U.S. Environmental Protection Agency
Region IX

Long Beach City Beaches and Los Angeles River Estuary Total Maximum Daily Loads for Indicator Bacteria

Photo: Long Beach

Approved by:

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Appendix A Data Compilation and Analysis

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List of Acronyms

Basin Plan	Water Quality Control Plan
BAT	Best Available Technology
BMPs	Best Management Practices
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
CFU	Colony forming units
cfs	Cubic feet per second
cms	Cubic meters per second
CREST	Clean Rivers through Effect Stakeholder TMDLs
CWA	Clean Water Act
E. coli	*Escherichia coli*
EFDC	Environmental Fluid Dynamics Code
FIB	Fecal indicator bacteria
HSPF	Hydrological Simulation Program FORTRAN
km^2	square kilometers
LA	Load Allocations
LA/LB	Los Angeles/Long Beach
LAR	Los Angeles River
LARWQCB	Los Angeles Regional Water Quality Control Board
LAX	Los Angeles International Airport
LBC beaches	Long Beach City beaches
LSPC	Loading Simulation Program C++
MGD	million gallons per day
MOS	Margin of Safety
MOU	Memorandum of Understanding
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PLSO	Private Lateral Sewer Overflow
REC-1	Contact Water Recreation
Regional Boards	California Regional Water Quality Control Boards
SCCWRP	Southern California Coastal Water Research Project
SGR	San Gabriel River
SSO	Sanitary Sewer Overflow
SWRCB	State Water Resource Control Board
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
VGP	Vessel General Permit
WDRs	Waste Discharge Requirements
WLA	Waste load allocations
WQOs	Water Quality Objectives
WWRPs	Waste Water Reclamation Plants

1 EXECUTIVE SUMMARY

The Long Beach City Beaches (LBC beaches) were identified on the 2006 and 2010 California 303(d) list of impaired waters as requiring a Total Maximum Daily Load (TMDL) due to exceedances in concentrations of indicator bacteria (SWRCB, 2006a, 2010). In addition, a recent review of bacteria data identified an impairment of the Los Angeles River (LAR) Estuary from Willow Street, to the mouth of the estuary. These impaired segments are located in the jurisdiction of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB).

A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree approved between USEPA and several environmental groups on March 22, 1999 (Heal the Bay Inc., et al. v. Browner, et al. C 98-4825 SBA). The consent decree was revised in the spring of 2010, extending the deadline of the TMDLs to be established and adding the LBC Beach Bacteria TMDLs, among others. To meet the consent decree deadline, USEPA is establishing TMDLs for the Long Beach City Beaches and the Los Angeles River Estuary.

The LBC beaches and the LAR Estuary are contaminated by bacteria which is of great concern as it poses a potential health risk to those recreating in these water bodies. Flow from the LAR contributes significant concentrations of bacteria to the estuary and, ultimately, the LBC beaches. These TMDLs address sources in the direct drainage areas of the LAR Estuary and LBC beaches, as the Los Angeles River is addressed under a separate bacteria TMDL (LARWQCB, 2010).

To implement the single sample bacteria water quality objectives (total coliform, fecal coliform, *enterococcus*, and fecal-to-total coliform ratio) for waters designated REC-1, an allowable number of exceedance days for three seasons (summer dry, winter dry and winter wet) is set for marine waters using a reference system/antidegradation approach. This approach ensures that bacteriological water quality is at least as good as that of a reference system and that no degradation of the existing bacteriological water quality is permitted where the existing condition is better than that of the selected reference system(s). The exceedance days are used to set load allocations (LA) and waste load allocations (WLAs) in these TMDLs.

Stormwater systems covered under the City of Long Beach, Los Angeles County and Caltrans MS4 permits are assigned WLAs in the form of exceedance days. During summer dry conditions, reductions in exceedance days are estimated to be 13-120 days during a 120 day period (11% – 100% of the time), depending on the location of the monitoring site. During winter wet conditions, reductions in exceedance days are estimated to be 11-45 days during a 75-day period (15% – 60% of the time) depending on the location of the monitoring site. During winter dry conditions, reductions in exceedance days are estimated to be 0-11 days during an 80 day period (0% – 14% of the time) depending on the location of the monitoring site.

WLAs of zero (0) exceedance days are set for other permitted dischargers in the watershed (general and individual NPDES permits, statewide industrial, construction and sanitary systems permits). The TMDLs recommend monitoring, and controlling both point and nonpoint sources (e.g., beachside dog zone, marina, and a recreational vehicle park).

2 INTRODUCTION

This technical report presents the required elements of the Total Maximum Daily Loads (TMDL) developed to address elevated concentrations of indicator bacteria at the Long Beach City Beaches (LBC beaches) and the Los Angeles River (LAR) Estuary and summarizes the technical analyses performed by the United States Environmental Protection Agency (USEPA), Region IX, to develop the TMDLs. Indicator bacteria represent a risk to public health and can impair recreational beneficial uses through beach closings. Health risks associated with indicator bacteria are discussed in more detail in Section 3.2. The goal of this TMDL is to determine the amount of indicator bacteria the LBC beaches and the LAR Estuary can receive and still meet water quality standards in the receiving waters.

Because monitoring for all potential waterborne pathogens is impracticable, water quality standards have been developed for select indicator bacteria (e.g., *E. coli, enterococci,* total coliform, and fecal coliform). Concentrations of indicator bacteria are used to indicate the risk associated with the presence of fecal material and associated pathogens. Currently, recreational water quality standards are based on epidemiological studies that simultaneously measured densities of fecal indicator bacteria (FIB) and the rates of gastrointestinal illness or other adverse health effects in swimmers (Cabelli, 1983; Dufour, 1984; Haile et al., 1999).

The LBC Beaches were identified on the 2006 and 2010 California 303(d) lists as impaired due to exceedances in concentrations of indicator bacteria (SWRCB, 2006a, 2010). In addