estuary. At the scoping meeting, the CEQA checklist of significant environmental issues and mitigation measures were discussed. This meeting fulfilled the requirements under CEQA (Public Resources Code, Section 21083.9).

In addition Regional Board staff solicited input from participants in the stakeholder group "Cleaner Rivers through Effective Stakeholder TMDLs" (CREST) in developing potential implementation options to achieve compliance with the waste load allocations, and in estimating associated costs of selected strategies. CREST is a stakeholder effort initiated by the City of Los Angeles geared towards collaborative TMDL development in the Los Angeles River and Ballona Creek watersheds. The product of this collaborative effort is summarized in the implementation section of this TMDL and provided in full in Appendix A.

1.2 Geographical Setting

The Ballona Creek Watershed covers an area of approximately130 square miles and is located in the coastal plain of the Los Angeles Basin. Its boundaries are defined by the Santa Monica Mountains to the north, the Harbor Freeway (110) to the east, and the Baldwin Hills to the south. The watershed includes the Cities of Beverly Hills and West Hollywood, and portions of the cities of Culver City, Inglewood, Los Angeles, Santa Monica, and unincorporated areas of Los

Angeles County (Figure 1). The watershed is highly developed with high-density single family residence (HDSFR), multiple family residence (MFR), and mixed residential comprising the primary land use in the watershed (60%). Open space and recreation are the second largest land use (17%), and commercial facilities take up 16% of the watershed. The remaining 6% of land area is taken up by miscellaneous uses including light industrial land use.

Ballona Creek flows as an open channel for just under 10 miles from Los Angeles (south of Hancock Park) through Culver City, reaching the Pacific Ocean at Playa del Rey. It is entirely lined in concrete and is fed by a complex underground network of storm drains, which reaches north to Beverly Hills and West Hollywood. Tributaries of the Creek and Estuary include Centinela Creek, Sepulveda Canyon Channel, Benedict Canyon Channel, and numerous other storm drains. The creek meets Ballona Estuary at Centinela Avenue, where concrete is replaced by grouted riprap side slopes and an earth bottom. Ballona estuary flows into the Santa Monica Bay, and its water quality affects the adjacent shoreline of Dockweiler Beach.

The Basin Plan defines three sections of the creek based on hydrologic units. The uppermost section referred to as "Ballona Creek" (Reach 1) is a 2-mile stretch from Cochran Avenue to National Boulevard. "Ballona Creek to Estuary" (Reach 2) is the longest segment of the creek (approximately 4 miles) continuing on from National Boulevard and ending at Centinela Avenue where the estuary begins. "Ballona Creek Estuary" continues to the Pacific Ocean for 3.5 miles and its lower portion runs parallel to the main channel of Marina del Rey (Figure 1). Unless otherwise specified, Reach 1 and Reach 2 will be referred to as Ballona Creek for the purpose of this TMDL.

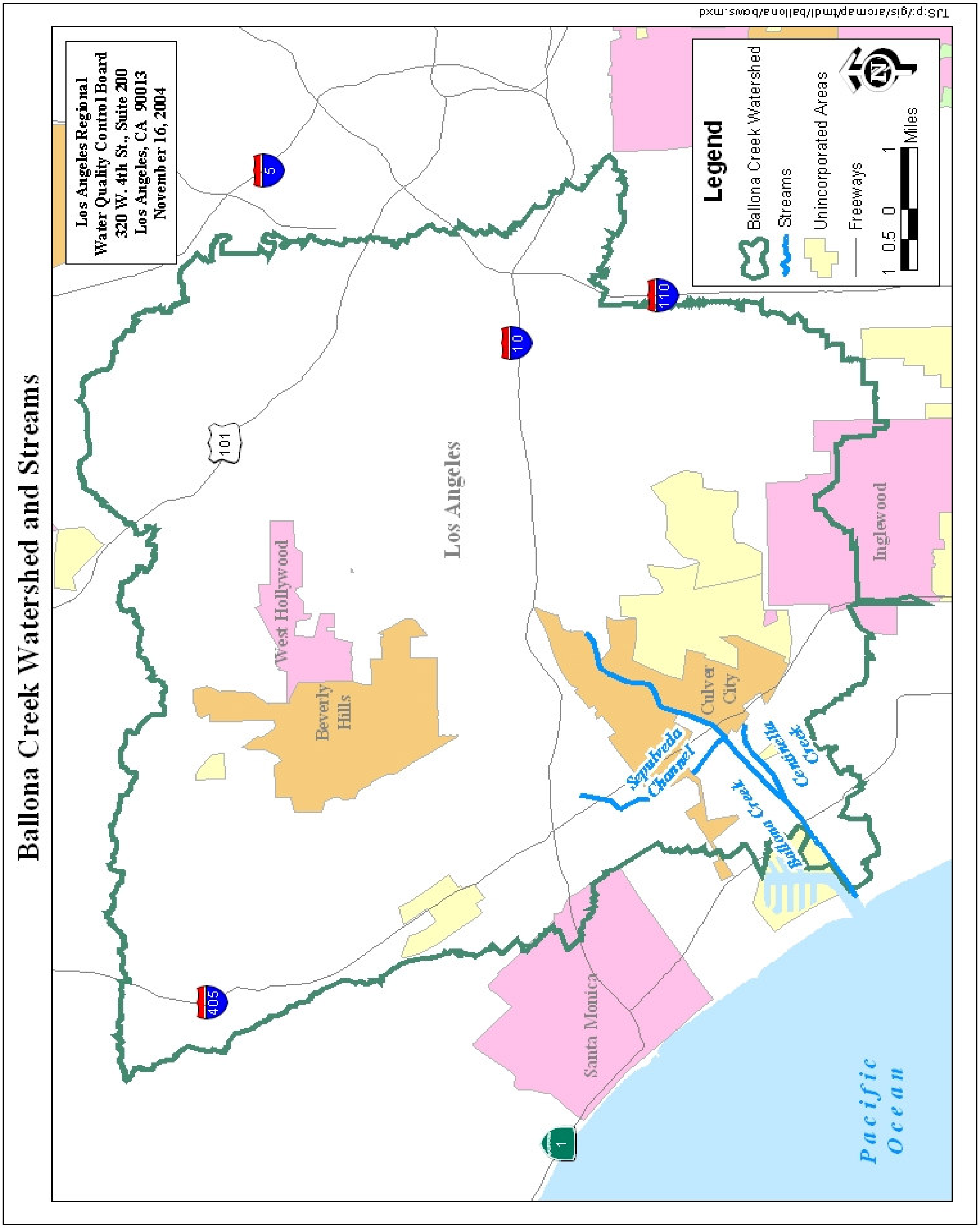

Figure 1: The Ballona Creek Watershed

1.3 Overview of the TMDL Approach

Since Ballona Creek Watershed is a subwatershed of the Santa Monica Bay Watershed, the approach for this bacteria TMDL will be consistent with that of the Santa Monica Bay Beaches (SMBB) dry- and wet-weather bacteria TMDLs, which were adopted by the Regional Board in 2002, and approved by EPA in June 2003. The SMBB TMDLs used a "reference system/anti-degradation approach" to achieve the bacteria objectives for REC-1 waters; and this will be applied to the REC-1 and LREC-1 segments of the creek for this TMDL. This approach allows a certain number of daily exceedances of the single sample bacteria objectives based on historical exceedance levels at existing monitoring locations, including a local reference site within Santa Monica Bay. In adopting this, the Regional Board recognized that there are natural sources of bacteria that may cause or contribute to exceedances of the single sample objectives. The reference system/anti-degradation 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.

In Reach 1, where the water contact (REC-1) beneficial use was recently removed, the associated non-contact recreation (REC-2) bacteria objectives contained in the Basin Plan will apply.

When there are differing recreational beneficial uses between reaches, TMDLs are developed to ensure attainment of water quality standards applicable to each reach, as well as protection of downstream beneficial uses. Therefore, downstream standards always apply at the confluence of any two reaches.

2 Problem Identification

This section discusses the water quality standards applicable to this TMDL, and provides some background on their development. Also a review of more recent water quality data is provided to support the 1998 303(d) listing of the creek, Estuary, and Sepulveda Channel for bacteria, and further determinations of bacteria impairment.

2.1 Water Quality Standards

The Basin Plan designates beneficial uses for water bodies in the Los Angeles Region. These are recognized as existing (E), potential (P), or intermittent (I) uses, all of which must be equally protected. Ballona Creek and Estuary have a variety of beneficial use designations including Contact and Non-contact Recreation for the Estuary, Non-contact Recreation for Reach 1, and Limited Contact and Non-contact Recreation for Reach 2 (See Table 2-1).

Sepulveda Channel was listed on the 303(d) list on the basis of the potential REC-1 beneficial use of Reach 2 to which it is tributary. This potential use has since been amended as a result of a use attainability analysis of Ballona Creek. However, the potential REC-1 use was not modified for Sepulveda Channel therefore, it retains the potential REC-1 use.

The REC-1 beneficial use is defined in the Basin Plan as "[U]ses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs" (Basin Plan, p. 2-2).

The LREC-1 beneficial use is defined as "Uses of water for recreational activities involving body contact with water, where full REC-1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent" (Attachment 1 to State Board Resolution No. 2005-0015).

The REC-2 beneficial use is defined as "[U]ses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to picnicking, sunbathing, hiking, beachcombing, camping, boating, tide-pool and marine life study, hunting, sightseeing, or aesthetics enjoyment in conjunction with the above activities" (Basin Plan, p. 2-2).

Table 2-1: Beneficial Uses of Ballona Creek and Estuary

Ballona Creek Watershed	Hydro Unit #	NAV	REC1	LREC-1	REC2	COMM	WARM	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET
Ballona Creek Estuary c, w	405.13	E	E		E	E		E	E	E	Ee	Ef	Ef	E	E
Ballona Creek to Estuary	405.13		Ps,ac	E	E		P			P					
Ballona Creek	405.15		Ps,ac		E		P			E					

E: Existing beneficial use
P: Potential beneficial use
e: One or more rare species utilize all ocean, bays, estuaries, and coastal wetlands for foraging and/or nesting.
f: Aquatic organisms utilize all bays, estuaries, lagoons and coastal wetlands, to a certain extent, for spawning and early development. This may include migration into areas which are heavily influenced by freshwater inputs.
s: Access prohibited by Los Angeles Count DPW.
ac: The REC1 use designation does not apply to recreational activities associated with the swimmable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use in the Basin Plan, or the associated bacteriological objectives set to protect those activities. However, water quality objectives set to protect other REC1 uses associated with the fishable goal as expressed in the federal Clean Water Act section 101(a)(2) shall remain in effect for waters where the (ac) footnote appears.

The Basin Plan and the California Ocean Plan, the provisions of which are included in the Basin Plan by reference, contain bacteria water quality objectives to protect REC-1 and REC-2 uses. In the current California Ocean Plan, total and fecal coliform bacteria are used as indicators of the likely presence of disease-causing pathogens in surface waters. The Regional Board recently updated the bacteria objectives for waters designated as REC-1 to be consistent with U.S. EPA's recommended criteria, which recommends the use of E. coli criteria for freshwater and enterococcus criteria for marine waters (See Regional Board Resolution R2001-018). The updated bacteria objectives were subsequently approved by the State Board on July 18, 2002 (State Board Resolution 2002-0142), the Office of Administrative Law on September 19, 2002 (OAL File No. 02-0807-01-S), and the U.S. EPA on September 25, 2002. The revised objectives include geometric mean limits and single sample limits for total coliform, fecal coliform, E. coli, and enterococcus. They are consistent with those contained in state law (California Code of Regulations, Title 17, Section 7958, which implements Assembly Bill 411 (1997 Stats. 765)).

A Use Attainability Analysis of the recreational beneficial uses in Ballona Creek Reaches 1 and 2 resulted in an amendment to the Basin Plan in 2005 that de-designated Reach 1 as potential REC-1 and re-designated Reach 2 as Limited REC-1 (State Board Resolution No. 2005-0015). In recognition of the reduced frequency of use and risk of illness from recreational contact in these reaches, the single sample limits set to protect the swimmable component of the REC-1 use were relaxed slightly in Reach 2, and removed entirely in Reach 1. This Basin Plan Amendment established bacteria objectives for the new LREC-1 beneficial use. These objectives include geometric mean limits and single sample limits for E. coli, and a geometric mean limit for fecal coliform. The single sample limit for E. coli is based on EPA's determination of the most appropriate single sample maximum density for water bodies infrequently used for full-body contact recreation (U.S. EPA. 1986. Ambient Water Quality Criteria for Bacteria – 1986. Report No. EPA 330/5-84-002. January 1986). The updated bacteria objectives for marine waters designated for REC-1, and those for the LREC-1 and REC-2 beneficial use are as shown in Table 2-2.

Table 2-2: Water Quality Objectives for Ballona Creek, Ballona Estuary, and Sepulveda Channel

Water Quality Objectives	Ballona Estuary (REC-1)	Sepulveda Channel (REC-1)	Ballona Creek Reach 2 (LREC-1)**	Ballona Creek Reach 1 (REC-2)
Single Sample				
E. coli	na	235	576	na
Fecal coliform	400	400	--**	4,000
Enterococcus	104	na	na	na
Total coliform*	10,000	na	na	na
Geomean				
E. coli	na	126	126	na
Fecal coliform	200	200	200	2000
Enterococcus	35	na	na	na
Total coliform	1,000	na	na	na

*Total coliform density shall not exceed 1,000/100 ml, if the ratio of fecal-to-total coliform exceeds 0.1
**LREC-1 has not been assigned a fecal coliform single sample limit.
na: not applicable

The Regional Board recently amended the Basin Plan to suspend the recreational beneficial uses for engineered channels during large wet-weather events in order to address the physically unsafe conditions in these channels during these periods (Regional Board Resolution 2003-010). This amendment was based on the results of a use attainability analysis, which determined that REC-1 and REC-2 uses are not fully attainable in these channels during storm events of 0.5 inch or greater – and the 24 hrs following the rain event. Reaches 1 and 2 of Ballona Creek are included in this high flow suspension.

2.2 Data Review

During the 1996 Water Quality Assessment, the Regional Board evaluated total and fecal coliform monitoring data collected between 1988 and 1994 by the Los Angeles County Department of Public Works in Ballona Creek, Ballona Estuary, and Sepulveda Channel. All three waterbodies exhibited a high frequency of exceedance of the single sample limit for fecal coliform. In addition there was a high occurrence of exceedance of the single sample limit for total coliforms in Ballona Estuary (Table 2-3). The listing data for Reach 2 of Ballona Creek was re-assessed using the bacteria water quality objectives for the recently modified use designation. A 1:1 E. coli to fecal coliform ratio was used to translate fecal coliform results to E. coli for the purpose of analysis. Results indicate that there was still a basis for listing even with the less stringent single sample limits (Table 2-3).

More recent bacteria water quality data sets were reviewed during the development of this TMDL: Data summarizing bacteria levels in Reaches 1 and 2 of Ballona Creek, the upper and lower estuary, and Sepulveda Channel are summarized in Table 2-4. The Pollutant Assessment Section of the City of Los Angeles Watershed Protection Division provided this data. Samples were collected three to four times per month from 2001 through 2005 at National Boulevard (Reach 1), Overland Boulevard (Reach 2), Centinela Boulevard (Upper Estuary) and Pacific Avenue (Lower Estuary). Samples were collected once per month in Sepulveda Channel from 2002 through 2005. For the purpose of analysis, the data were separated into three time periods - (i) summer dry weather (April 1 through October 31), (ii) winter dry weather ((November 1 through March 31), and (iii) wet weather (defined as days of 0.1 inch of rain or more plus three days following the rain event) [1]. In this instance, a 1:1 E. coli to fecal coliform ratio was used to translate E. coli results to fecal coliform for the purpose of analysis. Results indicate impairment during wet weather in all segments. In addition, the data show impairment during winter and summer dry weather in Sepulveda Channel, Reach 2 and the upper and lower Estuary. Although there is no indication of impairment in Reach 1 during summer and winter dry-weather, due to the less stringent objectives, data shows that this reach is frequently in exceedance of the water quality objectives of Reach 2 which is immediately downstream.

Additional data for the upper and lower estuary were obtained from the City of Los Angeles Environmental Monitoring Division. These data were collected five times a week in the upper estuary and weekly in the lower estuary from the period of 1996 through 2004 - with some lapses (see Table 2-5 a & b). The data further supports the finding of impairment during both winter and summer periods in the upper and lower estuary.

This TMDL addresses bacteria impairments in Ballona Creek Reaches 1 and 2, Ballona Estuary, and Sepulveda Channel.

[1] These time periods are consistent with the AB-411 implementing regulations (CCR, Title 17) as well as with protocols used by the Los Angeles County Department of Health Services to post beaches during wet weather.

Table 2-3: Summary of data used for 1996 determination of bacterial impairment, relative to the single sample objective, in the Ballona Creek Watershed (MPN/100 mL). *

Location	Total Coliform			Fecal Coliform				
	N	Average	REC-1 (%) > 10,000	N	Average	REC-1 (%) > 400	LREC-1 (%) .> 576	REC-2 (%) > 4,000
Ballona Creek	62	22291	na	*23*	*12170*	***91****	***91***	***45***
Sepulveda Channel	67	14963	na	*23*	*8142*	***100***	na	***35***
Ballona Estuary	*70*	*25406*	***37***	23	*4157*	***87***	na	***52***

* The 1996 assessment was based on the REC-1 bacteria water quality objectives for the creek (as set forth in the 1994 Basin Plan prior to the update to the bacteria objectives adopted in 2001).

Table 2- 4 Summary of Ballona Creek, Ballona Estuary, and Sepulveda Channel* bacteria data (2001-2005)
(Courtesy of the Pollutant Assessment Section of the City of Los Angeles' Watershed Protection Division)

Summer Dry Weather (April 1 through October 31)					
	Reach 1 @ National Boulevard	Reach 2 @ Overland Avenue	Upper Estuary** @ Centinela Boulevard	Lower Estuary @ Pacific Avenue	Sepulveda Channel
Number of Samples	101	101	59	100	28
No. of samples exceeding applicable objectives	2	52	54	49	27
% Exceedance of applicable objectives	2%	51%	92%	49%	96%
% Exceedance of downstream objectives	62%	94%	na	na	86%
Winter Dry Weather (November 1 through March 31)					
	Reach 1 @ National Boulevard	Reach 2 @ Overland Avenue	Upper Estuary @ Centinela Boulevard	Lower Estuary @ Pacific Avenue	Sepulveda Channel
Number of Samples	48	48	29	48	13
No. of samples exceeding applicable objectives	3	14	19	36	12
.23% Exceedance of applicable objectives	6%	29%	66%	75%	92%
% Exceedance of downstream objectives	33%	63%	na	na	38%
Wet Weather (Days with rain of ≥0.1 inch and three days following)					
	Reach 1 @ National Boulevard	Reach 2 @ Overland Avenue	Upper Estuary @ Centinela Boulevard	Lower Estuary @ Pacific Avenue	Sepulveda Channel
Number of Samples	23	23	23	23	7
No. of samples exceeding applicable objectives	9	21	21	21	7
% Exceedance of applicable objectives	39%	91%	93%	91%	100%
% Exceedance of downstream objectives	70%	91%	na	na	100%

Ballona Creek and Estuary data collected 3-4 times per month
*Sepulveda Channel Data collected once per month from 2002 - 2005 .
**no more samples collected from this location after March 3, 2004.
Exceedances assessed based on single sample objectives.
Downstream objectives for Reach 1 are those set to protect LREC-1. Downstream Criteria for Reach 2 are those set to protect REC-1 marine waters.
na: not applicable.

Table 2-5a: Summary of Summer weather Bacteria Counts for Ballona Estuary (1996-2004)
(Data courtesy of the Environmental Monitoring Division of the City of Los Angeles)

Location	Date	Total Coliform			Fecal Coliform			Enterococcus		
		N	Arithmetic Mean	Percent (%) Exceedance	N	Arithmetic Mean	Percent (%) Exceedance	N	Arithmetic Mean	Percent (%) Exceedance
Upper Estuary @ Centinela										
	1996	213	166974	79.3	212	11829	91.5	209	3265	90.0
	1997	119	62292	84.9	119	2303	92.4	118	595	82.2
	1998	200	141269	92.5	188	4728	93.1	112	3488	93.8
	1999	204	86374	83.3	209	3442	78.0			
	2000	161	77794	69.6	185	3644	81.1			
	2001	191	32287	69.6	193	1329	77.7			
	2003	205	51762	82.0	205	2723*	78.5	12	8055	66.7
	2004	208	75809	99.0	209	4125*	97.6	31	1680	90.3
Lower Estuary @ Pacific										
	1996	33	38097	15.2	33	2649	36.4	31	470	48.4
	1997	17	332	0.0	15	406	26.7	17	165	11.8
	1998	24	10497	16.7	25	2620	56.0	23	856	69.6
	1999	28	9703	14.3	28	606	17.9	25	586	48.0
	2000	29	11880	13.8	29	1893	41.4	28	1276	67.9
	2003	21	52417	52.4	21	796*	42.9	18	413	11.1
	2004	28	51614	75.0	29	5158*	31.0	29	232	34.5

Data collected 5 x per week at Centinela and weekly at Pacific
Exceedances assessed based on single sample objectives.
*Results reported are for E. coli counts.

Table 2-5b: Summary of Winter weather Bacteria Counts for Ballona Estuary (1996 – 2003)
(Data courtesy of the Environmental Monitoring Division of the City of Los Angeles)

Location	Date	Total Coliform			Fecal Coliform/ E. coli			Enterococcus		
		N	Arithmetic Mean	Percent (%) Exceedance	N	Arithmetic Mean	Percent (%) Exceedance	N	Arithmetic Mean	Percent (%) Exceedance
Upper Estuary @ Centinela										
	1996	147	119637	84.4	148	5526	85.1	148	3866	84.5
	1997	87	68990	58.6	87	3736	57.5	87	3486	69.0
	1998	61	220934	93.4	61	4901	88.5		n.a	n.a
	1999	132	154356	79.5	142	3480	74.6		n.a	n.a
	2000	142	58800	54.2	141	2783	56.0		n.a	n.a
	2001	137	88199	46.9	137	4226	46.7			
	2003	138	37217	40.6	139	**3424***	66.2	16	2494.75	62.5
Lower Estuary @ Pacific										
	1996	17	67059	35.3	17	6929	29.4	15	1493	46.7
	1997	11	50590	45.5	12	5458	50.0	13	5186	53.8
	1998	9	29378	33.3	8	476	25.0	9	1418	66.7
	1999	18	28088	33.3	21	735	33.3	21	2514	90.5
	2000	17	53575	35.3	17	1186	35.3	17	700	58.8
	2001	8	17276	37.5	8	1414	50.0	8	3797	62.5
	2003	17	34834	35.3	17	**2605***	58.8	16	1117	75.0

Data collected 5 x per week at Centinela and weekly at Pacific
Exceedances assessed based on single sample objectives.
*Results reported are for E. coli counts.
na: not available

3 Numeric Target

The TMDL will have multi-part numeric targets based on the updated bacteria objectives for marine and fresh waters designated for contact recreation (REC-1), and fresh waters with Limited REC-1 and REC-2 beneficial use designations. Both single-sample and 30-day geometric mean limits apply to Ballona Creek Reaches 1 and 2, Ballona Estuary, and Sepulveda Channel.

For Ballona Estuary, the numeric target will be the same as the recently adopted Basin Plan objectives for REC-1 in marine waters. The numeric target for Sepulveda Channel will be the updated REC-1 freshwater bacteria objectives. REC-2 and limited REC-1 (LREC-1) bacteria objectives will apply in Reaches 1 and 2 respectively. All applicable bacteria objectives are contained in Table 2-2.

To implement the single sample bacteria objectives for waters designated REC-1 and LREC-1, and to set allocations based on the single sample targets, an allowable number of exceedance days is set for each reach. The numeric target in the TMDL is expressed as 'allowable exceedance days' since bacterial density and the frequency of single sample exceedances is most relevant to public health. The US EPA allows states to select the most appropriate measure to express the TMDL; and 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 based on two criteria: (1) bacteriological water quality at any site is *at least* as good as at a designated reference site, and (2) there is no degradation of existing bacteriological water quality if historical water quality at a particular site is *better than* the designated reference site. Applying these two criteria allows the Regional Board to avoid imposing requirements to divert natural coastal creeks or treat natural sources of bacteria from undeveloped areas. This approach, including the allowable exceedance levels during summer dry-weather, winter dry-weather and wet-weather, is consistent with that used in Santa Monica Bay Beaches TMDL. The geometric mean targets, which are based on a rolling 30-day period, will be strictly adhered to and may not be exceeded at any time.

The Basin Plan bacteria objectives for REC-2 will serve as the numeric target in Reach 1. The REC-2 objectives allow for a 10% exceedance frequency of the single sample limit in samples collected during a 30-day period. This allowance, which is based on an acceptable level of health risk, will be applied in Reach 1 in lieu of the allowable exceedance days discussed earlier. As with the other reaches, the geometric mean target, which is based on a rolling 30-day period, will be strictly adhered to and may not be exceeded at any time.

4 Source Assessment

The TMDL requires an estimate of loadings from point sources and nonpoint sources. In the development of a TMDL waste load allocations are given for point sources and load allocations for 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.

Nonpoint source by definition includes 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. Urban runoff to Ballona Creek and Estuary is regulated as a point source discharge under two storm water NPDES permits. The first is the County of Los Angeles Municipal Storm Water NPDES permit (MS4 Permit), which was most recently renewed in December 2001 and is on a five-year renewal cycle. There are 85 co-permittees covered under this permit including 84 cities and the County of Los Angeles. The second is a separate statewide storm water permit specifically for the California Department of Transportation (Caltrans). Runoff from construction and industrial activities is also subject to a statewide general NPDES permit for storm water.

Storm drain system discharges may have elevated levels of bacterial indicators 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 bacteria indicators 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, and vegetation and food waste can be a source of elevated levels of total coliform bacteria, specifically.

4.1 Point Sources

The NPDES permits in the Ballona Creek Watershed include the MS4 and Caltrans Storm Water Permits, general construction storm water permits, general industrial storm water permits, minor NPDES permits, and general NPDES permits (Table 4-1). Other NPDES permits issued in the Ballona Creek watershed are for minor or general discharges, as listed in Table 4-1. The bacteria loads associated with these discharges are largely unknown, since most do not monitor for bacteria.

Table 4-1. NPDES Permits in the Ballona Creek Watershed

Type of NPDES Permit	*Number of Permits*
Municipal Storm Water	1
California Department of Transportation Storm Water	1
General Construction Storm Water	17
General Industrial Storm Water	14
Individual NPDES Permits (Minors)	12
General NPDES Permits:	
Construction and Project Dewatering	92
Petroleum Fuel Cleanup Sites	15
VOCs Cleanup Sites	7
Potable Water	7
Non-Process Wastewater	5
Hydrostatic Test Water	1
Total	**172**

4.2 Urban and Storm Water Runoff

The major contributors of flows and associated bacteria loading to Ballona Creek and Estuary, are dry- and wet-weather urban runoff discharges from the storm water conveyance system. Run-off to Ballona Creek is regulated as a point source under the Los Angeles County MS4 Permit, the Caltrans Storm Water Permit, and the General Construction and Industrial Storm Water Permits. In addition to these regulated point sources, the Ballona Estuary receives input from the Del Rey Lagoon and Ballona Wetlands through connecting tide gates.

4.2.1 Urban and Dry Weather Source Characterization

Many of the storm drains discharging to Ballona Creek and Estuary flow during both wet and dry weather. Dry weather flows are not directly attributable to precipitation, but rather to nuisance flows generated from over-irrigation of lawns, car washing, restaurant washout and other activities in the watershed, and intermittent permitted discharges. Staff identified two sources of data characterizing bacteria densities during dry-weather in Ballona Creek and Estuary

Table 4-2 summarizes dry-weather storm drain discharge data collected on three different occasions in the summer of 2003. Samples were collected from all flowing drains throughout the length of the Creek and Estuary, totaling 40-50 drains. In-stream data was also collected from 12 locations along the length of the Creek and Estuary (presented in the linkage analysis section). The data shows high concentrations of bacteria in all storm drains. A summary of discharge data from the Overland Storm drain, which is a major drain in Reach 2 of Ballona Creek, is provided in Table 4-3. These data were collected weekly from January 2002 through September 2004 by the SMBKt. Samples were also collected in-stream immediately upstream and downstream of the drain. The data show high frequencies of exceedance of the applicable bacteria single sample objectives and immediate downstream objectives.

Table 4-2: Summary of Drain discharge bacteria densities in Ballona Creek & Estuary (Summer 2003)

Location	***Total Coliform*** No. of Samples	Min	Median	Max
Reach 1	22	6000	28500	240000
Reach 2	68	100	66000	240000
Estuary	23	8200	130000	240000
	E. coli			
Reach 1	22	100	575	52000
Reach 2	68	100	1115	55000
Estuary	23	100	860	140000
	Enterococcus			
Reach 1	22	160	1100	24000
Reach 2	68	10	1300	24000
Estuary-	21	51	1250	24000

Table 4-3: Summary of Bacteria Densities in Overland Storm Drain Discharge and in-stream location immediately upstream and downstream (01/2002 – 09/ 2004).

Parameter	**Upstream of Drain**	**Drain Discharge**	**Downstream of Drain**
Total Coliform			
N	103	104	104
Min - Max	1,340 –241920	100 – 241,920	100 –241,920
Median	24890	96730	71996
% > REC-1 objectives	82.5	86.5	86.5
E. coli			
N	104	105	105
Min - Max	100 –16,690	100 –241,920	100 – 111,990
Median	740	41250	11456
% > REC-1 objectives	74	79	86.7
% > LREC-1 objectives	57.7	74.3	68.6
Enterococcus			
N	19	19	19
Min - Max	100 – 1,090	100 – 2,380	100 – 1,310
Median	100	740	200
% > REC-1 objectives	47.4	94.7	63.2

Data Source: Santa Monica BayKeeper

4.2.2 Wet-Weather Source Characterization

Data to characterize wet-weather sources of bacteria to Ballona Creek and Estuary is available from the monitoring program conducted as a requirement of the Los Angeles County MS4 Permit as well as other storm water NPDES permits throughout Southern California. The Los Angeles County permit requires monitoring of both instream water quality (to calculate mass emissions for various pollutants) as well as land use monitoring to attempt to quantify pollutant loads from specific land uses.

Table 4-4 summarizes the wet-weather data for specific land uses collected by Los Angeles County under the Municipal Storm Water Permit for the period 1994-2000, as well as similar land use-specific data compiled by SCCWRP, for the period 2001-2004. All land use sites in both data sets exceeded the objectives for total coliform, fecal coliform and enterococcus.

The Los Angeles County data set indicated that the high-density/single-family residential (HDSFR) category had the highest densities of all three bacterial indicators, followed by the commercial land use for total coliform and fecal coliform, and the light-industrial land use for enterococcus. SCCWRP's data set indicated that of those applicable to the Ballona Creek Watershed, the commercial land use had the highest densities for total coliform and enterococcus, while the low density residential land use had the highest indicator densities for fecal coliform (SCCWRP, 2001-2004).

Table 4-4. Summary of Bacteria Densities (MPN/100ml) from Various Land Uses during Wet Weather

Data Source	**Land Use**	**Total Coliform**		**Fecal Coliform**		**Enterococcus**	
		N	Arithmetic Mean	N	Arithmetic Mean	N	Arithmetic Mean
LA County (1994-2000)	Commercial	8	1,140,000	8	528,740	8	86,250
	Light Industrial	5	454,000	5	338,220	5	98,200
	Vacant	21	9,187	21	1,397	21	679
	HD/SF Residential	3	1,366,667	3	933,333	3	610,000
	Transportation	4	692,500	4	328,750	4	32,000
SCCWRP (2001-2004)	Commercial	5	463,000	5	11,300	5	77,400
	Industrial	6	193,000	6	3,770	6	20,900
	Open Space	2	25,600	2	5,370	2	20,800
	High Density Residential	5	47,700	5	7,820	5	77,400
	Low Density Residential	4	92,300	5	29,800	5	54,900
	Transportation	2	136,000	2	1,450	2	20,800
	Agricultural*	5	636,000	5	40,500	5	122,000
	Recreational (Horses)*	2	3,000,000	2	527,000	2	135,000

*not applicable in the Ballona Creek Watershed

4.3 Contributions from Major Tributaries

Benedict Canyon Channel is tributary to Reach 2 of Ballona Creek and flows into this reach as a covered channel. Centinela Creek is an open channel that is tributary to Ballona Estuary. Both tributaries act as sources of bacteria to their downstream reaches. Data for bacteria densities, collected just upstream of the confluences of the tributaries, were assessed and summarized in Table 4-5. These data were collected monthly from 2002 through 2005 by the Pollutant Assessment Section of the City of Los Angeles Watershed Protection Division. A 1:1 E. coli to fecal coliform ratio was used to translate E. coli data to fecal coliform as needed The high frequencies of exceedances of the applicable bacteria objectives are a strong indication that these tributaries contribute to the impairment of their downstream reaches and are themselves impaired. This TMDL will require further monitoring of each tributary at locations further upstream to make separate determinations of impairment.

Table 4-5: Summary of Data for Major Tributaries (2002-2005)
(Courtesy of the Pollutant Assessment Section of the City of Los Angeles' Watershed Protection Division)

Benedict Canyon Channel (near confluence with Ballona Creek Reach 2)			
	Total Coliform	**E. coli**	**Enterococcus**
Number of Samples	48	48	47
Min-Max	4,800 - 240,000	100 - 9,300	20 - 10,000
Median	36,000	565	710
Number exceeding downstream criteria	na	24	na
% Exceedance of downstream criteria	na	50%	na
Centinela Creek (near confluence with Ballona Estuary)			
	Total Coliform	**E. coli**	**Enterococcus**
Number of Samples	48	48	47
Min-Max	720 – 240,000	310 – 31,000	10 – 17,000
Median	84,500	2,000	440
Number exceeding downstream criteria	45	47	43
% Exceedance of downstream criteria	94%	98%	91%

Data collected monthly from 2002-2005
Exceedances assessed based on single sample objectives.
Benedict Canyon Channel is tributary to Reach 2, therefore the downstream criteria are those set to protect LREC-1.
Centinela Creek is tributary to the Ballona Estuary, therefore the downstream objectives are those set to protect REC-1.

4.4 Nonpoint Sources

A nonpoint source is a source that discharges to water of the US and/or State via sheet flow or natural discharges. An example of this would be the runoff from National Parks and State lands. In the Ballona Creek watershed National Park Service and State lands cover approximately 607 acres[2]. While not subject to the MS4 Permit, in the highly urbanized Ballona Creek watershed the contribution of runoff from these areas drain to the MS4 system, therefore, this discharge is regulated as a point source.

Inputs to Ballona Estuary from Del Rey lagoon and the Ballona Wetlands, via connecting tide gates, are considered non-point sources of bacterial contamination. These waterbodies may be considered natural sources if their contributing bacteria loads are determined to be as a result of wildlife in the area, as opposed to anthropogenic inputs. The TMDL will require a source identification study for the lagoon and wetlands in order to make such a determination.

Other nonpoint sources in Ballona Creek and Estuary include direct inputs from birds, waterfowl and other wildlife. Data do not currently exist to quantify the extent of the impact of wildlife on bacteria water quality in the Estuary.

[2] This acreage does not include the approximate 607 acres of the Ballona Wetlands that the State has acquired.

5 Linkage Analysis

Dry weather urban runoff and storm water, both conveyed by storm drains, are the primary sources of elevated bacterial indicator densities to Ballona Creek and Estuary during dry and wet weather.

Table 5-1 presents dry-weather exceedances of the single sample objectives in drain discharges to Ballona Creek and Estuary, along with water quality conditions in the corresponding reaches. This summary is based on the 2003 sampling efforts of SCCWRP and the Santa Monica BayKeeper, as discussed in the previous sections. In Reaches 1 and 2, the frequency of exceedances of the storm drain discharges correspond closely with the instream exceedances of the applicable single sample limits. Since the Estuary is subject to the diluting effect of tides a similar correlation cannot be made for it. The table also shows the impact of upstream bacteria water quality on downstream water quality conditions.

Table 5-1: Drain discharge exceedances and corresponding in-stream conditions within Ballona Creek and Estuary

Location	Drain Samples		In-Stream Samples		
	No. of Samples	Samples Exceeding Applicable Objectives	No. of Samples	Samples Exceeding Applicable Objectives	Samples Exceeding Downstream Objectives
Reach 1 (REC-2)	22	9%	12	0% (FC)	67% (EC)
Reach 2 (LREC-1)	68	57%	11	55% (EC)	91% (TC), 91% (EC), 73% (Ent)
Estuary (REC-1)	23*	91% (TC) 74% (EC) 95% (Ent)	9	56% (TC) 67% (EC) 89% (Ent)	NA

FC- fecal coliform, EC- E. coli, Ent – Enterococcus
*21 samples for Ent analysis

The loading capacity for Ballona Creek, Estuary, and Sepulveda Channel is defined in terms of bacterial indicator densities and is equivalent to the numeric targets in Section 3. This is consistent with the approach used in the Santa Monica Bay Beaches TMDL.

5.1 Critical Condition

The critical condition in a TMDL defines an extreme condition for the purpose of setting allocations to meet the TMDL numeric target. While a separate element of the TMDL, it may be thought of as an additional margin of safety such that the allocations are set to meet the numeric target during an extreme (or above average) condition. Tables 5-2a & b present probabilities of exceedance of the single sample limits in Ballona Creek and Estuary respectively. The former is based on monitoring data collected in the Creek from 2001-2005 by the Los Angeles City Watershed Protection Division, and the latter on monitoring in the Estuary from 1996-2000 by the Los Angeles City Environmental Monitoring Division. The lowest exceedance probabilities generally occur during winter dry-weather - with the exception of Reach 1. The highest exceedance probabilities occur during wet-weather, with the greatest magnitude of exceedance probability occurring within the upper estuary and Reach 2. The lower exceedance probabilities in Reach 1 of Ballona Creek are due to the less stringent water quality objectives associated with the REC-2 beneficial use. However water quality conditions in this reach can negatively impact the downstream reaches with more stringent limits.

Table 5-2a: Bacteria Indicator Exceedance Probabilities in Reaches 1 & 2 of Ballona Creek

Location	Description	Summer dry weather		Winter dry weather		Wet weather	
		N	Exceedance probability	N	Exceedance probability	N	Exceedance probability
Reach 1	National Boulevard	101	0.02	48	0.06	23	0.39
Reach 2	Overland Avenue	101	0.51	48	0.29	23	0.91

Source: Los Angeles City Watershed Protection Division – Pollutant Assessment Division. Data analyzed from 2001 to 2005. Wet days as provided by source

Table 5-2b: Bacteria Indicator Exceedance Probabilities in Ballona Estuary

Location	Description	Summer dry weather		Winter dry weather		Wet weather	
		N	Exceedance probability	N	Exceedance probability	N	Exceedance probability
Upper Estuary	Centinela Boulevard	920	0.94	413	0.81	168	0.95
Lower Estuary	Pacific Avenue	131	0.64	56	0.55	24	1.00

Source: Los Angeles City Environmental Monitoring Division. Data analyzed from 01/96 to 12/00. Wet days determined from LAX rainfall data

Unlike many TMDLs where the critical condition is during low flow conditions or summer months, the critical condition for bacteria loading is during wet weather. This is because intermittent or episodic loading sources such as surface runoff can have maximal impacts at high (i.e. storm) flows (US EPA, 2001). Local and bight-wide shoreline monitoring data show a higher percentage of daily exceedance of the single sample targets during wet weather, as well as more severe bacteriological impairments indicated by higher magnitude exceedances and exceedances of multiple indicators (Noble *et al.*, 2000, Schiff *et al.*, 2001). This also appears to be the case for Ballona Creek, which is an inland waterbody.

The Santa Monica Bay Beaches Bacteria TMDL identified the critical condition within wet weather more specifically, in order to set the allowable number of exceedances of the single sample limit days. The 90th percentile storm year in terms of wet days was used as the reference year. The 90th percentile year was selected 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 do. Finally, the Regional Board 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 1947-2001. This means that 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 a retrospective evaluation of data showed that the number of sampling events during which greater than 10% of samples exceeded the fecal coliform objective on the day after a rain was nearly equivalent for rainstorms less than 0.5 inch and those greater than 0.5 inch, concluding that even small storms represent a critical condition (Noble *et al*., 2000). This is particularly true since the TMDL's numeric target is based on number of days of exceedance, not on the magnitude of the exceedance.

5.2 Margin of Safety

By directly applying the numeric water quality standards and implementation procedures as Waste Load Allocations, there is little uncertainty about whether meeting the TMDLs will result in meeting the water quality standards.

6 Waste Load Allocations and Load Allocations

WLAs and LAs for the REC-1 and LREC-1 waters, are expressed as the number of daily or weekly sample days that may exceed the single sample targets identified in Section 3. WLAs and LAs are expressed as allowable exceedance days because the bacterial 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). For each reach, allowable exceedance days are set on an annual basis as well as for three other time periods. These three periods are (1) summer dry-weather (April 1 to October 31), (2) winter dry-weather (November 1 to March 31), and (3) wet-weather (defined as days of 0.1 inch of rain or more plus three days following the rain event).[3] TMDLs for the impaired reaches are assigned as Waste Load allocations (Table 6-1).

Table 6-1: TMDLs for the Ballona Creek Watershed Bacteria TMDL*

Time Period	Ballona Estuary, Ballona Creek Reach 2, and Sepulveda Channel **	Ballona Creek Reach 1***
Summer Dry-Weather (April 1 to October 31)	Zero (0) exceedance days based on the applicable Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives	No more than 10% of the Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives
Winter Dry-Weather (November 1-March 31)	Three (3) exceedance days based on the applicable Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives	No more than 10% of the Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives
Wet-Weather (days with ≥0.1 inch of rain + 3 days following the rain event)	17 exceedance days based on the applicable Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives	No more than 10% of the Single Sample Bacteria Water Quality Objectives Zero (0) exceedance days based on the Rolling 30-Day Geometric Mean Bacteria Water Quality Objectives

*The allowable exceedance days are based on daily sampling. If weekly sampling is performed, the allowable exceedance days are scaled accordingly (i.e. 1 exceedance day for winter dry weather, and 3 exceedance days for wet weather).
** Exceedance days for Ballona Estuary based on REC-1 marine water numeric targets; for Ballona Creek Reach 2 based on LREC-1 freshwater numeric targets; and for Sepulveda Channel, based on fresh water REC-1 numeric targets
***Exceedance frequency for Ballona Creek Reach 1 based on freshwater REC-2 numeric targets

[3] These time periods are consistent with the AB-411 implementing regulations (CCR, Title 17) as well as with protocols used by the Los Angeles County Department of Health Services to post beaches during wet weather.

Presently, the reference watershed approach is based on a statistical analysis of the historical exceedance frequency observed at a reference Beach. The allowable days of exceedance are based on the historical exceedance frequency (expressed as a percentage) multiplied by the number of wet-weather days in the 90th percentile year. The allowable days of exceedance are dependent on the sampling frequency. Under a daily sampling program, the approach currently allows for 17 days of exceedance during wet weather, three days during winter dry weather and no exceedance days during summer dry weather. Under a weekly sampling program, the allowable days are proportionately reduced to three days during wet weather, one day during winter dry weather, and no exceedance days during summer dry weather. Two on-going reference watershed studies are being led by SCCWRP to look at other reference watersheds, including inland watersheds. The results of these studies may lead to future changes in the allowable days of exceedance.

In Reach 2, which is designated with the non-contact recreation (REC-2) beneficial use, WLAs are as expressed in the Basin Plan objectives for REC-2 waters. This allows for no more than a 10% exceedance of the single sample limit and no exceedance of the geometric mean limit.

In addition to assigning TMDLs for the impaired reaches, Waste Load Allocations and Load Allocations are assigned to the tributaries to these impaired reaches. These WLAs and LAs are to be met at the confluence of each tributary and its downstream reach (Table 6-2).

Table 6-2: WLAs and LAs for tributaries to the Impaired Reaches of Ballona Creek Watershed.

Tributary	**Point of Application**	**Water Quality Objectives**	**Waste Load Allocation** (No. exceedance days)
Ballona Creek Reach 1	At confluence with Reach 2	LREC-1 Freshwater	For single sample objectives: *(0) summer dry weather,* *(3) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*
Benedict Canyon Channel	At confluence with Reach 2	LREC-1 Freshwater	For single sample objectives: *(0) summer dry weather,* *(3) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*
Ballona Creek Reach 2	At confluence with Ballona Estuary	REC-1 Marine water	For single sample objectives: *(0) summer dry weather,* *(3) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*
Centinela Creek	At confluence with Ballona Estuary	REC-1 Marine water	For single sample objectives: *(0) summer dry weather,* *(4) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*
Ballona Wetlands	At confluence with Ballona Estuary	REC-1 Marine water	For single sample objectives: *(0) summer dry weather,* *(4) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*
Del Rey Lagoon	At confluence with Ballona Estuary	REC-1 Marine water	For single sample objectives: *(0) summer dry weather,* *(5) winter dry weather* *(17) winter wet weather* For geometric mean objectives: *(0) for all periods*

Sepulveda Channel was not assigned a waste load allocation at its confluence with Reach 2 since the TMDL requires the more stringent REC-1 objectives to be met in this waterbody, which should lead to the attainment of the less stringent LREC-1 objectives of the downstream reach.

The County of Los Angeles, Caltrans, and the Cities of Los Angeles, Culver City, Beverly Hills, Inglewood, West Hollywood, and Santa Monica are the responsible jurisdictions and responsible agencies[4] for the Ballona Creek Watershed. The responsible jurisdictions and responsible agencies within the watershed are jointly responsible for complying with the waste load allocation in each reach. For the single sample objectives, the proposed WLA for summer dry-weather are zero (0) days of allowable exceedances, and those for winter dry-weather and wet-weather are three (3) days and seventeen (17) days of exceedance, respectively. In the instances where more than one single sample objective applies, exceedance of any one of the limits constitutes an exceedance day. The proposed waste load allocation for the rolling 30-day geometric mean for the responsible agencies and jurisdictions is zero (0) days of allowable exceedances.

The City of Los Angeles is the responsible jurisdiction for the Del Rey lagoon, and is responsible for complying with the assigned load allocations presented in Table 6-2 at the tide gate(s) between the Lagoon and the Estuary.

The California State Lands Commission and the Department of Fish and Game are responsible jurisdictions for the Ballona Wetlands. Both agencies are responsible for complying with the LAs for the Wetlands (presented in Table 6-2) that are to be met at the tide gate(s) connecting it to the Estuary.

If other unidentified nonpoint sources are directly impacting bacteriological water quality and causing an exceedance of the numeric targets, within the Estuary, the permittee(s) under the Municipal Storm Water NPDES Permits are not responsible through these permits. However, the jurisdiction or agency adjacent to the monitoring location may have further obligations to identify such sources.

6.1 Relationship between High Flow Suspension of Recreational Beneficial Uses and Allowable Exceedance Days

The high flow suspension temporarily removes the recreational beneficial uses for engineered channels during and immediately following large wet-weather events**.** This means that the bacteria water quality objectives – both single sample and geometric mean- do not apply during these periods. An analysis of historical rainfall data in the Ballona Creek watershed produced a median value of 16 days per year during which the suspension of the recreational beneficial uses would apply.

As previously mentioned, the reference system approach was developed to account for natural source contributions to bacterial loading to water bodies during both dry weather and wet weather. Based on a historical analysis of bacteriological data from the selected reference site, the Santa Monica Bay Beaches TMDL assigned a *wet-weather* waste load allocation of 17 allowable exceedance days at the beach located at the mouth of Ballona Creek.

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[4] For the purposes of this TMDL, "responsible jurisdictions and responsible agencies" are defined as (1) local agencies that are permittees or co-permittees on a municipal storm water permit, (2) local or state agencies that have jurisdiction over Ballona Creek and Estuary, and (3) the California Department of Transportation pursuant to its storm water permit.

Local and bightwide shoreline bacteria monitoring data confirm a higher exceedance rate of the single sample objectives during wet weather as compared to dry weather. This difference in the rate of exceedance between dry and wet weather has also been observed in largely natural ‘reference’ systems (SCCWRP Technical Report #448). Clearly a certain percentage of the exceedances in natural systems are caused by rain events of ≥0.5 inch. Using this logic, the application of the high-flow suspension and the allowable exceedance days during wet weather are mutually exclusive in Reach 2 to prevent allowing exceedances of the single sample limits in excess of what would be observed in a natural [reference] system. Both the reference system approach and the high flow suspension are provisions developed to accommodate existing conditions and have no basis in health risk assessment. Therefore the allowable days of exceedance will be based on the reference approach or the high flow suspension, whichever is greater.

While Benedict Canyon Channel is not subject to the high flow suspension, the WLAs will not apply during these periods since they are assigned at its confluence with Reach 2 of Ballona Creek, which is subject to the suspension. As in the case of Reach 2, the application of the high-flow suspension and the allowable exceedance days during wet weather are mutually exclusive.

In Reach 1, which has a REC-2 designation, the 10% exceedance frequency allowance is based on an acceptable level of health risk, and is applicable only when the REC-2 beneficial use exists. Since the REC-2 beneficial use does not exist during the high-flow suspension, these periods are not included in determining the 10% exceedance of the single sample objective.

6.2 Application of the Natural Source Exclusion Provision

Under the natural sources exclusion implementation provision of the updated bacteria objectives, after all anthropogenic sources of bacteria have been controlled such that they do not cause an exceedance of the single sample objectives, 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 may be used if an appropriate reference system cannot be identified due unique characteristics of the target water body. This approach is consistent with the State Antidegradation Policy (State Board Resolution No. 68-16) and with federal antidegradation requirements (40 CFR 131.12).

Del Rey Lagoon and the Ballona Wetlands are nonpoint sources to Ballona Estuary that likely receive the bulk of their bacteria loading from natural sources. This makes them potential candidate waterbodies for the natural sources exclusion. Therefore, this TMDL requires responsible agencies for each waterbody to conduct a natural sources study in order to determine its eligibility for such exclusion.

7 Implementation Strategies

7.1 Introduction

As required by the federal Clean Water Act, discharges of pollutants to Ballona Creek and Estuary 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 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. 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. Below staff have presented some potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the maximum allowable exceedance days for each time period are not exceeded. The implementation strategies presented 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. The final report in its entirety is provided in Appendix A.

The County of Los Angeles, Caltrans, and the Cities of Los Angeles, Culver City, Beverly Hills, Inglewood, West Hollywood, and Santa Monica are jointly responsible for meeting the TMDL Waste Load Allocations for Ballona Creek and Estuary. Therefore, they may jointly decide how to achieve the necessary reductions in exceedance days at each location by employing one or more of the implementation strategies discussed below or any other viable strategy. The City of Los Angeles is the primary jurisdiction as it makes up the greatest portion of the watershed (see Table 7-1).

Table 7-1: Responsible Jurisdictions in the Ballona Creek Watershed

Jurisdiction	Land Area (acres)	% of Watershed covered by Jurisdiction
Los Angeles	67204	82.0
Unincorporated	4718	5.8
Beverly Hills	3626	4.42
Culver City	3277	4.0
Inglewood	1729	2.1
West Hollywood	1202	1.5
Santa Monica	223	0.3
Total Land Area (acres)	**81980**	**100**

As mentioned earlier, the necessary reductions in the number of exceedance days must be achieved at compliance points within each reach or waterbody. This means that each municipality and permittee will be required to meet the total reduction at the monitoring location, not necessarily an allocation for their jurisdiction or for specific land uses. Clearly the focus should be on developed areas or areas with significant human use (i.e., open space heavily used for recreation). Flexibility will be allowed in determining how to reduce bacteria densities as long as the required allocations are achieved at pre-determined monitoring locations.

To achieve the necessary reductions to meet the allowable exceedances presented in Section 6, Regional Board staff recognizes the need to balance short-term capital investments directed towards addressing this and other TMDLs in the Ballona Creek watershed with long-term planning activities for storm water management in the region as a whole. It should be emphasized that the potential implementation strategies discussed below may significantly contribute to the implementation of other TMDLs in the watershed.

7.2 Potential Implementation Strategies

Two different strategies for achieving compliance with the TMDL were developed by the stakeholders using a combination of treatment and control options. The "Preferred Strategy" provides an integrated resources approach to the TMDL implementation and meets a range of other long-term watershed planning goals. This "Preferred Strategy" relies on a combination of options, including flow and bacteria source control, with limited treatment and discharge as well as small amount of diversion to Hyperion Treatment Plant (HTP). Some of the activities and projects that can begin to address this strategy are already in the planning phase by certain stakeholder groups in some areas of the watershed. An "Alternative Strategy" was also developed that relies more heavily on the capture, treatment and discharge of stormwater. This strategy was developed to compare the preferred strategy against an alternative based on more conventional engineering and construction with potentially lower risk but much greater investment in infrastructure and much less opportunity to achieve multiple objectives.

Implementing some of these strategies is likely to require investigative studies to determine their potential environmental impact to the Creek and Estuary. In addition consultation with prospective permitting agencies such as the Department of Fish and Game, National Marine Fisheries Service, and the California Coastal Commission will be necessary during the planning phase. These environmental and regulatory feasibility issues would need to be addressed early in the implementation phase when stakeholders develop the Implementation Plan.

In implementing the TMDL, responsible jurisdictions and agencies will likely include a combination of the various options presented in the Preferred and Alternative Strategy. It is assumed that this combination of options, which include institutional and structural flow source control, various options for treat and discharge, bacteria source control, and in stream solutions will result in compliance with water quality objectives.

7.2.1 *Preferred Strategy- Emphasis on Watershed-based and Integrated Solutions for Progressively Achieving Compliance*

The Preferred Strategy relies primarily on an integrated water resources approach. This approach takes a holistic view of regional water resources by integrating planning focused on beneficial re-uses of stormwater and other multi-purpose goals. The facilities required for the preferred strategies include use/conversion of the existing North Outfall Treatment Facility (NOTF) as well as new diversion facilities within select tributaries. The NOTF is located on the south bank of Ballona Creek, approximately midway in Reach 2 . The facility was constructed, and is owned, by the City of Los Angeles for use as a sewage overflow structure to prevent untreated wastewater overflows discharging to Ballona Creek. The facility provides 1 million gallons of storage capacity with a capacity for treatment of up to 150 cfs (Ballona Creek Treatment Facility Feasibility Study and Preliminary Design; City of Los Angeles Bureau of Engineering Report). The NOTF is currently not in use.

This strategy incorporates the following options, in decreasing order of reliance:

- **Institutional flow source control** - Implement aggressive institutional flow source control strategies to reduce dry weather runoff throughout the watershed. A target of 25% redirection of dry weather flows has been established based on estimates developed under the LAIRP and the Santa Monica Bay Beaches TMDL Implementation Plan.
- **Bacteria source control** - Implement aggressive institutional bacterial source control strategies to reduce bacteria densities in dry and wet weather runoff.
- **Structural/physical source control** - Implement extensive structural flow source control (i.e. onsite capture for infiltration, use, treatment) options throughout the watershed. Reuse portion of captured water where possible.
- **Treatment and discharge/reuse** - Divert, treat and return to Creek or reuse as much wet weather flow as possible at the NOTF without adding additional storage In addition, capture cumulative dry weather flows in Creek at the NOTF (average 7 cfs, plan for maximum 15-23 cfs, which is high-end of dry weather flows); treat 100% of flow at a minimum to meet REC-1 water quality objectives (WQOs); reuse up to approximately 4 cfs of treated water in accordance with the IRP reclaimed water plan and additional treatment equivalent to Title 22 requirements for unrestricted irrigation for reuse water. Return to creek balance of treated dry weather flow not delivered for reuse (between 3 cfs and 19 cfs).
- **Diversion to HTP** - Divert 100% of the remaining dry weather flows downstream of NOTF from Westwood Village (un-named tributaries), West L.A. (Sepulveda Channel) and Windsow Hills (Centinela Channel) sub-watersheds to HTP at multiple locations within Ballona Creek or tributaries. Also consider alternative possible diversion of Windsow Hills sub-watershed (Centinela Channel) to a constructed wetlands facility if feasible.
- **In-stream solutions** - Provide in- stream treatment through Creek restoration and/or storm drain daylighting where feasible {dry weather conditions only).

The implementation of the above combination of implementation measures is expected to provide sufficient reduction of flow and/or bacteria within the watershed to achieve the final dry and wet weather bacteria targets specified in the TMDL. This assumption will be periodically reviewed through evaluation of monitoring data at future implementation milestone points.

7.2.2 The Alternative Strategy – Divert Dry Weather Flow and Intercept, Treat, Temporarily Store, Disinfect and Discharge Wet Weather Runoff

The Alternative Strategy relies primarily on the capture, treatment and reuse and/or return of stormwater to the Creek. The alternative to the Preferred Strategy was developed for two reasons. First, stakeholders wanted to explore the range of potential implementation strategies in order to compare the cost-effectiveness and the relative benefits of the two implementation scenarios. Second, the Alternative Strategy was developed to address the possibility of a shorter implementation timeline for compliance with the TMDL. The dispersed, watershed-based solutions that are the primary focus of the Preferred Alternative may require longer implementation timelines and adaptive management approaches, whereas the Alternative Strategy could potentially provide compliance with the WQOs in a potentially shorter timeline although siting and construction of new capture and treatment facilities will also require significant time.

The Alternative Strategy would require new facilities (multiple new treatment plants) and diversion facilities designed to collect wet weather flow and direct it to the new treatment facilities, which may return wet-weather flow to the Creek after treatment. These facilities would also direct all dry weather flow to Hyperion Treatment Plant (HTP), effectively transferring these flows completely out of the creek.

The primary differences between the Alternative Strategy from the Preferred Strategy is the incorporation of three capture storage and treatment facilities for wet weather flow and the diversion of all dry weather flows to HTP.

The Alternative Strategy incorporates the following elements, in decreasing order of reliance:

- **Institutional flow and bacteria source control** - Implement institutional source control strategies to reduce dry weather flows and bacteria throughout the watershed.
- **Structural source control -** Implement structural flow source control (i.e. onsite capture for infiltration, use) options on an opportunistic basis throughout the watershed, where feasible.
- **Capture, store, treat and discharge -** Temporarily divert, capture, treat and discharge and/or reuse wet weather flow at three new treatment facilities located at strategic locations with sufficient capacity to capture the runoff from approximately 0.45 in of rainfall across all sub-watersheds (Figure 3). This estimate was originally developed as a theoretical target storm event to approximately represent the 17 day storm event in 90th percentile year for beaches TMDL WLA. While not a regulatory standard, this provides an order-of-magnitude runoff target for facility sizing. This includes treatment facilities to serve the Upper Watershed (Proposed Treatment Plant 1), West

L.A. and Westwood Village sub-watersheds (Sepulveda Channel and unnamed tributaries; Proposed Treatment Plant 2), and Windsow Hills sub-watersheds (Centinela Creek; Proposed Treatment Plant 3).

- **Full diversion to sewer system** - Divert cumulative dry weather flows in the Creek at North Outfall Treatment Facility less source control reductions (7-8 cfs on average; plan for max 15-23 cfs, which is the maximum dry weather flow) to HTP at the sewer junction structure near the North Outfall Treatment Facility. There would be no return of flows to the creek under this strategy. Note that although this strategy does not focus on reuse of runoff, it would be possible to construct a facility similar to that described under the Preferred Strategy for treatment and reuse of up to 4 cfs of runoff. Divert 100% of the remaining dry weather flows from Westwood Village, West L.A. (Sepulveda Channel), and Windsow Hills (Centinela Channel) sub-watersheds, downstream of NOTF, to HTP at multiple locations within Ballona Creek or tributaries.

7.3 Implementation Schedule

The proposed implementation schedule shall consist of a phased approach as discussed below and outlined in Table 7-1:

Within six years of the effective date of the TMDL, there shall be no allowable exceedances at any location during summer dry-weather (April 1 to October 31), and compliance with the allowable number of winter dry-weather exceedance days (November 1 to March 31) must be achieved. The longer schedule, as compared to that provided for in the Santa Monica Bay TMDL, is warranted due to the foreseeable implementation measures. In the case of the SMB Beaches Bacteria TMDL, responsible agencies had initiated implementation measures prior to TMDL adoption, therefore a three-year schedule for summer dry weather was feasible. To be consistent with the final compliance date for the wet-weather SMB Beaches TMDLs, the allowable number of wet-weather exceedance days must be achieved no later than 14 years of the effective date of the TMDL.

The SMB beaches TMDLs are scheduled to be re-considered within a year: to re-evaluate the allowable winter dry-weather and wet-weather exceedance days based on additional data; to re-evaluate the reference system selected to set allowable exceedance levels; and to re-evaluate the reference year used in the calculation of allowable exceedance days. This TMDL is scheduled to be re-considered in four years from the effective date to incorporate applicable revisions to the Santa Monica Bay Beaches TMDL and results of special studies conducted for this TMDL.

Until the TMDL is revised, the allowable number of winter dry-weather and wet-weather exceedance days will remain as presented in Table 6-1. Revising the TMDL will not create a conflict in the interim, since the TMDL does not require compliance during winter dry-weather or wet-weather until six and fourteen years, respectively, from the effective date of the TMDL. Therefore, the allowable exceedance days for winter dry-weather and wet-weather will be revised as necessary before the compliance deadlines.

Table 7-2. Summary of Implementation Schedule

Date	Action
Responsible Jurisdictions for the Waste Load Allocations	
12 months after the effective date of the TMDL	Responsible jurisdictions and responsible agencies must submit, for Regional Board approval, a comprehensive bacteria water quality monitoring plan for the Ballona Creek Watershed. The plan must be approved by the Executive Officer before the monitoring data can be considered during the implementation of the TMDL. The plan must provide for analyses of all applicable bacteria indicators for which the Basin Plan and subsequent amendments have established objectives The plan must also include a minimum of two sampling locations (mid-stream and downstream) in Ballona Estuary, Ballona Creek (Reach 1 and 2), and their tributaries. The draft monitoring report shall be made available for public comment and the Executive Officer shall accept public comments for at least 30 days. Once the coordinated monitoring plan is approved by the Executive Officer, monitoring shall commence within 6 months.
$2^1/_2$ years after the effective date of the TMDL	Responsible jurisdictions and agencies must provide a draft Implementation Plan to the Regional Board outlining how each intends to cooperatively achieve compliance with the dry-weather and wet-weather TMDL Waste Load Allocations. The report shall include implementation methods, an implementation schedule, and proposed milestones. As part of the draft plan, responsible agencies must submit results of all special studies and/or Environmental Impact Assessments, designed to determine feasibility of any strategy that requires diversion and/or reduction of Creek flows. If a responsible jurisdiction or agency is requesting a longer schedule for wet-weather compliance based on an integrated approach, the plan must include a clear demonstration that the plan meets the criteria of a IWRA, and a clear demonstration of the need for the proposed schedule. Compliance with the wet-weather allocations shall be as soon as possible but under no circumstances shall it exceed the time frame adopted in the TMDL for non-integrated approaches or for an integrated approach. The draft Plan shall be made available for public comment and the Executive Officer shall accept public comments for at least 30 days.
3 months after receipt of Regional Board comments on the draft plan	Responsible jurisdictions and agencies submit a Final Implementation Plan to the Regional Board.
Responsible agencies for Load Allocations	
1 year after the effective date of the TMDL	Responsible agencies must submit, for Regional Board approval, separate comprehensive bacteria water quality monitoring plans for inputs from Del Rey Lagoon and the Ballona Wetlands to the Ballona Estuary. Each plan must be approved by the Executive Officer before the monitoring data can be considered during the implementation of the TMDL. The plan must provide for analyses of all applicable bacteria indicators for which the Basin

Date	Action
	Plan and subsequent amendments have established objectives The plan must also include a minimum of one sampling location at the connecting tide gate(s). The draft monitoring reports shall be made available for public comment and the Executive Officer shall accept public comments for at least 30 days. Once a coordinated monitoring plan is approved by the Executive Officer, monitoring shall commence within 6 months.
3 years after the effective date of the TMDL.	Responsible agencies shall submit the results of separate natural source studies for Del Rey Lagoon and the Ballona Wetlands, to the Executive Officer of the Regional Board. Each study should include a comprehensive assessment of all sources of bacteria loads to the waterbody and estimates of their individual contributions. In addition, a determination of the number of exceedance days caused by these sources should be made These studies shall be made available for public comment and the Executive Officer shall accept public comments for at least 30 days.
Responsible Agencies for WLAs and LAs* *(*Only if not eligible for natural source exclusion(s)*	
4 years after the effective date of the TMDL:	The Regional Board shall reconsider this TMDL to: (1) Re-assess the allowable winter dry-weather and wet-weather excellence days based on a re-evaluation of the selected reference watershed and consideration of other reference watersheds that may better represent reaches of Ballona Creek and Estuary, (2) Consider whether the allowable winter dry-weather and wet-weather exceedance days should be adjusted annually dependent on the rainfall conditions and an evaluation of natural variability in exceedance levels in the reference system(s), (3) Re-evaluate the reference year used in the calculation of allowable exceedance days, and (4) Re-evaluate whether there is a need for further clarification or revision of the geometric mean implementation provision. (5) Consider natural source exclusions for bacteria loading from Del Rey Lagoon and the Ballona Wetlands based on results of the source identification study. (6) Re-assess WLAs for Benedict Canyon Channel, Sepulveda Channel, and Centinela Creek based on results of the required compliance monitoring, and/or any voluntary beneficial use investigations.
6 years after the effective date of the TMDL:	Achieve compliance with the allowable exceedance days for summer and winter dry-weather as set forth in Table 6-1 and rolling 30-day geometric mean targets.
10 years after effective date of the TMDL or, if an Integrated Water Resources Approach is implemented, up to 14 years from the effective date of the TMDL.*	Achieve compliance with the allowable exceedance days as set forth in Table 6-1 and rolling 30-day geometric mean targets during wet-weather.

*14 years from the effective date of this TMDL will be 18 years from the effective date of the Santa Monica Bay Beaches Bacteria Wet-Weather TMDL.

An implementation schedule proposed by CREST stakeholders is shown in Table 8-2 as it appears in the *Ballona Bacteria TMDL Technical Memorandum* provided in Appendix A. The schedule provides a more detailed breakdown of activities and creates a disconnect between Ballona Creek and Ballona Estuary by assigning a separate compliance schedule for the Creek that is longer and less defined than that of the Estuary. Also a final wet-weather compliance date was not included due to the difficulty in reaching a consensus on this matter.

Table 7-3: Stakeholder-proposed Implementation Schedule

Time after BC Bacteria TMDL Effective Date	Implementation Activity/Compliance Target		
	Estuary (Mouth)	**Reach 2 and Sepulveda Channel**	**Reach 1**
12 months	• Responsible jurisdictions and agencies submit and obtain Regional Board approval of a comprehensive monitoring plan.		
18 months	1. Responsible jurisdictions and agencies provide a draft Interim Report to the Regional Board outlining how each intends to cooperatively achieve compliance with the TMDL. The report shall include implementation methods, an implementation schedule, and proposed milestones. Specifically, the plan must include 1) a comprehensive description of all steps to be taken to meet the summer dry weather compliance schedule for the estuary and 2) the specific milestones associated with the 6-Year intervals for the inland reaches and the named tributaries.		
	2. If the responsible jurisdiction or agency is requesting an extension of the summer dry-weather compliance schedule, the plan must include a description of all local ordinances necessary to implement the detailed work plan and assurances that such ordinances have been adopted before the request for an extension is granted.		
	3. If a responsible jurisdiction or agency is requesting a longer schedule to the wet-weather compliance schedule based on an integrated approach, the plan must include a description of the integrated water resources (IRP) approach. Compliance with the wet-weather allocations shall be as soon as possible but under no circumstances shall it exceed the time frame adopted in the TMDL for non-integrated approaches or for an integrated approach.		
3 months after receipt of RWQCB comments on draft	4. Responsible jurisdictions and agencies submit a Final Interim implementation Report to the Regional Board.		
1-4 Years	• Conduct special studies with the potential to change the TMDL. Results to be reported by the end of Year 4.		
2-5 Years	• Initiate implementation of flow and bacteria non-structural source control measures and dry weather flow management projects (diversion, capture treat and return or reuse) • Initiate planning and where feasible implement structural source control measures		
5 years	• Reconsider TMDL based on revisions to SMBBB TMDL and results of special studies.		
6 years	• Submit an Updated Implementation Plan based on Special Study Results and potential TMDL revisions		
6 Years	• No exceedances due to summer dry weather flows.	• Achieve interim implementation milestones to be described by each responsible jurisdiction in the detailed implementation plan.	• Achieve interim implementation milestones to be described by each responsible jurisdiction in the detailed implementation plan.
	• Achieve 10% reduction from the total wet weather exceedance-day reduction*		
	• Achieve compliance with allowable number of exceedance days – 3 winter dry weather days (under daily sampling) or 1 winter dry weather day (under weekly sampling) for Ballona Creek mouth (bottom of estuary)		
10 Years	• Achieve 25% reduction from the total wet weather exceedance-day reduction*	• No exceedances due to summer or winter dry weather flow • Achieve 15% reduction from	• Achieve 15% reduction from total wet weather exceedance-day

		total wet weather exceedance-day reduction	reduction
See Text* Discussion	• Achieve final wet weather exceedance-day reduction.		

* It was recognized that in the Santa Monica Bay Beaches Bacteria TMDL a compliance schedule is already established for the mouth of Ballona Creek which calls for full wet-weather compliance within 18 years of the effective date of that TMDL (July 15, 2021). Regional Board staff have indicated that final wet-weather compliance dates for the Ballona Creek Bacteria TMDL should be consistent with the Santa Monica Bay Bacteria TMDL. Because the Ballona Creek Bacteria TMDL will not be adopted until late 2006 (close to four years after the effective date of the SMBB Bacteria TMDL), this would potentially result in an overall shorter final time frame for full implementation for the Ballona Creek Watershed.

Stakeholders responsible for implementation acknowledge that full wet-weather compliance must be achieved by this date at the mouth of Ballona Creek. However, they are concerned that achieving full wet weather compliance at other locations in the watershed (particularly in Reaches 1 and 2 and tributaries) within 3 years for dry weather and 14 years for wet weather will have challenges. For many of the Santa Monica Bay storm drains, planning and/or construction of diversion facilities were already under way at the time of TMDL adoption, which is not the case for the Ballona Creek watershed. In addition, relatively short deadlines could result in driving dry weather solutions toward more sewer system diversions, which is not the focus of the Preferred Strategy. The Preferred Strategy could require a longer time frame for implementation, due to its approach that emphasizes distributed, watershed-wide measures, and reuse that can address multiple pollutants as opposed to the a largely treatment-and-diversion approach that focuses primarily on bacteria reduction only.

7.4 Implementation Cost Estimates

Two implementation cost estimates were developed. The first is for the "Preferred Strategy" which takes a holistic view of regional water resources by integrating TMDL compliance with planning focused on beneficial re-uses of stormwater and other multiple purpose goals. While this is the preferred strategy based on the summary of all the objectives, it is also more challenging to predict implementation costs as it relies to a much greater degree on distributed, watershed-wide multi-objective solutions, the majority of which will require partnerships with private landowners, residents and businesses, and other public landowners (e.g. school districts) that are not directly responsible for TMDL compliance. Therefore, the cost estimate attempts to account for a range of economic factors and requires a number of assumptions regarding the extent and cost of implementing many of the measures. The alternative, "single-purpose" strategy of capture, treat and return and/or reuse is based primarily on larger, less distributed regional or subregional structural approaches that focus principally on end-of-pipe bacteria reduction. The cost estimates for this approach are less detailed and also require a number of assumptions.

The following sections describe how the costs were derived for the various components of both strategies. Following the description, a summary of the costs for each strategy is presented. In reviewing these cost estimates, it should be noted that there are multiple additional benefits associated with the implementation of the dry and wet weather solutions under the Preferred Strategy. Many of the BMPs (both source and treatment control 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 Ballona Creek existing and emerging TMDLs, such as the Metals, Toxics and Trash TMDLs (e.g. the infiltration trenches with a gross solids removal system would remove metals and trash from the runoff as well).

7.4.1 Institutional Flow and Bacteria Source Control Costs

Institutional source controls are measures that seek to reduce either the total flow or the amount of bacteria entering Ballona Creek and are assumed to be applicable and appropriate for implementation under either strategy. As these source controls are on an institutional level, the actual volume or concentration of bacteria that will be reduced cannot be accurately or precisely quantified. In the future, when these types of programs are implemented, a quantifiable correlation will likely be able to be made but it is not available at this time. For the purposes of reasonable assurances to compliance with WQS it has been estimated that dry weather flows will be reduced by at least 25% through these measures.

Bacteria Source Control

A number of similar source control measures were already 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 Ballona Creek Watershed is 128 square miles, the control measure costs were scaled down proportionally. The following represent the approximate values for Ballona Creek Watershed for these source control measures:

- Enforcement of litter ordinances - $0.4 million per year;
- Public education - $0.2 million per year;
- Improved street cleaning - $0.3 million per year;
- Increased Storm Drain Cleaning - $1.1 million per year.

In addition to these source controls identified in the Metals TMDL, an estimated $1 million per year was added for additional for bacteria source control measures specifically 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 $3 million per year much of which can be shared with other TMDL (metals and toxics) implementation requirements.

Summary:

- Capital costs – NA;
- Operation and Maintenance Costs - $3 million (M)/yr.

Institutional Flow Source Control

"Smart Irrigation" refers to the use of irrigation controllers to monitor irrigation, based on actual weather data and soil moisture content using evapotranspiration (ET) controllers. In addition to reducing the amount of water use, the units would also reduce or eliminate over-watering, a significant contributor to dry weather runoff.

The City of Los Angeles IRP looked at studies being done in both the City and by the Irvine Ranch Water District (IRWD). Based on the findings described in the IRP, effectiveness rates of installing the devices at various land uses were determined as well as the costs for implementing these devices.

The IRP estimated that ET controllers could be installed at 70 percent of land uses throughout the City. The land use data presented in Table 7-4 shows the residential and commercial acreage in the Ballona Creek Watershed.

Table 7-4: Land use in Ballona Creek Watershed

Land Use	Area (acres)
High Density Residential	45,600
Low Density Residential	2,950
Mixed Urban	100
Commercial	12,950
Industrial	4,200
Open Space	14,000
Other	2,200
Total	82,000

Ballona Creek Metals TMDL Land use data.

Table 7-5 presents the estimated runoff reduction from employing Smart Irrigation. As shown in the table, the runoff rate (as determined by the IRP) was multiplied by 70 percent of the total area for residential and commercial properties. This runoff amount was multiplied by the effectiveness rate of ET controllers in reducing this runoff amount for each land use shown. Finally, the calculation shows that runoff could be reduced by 3 million gallons per day (mgd) by implementing Smart Irrigation. Source: Assuming ET controllers were installed in 70% of all properties, total area of about 43,000 acres would be targeted for controllers. While there would be a wide range of densities and lot sizes for both single and multi-family residential properties, for cost estimating purposes an average of one controller per acre was assumed, with a particular emphasis on larger properties. Therefore the cost estimated is based on installing up to 43,000 units. At a cost of $175 per device (which includes installation), the total capital cost would be $7.5 million.

Table 7-5: Flow Reduction Through Implementation of Smart Irrigation

	High Density Res.	Low Density Res.	Commercial	Total
Area (acres)	45,600	2,950	12,950	61,500
70% of area implementing S.I. (acres)	31,920	2,065	9065	43,050
Runoff Coefficient (gpd/ac) [1]	230	230	230	NA
Total Runoff (mgd):	7.3	0.5	2.1	10
% Effectiveness of Smart Irrigation (%)[2]	30%	71%	20%	NA
Total Runoff Reduction (mgd)[3]	2.2	0.3	0.4	3.0

Notes:

1 The Runoff coefficient is for the Ballona Creek Watershed as determined in the IRP.

2 The % effective is the effectiveness of the Smart Irrigation device at reducing the amount of runoff for a given land use and is based on IRP Smart Irrigation analysis, which was based on Irvine Ranch Water District pilot project data.

3 Total Runoff Reduction is the total runoff multiplied by the % effectiveness of the devices.

For an ET controller to operate, it must receive a satellite signal that controls the amount of irrigation that occurs. The monthly cost for this is $4 per device. With up to 43,000 devices installed, the annual operation and maintenance cost would be about $2 million per year

Since these devices will reduce the amount of potable water demand that each residence or commercial facility uses for irrigation, these users will have a significant savings in potable water purchasing costs. As such, the capital and/or long-term operation and maintenance and replacement costs could be borne by the individual user rather than the municipalities of the Ballona Creek Watershed.

It should be noted that this approach could over-estimate the reduction of runoff since the number of real estate properties with underground irrigation systems and automatic controllers is unknown. In addition, future implementation would depend on available funding, customer acceptance, reliability, and commercial availability of Smart Irrigation controllers. More detailed studies would be needed to determine the full benefits of a smart irrigation program.

Summary:

- Capital costs – $7.5M;

- Operation and Maintenance Costs - $2 M/yr.

7.4.2 Structural Flow Source Control Costs

Cisterns

For developing a cost estimate for the cisterns component, 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, commercial, etc. Programs to promote and assist in providing cisterns for private residential development (single or multifamily) would be encouraged but specific costs are not included in this estimate.

For schools and government facilities, it was assumed that a similar percentage of citywide implementation as was used in the IRP would apply to Ballona Creek. As shown in the IRP, which used Southern California Association of Governments (SCAG) land use data, schools and government facilities cover 3% of the total area of the City of Los Angeles. Using the same percentage for the Ballona Creek Watershed, which is 82,000 acres, the resulting area for schools and government facilities in the Ballona Creek Watershed is 2,500 acres.

Additionally, the IRP estimated the number of cisterns required to treat a target volume of 80 MG was 10,000. As shown in Table 7-6, these values were used to determine the proportional amount that Ballona Creek Watershed would require.

Table 7-6: Ballona Creek Watershed vs. City of Los Angeles

Land use	LA IRP	Ballona Creek Watershed
Total Area (acres)	295,000	82,000
Area of Schools/Gov. Facilities (acres)	9,200	2,500
Runoff Target Volume [1]	80	14
Number of 10,000 Gallon Cisterns Required [2,3]	10,000	2,260

Note:

1. Runoff coefficient = 0.47 (per Watershed Protection Division Pollutant Load Model
2. Cisterns are assumed to be 10,000 gallons, as determined by the IRP. In the IRP, 50 years of rainfall data was analyzed to estimate what size cistern would be required to manage all of the flow from these land uses. Though actual size would be determined on a site by site basis, for the purposes of cost estimation an average size of 10,000 gallons is assumed.
3. The number of cisterns needed for Ballona Creek Watershed (BCW) at schools and government facilities was determined on a percentage basis using the average of the % by area and % by flow volume. (BCW has 18% of the flow from schools/government that the entire City of LA has, and 28% of the area. The average is 23%, which is used here).

Based on the data shown in Table 7-6, up to 2,260 cisterns could be installed in the Ballona Creek 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 IRP, for the 10,000 gallon cisterns the total cost would be: $1/gallon * 10,000 gallons/cistern * 2,260 cisterns = $22.6 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 the cistern analysis done for the IRP (referred to in Note 2 of Table 7-6), 50 years of rainfall data was analyzed to estimate the size of cisterns that would be required to manage the flows for these land uses for these rainfall amounts. 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 2,260 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 $0.2 per mgd was assumed to allow for other operation, maintenance and replacement costs.

Summary:

- Capital costs – $22.6M;
- Operation and Maintenance Costs - $0.2 M/yr.

Neighborhood Recharge Costs

The concept of "neighborhood recharge" is based on developing local, on-site or subwatershed-based projects in parks, public land, vacant property, and other open spaces within the Ballona Creek Watershed. As shown in Table 3 above, the area of open space in Ballona Creek Watershed not located in the hills is estimated at 7,500 acres. Although substantial portions of the remaining 7,500 acres watershed would 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 remaining 7,500 acres of open space might be suitable for neighborhood recharge. This results in the potential to develop up to 375 acres of land for some form of neighborhood 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 recreational aesthetic benefits.

It was also estimated that 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 375 acres of land, an estimated 61 mgd could be managed by implementation of neighborhood recharge projects.

For the IRP, a unit cost of $0.65 M/ac was assumed based on data developed under the Sun Valley Project. Therefore, the total estimated capital cost for full implementation of this concept could be as high as $244 million.

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/ac/yr. This would result in approximately $1.1 M/yr in operation and maintenance costs for 375 acres of neighborhood recharge facilities.

Summary:

- Capital Costs - $244 M;
- Operation and Maintenance Costs - $1.1 M/yr.

Sand Filters and Infiltration Trenches Costs

An additional implementation method that was included was implementation of sand filters or infiltration trenches in local watersheds, which is also being considered for the Ballona Creek Metals TMDL. Sand filters are specifically designed to treat urban runoff in high density areas, and are proposed as part of the implementation strategy to address the Ballona Creek Metals TMDL. In the Metals TMDL, these BMPs were selected in part due to the fact that they can also remove bacteria. USEPA reports that sand filters have a 76 percent removal rate for fecal coliform (USEPA, 1999b). These BMPs have the additional positive impact of addressing the effects of development and increased impervious surfaces in the watershed, and both approaches can be designed to capture and treat at least 0.5 to 1 inch of runoff. Additional flow exceeding the design capacity would be allowed to bypass the device and enter the storm drain untreated. The device could also manage the entire dry weather flow.

Sand filters must be used in conjunction with a pretreatment device such as a biostrip or gross solids removal device to remove sediment and trash in order to increase their efficiency and service life. As stated above, these devices would then have the combined effect of achieving compliance with the Metals TMDL and the Trash TMDL as well as the Bacteria TMDL. The cost analysis was done for the Trash and Metals TMDLs, as shown below, and accounts for the gross solids removal systems, including structural vortex separation systems and end of pipe nets, as well as the costs associated with installing sand filters.

The Metals TMDL assumed that sand filters would treat 20 percent of the urbanized portion of the watershed. Costs were estimated by using data provided by USEPA (USEPA, 1999a and 1999b) in 1997 dollars, and the Federal Highway Administration (FHWA, 2003) in 1996 dollars for infiltration trenches and 1994 dollars for sand filters. Where costs were reported as ranges, the highest range was assumed. These costs were then compared to Caltrans costs determined in their BMP Retrofit Pilot Program (Caltrans, 2004) that were reported in 1999 dollars. Refer to Appendix A of the Ballona Creek Metals TMDL for the cost analysis and sizing constraints.

Since the 0.45-inch storm event, rather than the 0.5 inch storm, was used to develop this analysis, an adjustment was made to determine 20% of this flow. As was determined by the EPA/Tetra Tech flow model, the total flow from the 0.45 inch storm for this area is 544 MG per event. Therefore, 20 percent of this flow is 109 MG per event, which is what would be managed with sand filters.

For this TMDL, the cost data provided in the Metals TMDL and estimating the runoff from the 0.5 inch storm event that these costs were based on, a unit cost for the sand filter was determined. Taking the 109 MG/event that the sand filter would manage, the total capital and O&M costs were calculated as shown in table 7-7.

Table 7-7: Capital and Operation and Maintenance Costs for Sand Filters

Sand Filters	From Metals TMDL (0.5 in rainfall)					For 20% of flow from 0.45 inch storm event	
	Capital Costs ($M)[1]	O&M Costs ($M/yr)[1]	Flow Managed (MG/event)[2]	Unit Capital Cost per MG ($M/MG)[2]	Unit O&M Cost per MG ($M/MG/yr)[2]	Total Capital Costs ($M)[3]	Total O&M Costs ($M/yr)[3]
	88.00	4.00	120.93	0.73	0.03	$79	$3.60

Note:
[1] Source: Ballona Creek Metals TMDL - for columns 2,3,4. All other columns calculated based on this data and flow from 0.45-inch storm event. These costs are the average of USEPA and FHWA Estimates that were presented in the Metals TMDL. FHWA did not report O&M data, so O&M data shown in from USEPA only. Only Delaware sand filters are presented as they are used from smaller drainage areas (approx 1 acre) as opposed to 50 plus acres.
[2] Flow managed in this column is based on Metals assumptions listed and IRP values. Unit costs calculated based on this flow and the total costs in columns 2 and 3.
[3] Total capital and O&M costs based on, which is 47 MG/event.

Summary:

- Capital Costs - $79 M;
- Operation and Maintenance Costs - $3.6 M/yr.

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 Hyperion Treatment Plant (HTP). The Cities of Los Angeles and Santa Monica have already initiated diversion programs on most 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, the unit capital cost of $1.6 million per mgd was assumed.

For the two strategies discussed, different amounts of dry weather runoff would require diversion. For the Preferred Strategy, only dry weather flows downstream of the North Outfall Treatment Facility that would not be managed by source controls or other watershed-based BMPs would be diverted. This is estimated to be a peak flow total of about 7.8 mgd, which results in a capital cost of approximately $12 million. For the

Alternative Strategy, all of the dry weather runoff that is not already reduced through source controls would be diverted, an estimated peak flow of 19.7 mgd, which would result in a capital cost of $31 million.

Operation and maintenance costs are also taken 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 an average of 4 mgd of diverted flow for the Preferred Strategy, the total operation and maintenance cost estimate is $0.13 M/yr. For the Alternative Strategy, with an average flow of approximately 19.7 mgd diverted, the total operation and maintenance cost would be $0.32 M/yr.

Summary:

- Capital Costs - $12.1 M (Preferred Strategy); $31 M (Alternative Strategy);
- Operation and Maintenance Costs - $0.11 M/yr (Preferred Strategy); 0.32 M/yr (Alternative Strategy).

Treatment and Discharge/Reuse Costs

The following runoff capture and treatment facilities are included in the costs:

- Retrofit North Outfall Treatment Facility (NOTF) to treat dry and wet weather runoff, with reuse of up to 4 cfs of dry weather runoff (Preferred Strategy).
- Install New Urban Runoff Treatment Plant in Upper Watershed (Alternative Strategy).
- Install Urban Runoff Treatment Plant at West Los Angeles Subwatershed (Alternative Strategy.
- Install Urban Runoff Treatment Plant at Windsow Hills Subwatershed (Alternative Strategy).

The following dry weather flow data represents the maximum dry weather flow rate:

- North of NOTF = 23 cfs = 15 mgd;
- Sepulveda & West LA = 7 cfs = 5 mgd;
- Centinela = 5 cfs = 3 mgd;
- Total = 35 cfs = 23 mgd.

The following wet weather flow information was determined based on an EPA/Tetra Tech flow modeling program to manage up to a 0.45 inch storm event. This data is also presented in Figure 3 below.

Subwatershed flows:

- Hollywood Subwatershed: 247 cfs;
- Cienega: 164 cfs;

- Windsow Hills: 77 cfs.

Flows within Ballona Creek:

- Approx. at NOTF: 439 cfs;
- At Westwood Village Subwatershed: 447 cfs;
- At West LA Subwatershed: 765 cfs;
- Runoff Volume from a single storm event: 471 MG = 1,445 AF.

Retrofit NOTF to Treat Dry and Wet Weather Runoff, with Reuse of up to 4 cfs of Dry Weather Runoff

Part of the Preferred Strategy includes retrofitting the existing NOTF. A study was done for the City of Los Angeles Bureau of Engineering in 1995 entitled *Ballona Creek Treatment Facility Feasibility Study and Preliminary Design (Study).* This study estimated the costs associated with retrofitting the NOTF, which is currently not in use as a wet weather sewer overflow facility, to capture, store, treat, disinfect and discharge urban runoff. One of the alternatives analyzed included treating dry weather runoff and a fraction of wet weather runoff and reusing a portion of the dry weather runoff. Costs were presented for two different amounts of reuse, and the costs shown below represent an interpolation of the two to meet the reuse target of 4 cfs.

The feasibility study examined converting the existing NOTF, maximum capacity is of approximately 150 cfs (97 mgd) for solids reduction and disinfection sufficient to achieve REC-1 standards in the discharge and it has 1 MG of storage available without additional construction. Using a typical hydrograph presented in the *Study*, the 1 MG of storage could manage an additional 19 cfs (12 mgd). Therefore, the wet weather total flow that could be managed at the retrofitted NOTF is 109 mgd. Under the Preferred Strategy, if a full suite of non-structural and structural source control measures are ultimately developed across the upper subwatersheds, the combination of implementing source control measures and projects and making use of conversion of existing facilities at the NOTF make it possible to manage sufficient flow to meet the TMDL target for the upper watershed as well as provide a significant source of treated dry weather flow for reuse.

By updating study costs to current (2005) values, the capital costs for constructing diversion facilities into the plant, retrofitting the plant for treatment and discharge, and constructing additional facilities to provide water of sufficient quality for unrestricted non-potable reuse of up to 4 cfs (2.6 mgd) of dry weather runoff, is estimated to be approximately $9 million. Operation and maintenance costs are estimated to be approximately $0.9 million per year (adjusted for inflation). Neither the capital nor the operation and maintenance costs include any reuse distribution costs. Conversely, the cost estimate does not include any "revenue" that could be realized from potential sale of the recycled water. For example, assuming the project could produce up to 2,900 acre-ft of water, the potential "value" of the water is up to $1.4 M at $500/ac-ft.

Summary:

- Capital Costs - $9 M;
- Operation and Maintenance Costs - $0.9 M/yr.

Construct Urban Runoff Treatment Plant in the Upper Watershed (Plant 1)
Under the Alternative Strategy, one new urban runoff treatment plant is assumed to be constructed, with sufficient storage and capacity to serve the upper watershed (approximately the same portion of the watershed as is tributary to the vicinity of the existing NOTF). The watershed flows at this point are approximately 440 cfs, as shown in Figure 3. In order to analyze the flows, hydrograph from the NOTF *Study* discussed above was used. This hydrograph, which is Figure 2-5 of that document is for a comparable flow (470 cfs at its peak[5]), and therefore this hydrograph was assumed to be comparable. This hydrograph shows that the average flow is approximately 250 cfs for a duration of 2 hours. Using this data, and assuming that 150 cfs (97mgd) would be treated instantaneously, the storage required to treat this entire 437 cfs (284 mgd) was calculated as follows:

- Storage required = (250cfs-150cfs) * 3600 sec/hr * 2 hrs * 7.48 gal/cf / 1M gal/MG = 5.4 MG.

The unit cost of $4.7 M/mgd that was used in the IRP resulted in a total treatment plant cost (including land acquisition) of 97 mgd * $4.7 M/mgd = $456 M. The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of $1.30M/MG of storage capacity. For the 5.4 MG of storage, the total cost would be $7 million. In addition, a lump sum cost for collection and discharge pipelines was included at $50 million. The total capital cost is therefore estimated at $512 million.

Operation and maintenance costs were estimated based on the information presented in the *Study*. These costs included the following:

- Power: $0.20 million/yr;
- Labor: $0.25 million/yr;
- Chemicals: $0.01 million/yr;
- General Maintenance: $0.07 million/yr.

This results in a total unit cost of $0.53 million per year in operation and maintenance costs.

Summary:

- Capital Costs - $512 M;
- Operation and Maintenance Costs - $0.53 M/yr.

[5] Flow from hydrograph metered at Sawtelle Blvd., determined to be within 2% of flow at BCTF and negligible for the purposes of this study.

Construct Urban Runoff Treatment Plant at West Los Angeles Subwatershed
Construction of a new treatment plant built at a location north of Ballona Creek, downstream of flow coming from West LA and Westwood Village subwatersheds is for Alternative 2 only. At this point in Ballona Creek, the flow is 326 cfs. For developing cost estimates, it was assumed that a treatment plant constructed with a capacity of 100 cfs would be built. With this assumption, a proportionally scaled down version of the hydrograph as shown in the *City of LA BOE Ballona Creek Treatment Facility Feasibility Study and Preliminary Design* document was used to estimate the amount of storage needed. From this scaled down hydrograph, an average flow of 175 cfs, with a duration of 2 hours resulted in the following storage required to treat the entire 326 cfs (210 mgd) of flow in a 100 cfs (65 mgd) treatment plant:

- Storage required = (175cfs-100cfs) * 3600 sec/hr * 2 hrs * 7.48 gal/cf / 1M gal/MG = 4 MG.

To determine the cost associated with constructing this plant, again unit cost estimates from the IRP were used. The unit cost of $4.7 M/mgd resulted in a total treatment plant cost (including land acquisition) of 65 mgd * $4.7 M/mgd = $304 M. The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of $1.30M/MG of storage capacity and a 4 MG tank is estimated at approximately $5.3 M. Additionally, collection pipelines and discharge pipelines were assumed to be a lump sum of $40 M. The total cost is then $349 M.

Using a similar approach to operation and maintenance costs, the unit cost per cfs would be: $0.53 M/yr divided by 150 cfs = $3,530 /yr. Adjusted for the 100 cfs treated at this site, the total operation and maintenance costs would be approximately $0.35 M/yr.

Summary:

- Capital Costs - $343 M;
- Operation and Maintenance Costs - $0.35 M/yr.

Construct Urban Runoff Treatment Plant at Windsow Hills Subwatershed
This treatment plant would be constructed at point south of Ballona Creek to intercept flow coming from Windsow Hills sub-area (Centinela Creek). At this point in Ballona Creek, the estimated target flow is 77 cfs. It is assumed that a treatment plant designed to treat 25 cfs would be built, and with this assumption, a proportionally scaled down version of the aforementioned hydrograph as shown in the *Study*, with an average flow of 40 cfs and a duration of 2 hours, the resulting storage required to treat the entire 77 cfs (50 mgd) of flow in a 25 cfs (16 mgd) treatment plant would be:

- Storage required = (40cfs-25cfs) * 3600 sec/hr * 2 hrs * 7.48 gal/cf / 1M gal/MG = 0.8 MG.

To determine the cost associated with building this plant, unit cost estimates from the IRP were used. The unit cost of $4.7 M/mgd resulted in a total treatment plant cost (including land acquisition) of 16 mgd * $4.7 M/mgd = $75 M. The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of , $1.3 M/MG, which for the 0.8 MG tank is $1.1 M. Additionally, collection pipelines and discharge pipelines were estimated to be a lump sum of $10.0 M. The total capital cost is then estimated at approximately $87 M.

Using a similar approach to O&M costs as previously presented, the unit cost per cfs would be: $0.53 M/yr divided by 150 cfs = $0.00353 M/yr. Adjusted for the 25 cfs treated here, the total operation and maintenance costs would be $0.09 M/yr.

Summary:

- Capital Costs - $82 M;
- Operation and Maintenance Costs - $0.09 M/yr.

In-Stream Solutions

"In-Stream Solutions" represent a range of potential approaches which may include "daylighting" of segments of tributary reaches that are currently underground storm drain systems, and restoring natural habitat along an existing stream segment (tributary or main stem) in a reach that is currently fully lined, which is typical of nearly all of inland Ballona Creek and it's tributaries. Under this concept, the restoration or daylighting project concept would be undertaken to provide multiple benefits, one of which would be to optimize the ability of the restored reach to provide in-stream or off-stream bacteria reduction. This would be primarily targeted at reducing bacteria reduction in dry weather flow.

7.4.3 Summary and Discussion

The following two tables identify the total cost estimates for the Preferred Strategy (Table 7-8) and the Alternative Strategy (Table 7-9).

While the above summary tables present an initial range of potential costs for the two different strategies based on the assumptions previously noted in the discussions on individual components, there are several key observations to note with respect to the cost estimates.

- Costs for the integrated approach are based on a limited number of potential "options" to keep the cost approach simplified. In reality there will likely be other opportunities that may be identified over time that afford both water quality improvement and other multiple benefits that may be implemented
- The estimated capital costs for full implementation of potential neighborhood recharge projects represent over 60 per cent of the total estimated cost while the relative contribution to reduction in wet weather flow and therefore presumed reduction in bacteria contribution is estimated at slightly greater than 10% of the wet weather flow. This results in part from extending cost estimates from a limited base of projects and also accounting for generally lower effective recharge capabilities within the coastal watersheds. As implementation of projects and programs progresses, it is anticipated that the responsible agencies will focus on the projects with highest potential return first wherever possible, evaluate results and attempt to optimize the overall program effectiveness and costs. Therefore it is possible that close to similar levels of bacteria

reduction could potentially be achieved with substantially less capital and associated operation and maintenance costs. 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.

- The cost estimates indicate that the preferred strategy has the potential for significantly lower (though still major) capital costs compared to the Alternative Strategy, but higher operation and maintenance costs. The two strategies were not compared on a present worth or equivalent annual cost basis as this was not intended to be a full economic analysis with selection based on cost estimate. The two options simply represent different overall approaches that can be considered. The direction from CREST to focus on the Preferred Strategy was based on a number of considerations rather than primarily costs.

- Most of the program components included in the Preferred Strategy 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

Table 7-8: Preferred Strategy Summary Table

Option	Average Dry Weather Flow Managed (cfs)	Volume of Wet Weather Flow Managed (MG/event)	% of Dry Weather Flow Managed	% of Wet Weather Flow from 0.45 inch storm[1]	Capital Cost ($M)	O&M Cost ($M/yr)
Non-Structural Flow Source Controls[2]	4.7	NA	25%	NA	$8	$2.07
Bacterial Source Control						$3.00
Cisterns	NA	14	NA	3%	$23	$0.06
Neighborhood Recharge	1	61	5%	11%	$244	$2.63
Sand Filter	1.3	109	7%	20%	$79	$3.60
Dry Weather Diversions	5	NA	26%	NA	$12	$0.26
NOTF (reuse plus discharge)	7	99	37%	18%	$9	$0.84
Total	**19**	**283**	**100%**	**52%**	**$375**	**$12.46**

[1] The % of total wet weather flow is based on the total wet weather flow from the 0.45-inch storm for Ballona Creek at West LA subwatershed point plus the flow from Windsow Hills (i.e. 765 cfs+77cfs=842dfs = 544 mgd).

[2] Non-structural source controls include institutional solutions and smart irrigation implementation.

Table 7-9: Alternative Strategy Summary Table

Component	Average Dry Weather Flow Average Managed (cfs)	Volume of Wet Weather Flow Managed (MG/ event)	% of Dry Weather Flow Managed	% of Wet Weather Flow from 0.45 inch Storm.[1,2]	Capital Cost ($M)	O&M Cost ($M/yr)
Non-Structural Source Controls[3]	4.7	NA	25%	13%	$8	$5.07
Dry Weather Diversions	14.3	NA	75%	87%	$31	$0.66
Proposed Wet Weather Treatment Plant 1	NA	284	NA	52%	$453	$0.53
Proposed Wet Weather Treatment Plant 2	NA	211	NA	39%	$343	$0.35
Proposed Wet Weather Treatment Plant 3	NA	50	NA	9%	$82	$0.09
Total	**19**	**545**	**100%**	**100%**	**$917**	**$6.7**

Notes:

[1] The % of flow for dry weather is the percent of the total Dry Weather flow that is managed through diversions.

[2] The % of total wet weather flow is based on the total wet weather flow from the 0.45-inch storm for Ballona Creek at West LA subwatershed point plus the flow from Windsow Hills (i.e. 765 cfs+77cfs=842dfs = 544 mgd).

[3] Non-structural source controls include institutional solutions and smart irrigation implementation.

8 Monitoring Program

Responsible jurisdictions and responsible agencies are jointly responsible for developing and implementing a comprehensive monitoring plan to better characterize existing water quality based on applicable bacteria water quality objectives and to assess compliance with the waste load allocations and load allocations in the TMDL. The monitoring plan should include all applicable bacteria water quality objectives and sampling frequency must be adequate to assess compliance with the 30 day geometric mean limits (i.e., at least 5 samples per 30 days).

8.1 Ambient Monitoring

Ambient monitoring of water quality conditions prior to compliance deadlines is necessary to track progress towards achieving the wasteload allocations. Monitoring should be conducted in each impaired reach and at the confluences of each tributary, for this purpose. On-going monitoring efforts by the City of Los Angeles and County of Los Angeles within the Ballona Creek watershed may fulfil this requirement - however, all responsible jurisdictions and responsible agencies are ultimately accountable for ensuring that these monitoring requirements are met. Additional monitoring in the open channel portions of Benedict Canyon Channel, and throughout Centinela Creek is required to confirm or refute indications of bacteria impairment. Monitoring geared towards refining source identification is encouraged. There is also much yet to be learned with regard to the frequency of exceedances of the single sample limits during wet weather and changing trends in bacteria levels throughout the creek estuary and their tributaries. A better understanding of the sources and variations in bacteria loading will lead to a more cost-effective and time-efficient implementation strategy.

8.2 TMDL Effectiveness Monitoring

The TMDL effectiveness monitoring program will assess attainment of the allowable exceedances for Ballona Creek, Ballona Estuary, and Sepulveda Channel, and the WLAs for the tributaries. Responsible jurisdictions and responsible agencies shall conduct daily or systematic weekly sampling at a minimum of two locations within Ballona Estuary and Reach 2 of Ballona Creek, and at least one location each in Reach 1 of Ballona Creek, Sepulveda Channel, Centinela Creek, and Benedict Canyon Channel, to determine compliance. Similar monitoring at the connecting tide gates of the Ballona Wetlands and Del Rey Lagoon is also required. Where monitoring locations are located at or close to the boundary of two reaches, data from sampling points will also be used to assess the immediate downstream reach. This will ensure that the downstream reaches, which have more stringent water quality objectives, are adequately protected.

If the number of exceedance days is greater than the allowable number of exceedance days in the REC-1 and LREC-1 waters, and/or the frequency of exceedance is greater than 10% in the REC-2 waters, the responsible jurisdictions and/or responsible agencies shall be considered not to be attaining the TMDLs and/or assigned allocations (non-attaining). Responsible jurisdictions or agencies shall not be deemed non-attaining if the investigation described in the paragraph below demonstrates that bacterial sources originating within the jurisdiction of the responsible agency have not caused or contributed to the exceedance.

If an instream location is non-attaining as determined in the previous paragraph, the Regional Board shall require responsible agencies to initiate an investigation, which at a minimum shall include daily sampling at the existing monitoring location until all single sample events meet bacteria water quality objectives.

8.3 Special Studies

8.3.1 Required Studies

This TMDL requires jurisdictional agencies for Del Rey Lagoon and the Ballona Wetlands to conduct separate bacteria source identification studies to determine the eligibility of each waterbody for the natural source exclusion. Each study should identify all probable sources of bacteria loads, their estimated contributions to the waterbody of concern, and a determination of the frequency of exceedances of the single sample bacteria objectives caused by the identified natural sources.

8.3.2 Recommended Studies

Responsible jurisdictions and agencies within the watershed may conduct special studies designed to help refine waste load allocations and/or assist with TMDL implementation. It is also anticipated that the responsible jurisdictions and agencies will also be participating in the reference and source characterization efforts initiated as part of the SMB beaches TMDLs. Below are a number of studies identified by the CREST stakeholder group that may provide such information.

- Monitoring an inland reference watershed to quantify the loading of indicator bacteria from background/natural sources (in conjunction with and/or support of others e.g. the Southern California Coastal Water Research Project).
- Source characterization.
- Water quality modeling to better define the effectiveness of implementation strategies.
- Characterizing the hydrodynamics in the Estuary and the relationship of Ballona Creek water quality and tidally-influenced flows; potentially including a determination of the most appropriate monitoring location/depth, the effect of the estuarine environment on bacteria moving through the Estuary; and the relative effectiveness of diverting upstream dry weather flows.
- Analyses and studies to evaluate unintended impacts (i.e. minimum flow to creek) when implementing BMPs and other implementation strategies. Investigating potential impact to biological resources in Creek should diversion of all or dry weather flow from the Creek be required or proposed.

Furthermore, Regional Board staff also encourage responsible entities to undertake beneficial use investigations of all major tributaries to the Creek and Estuary – Benedict Canyon Channel, Sepulveda Channel, and Centinela Creek - in order to (i) to refine waste load allocations and (ii) to determine eligibility for the application of the high flow suspension of recreational uses.

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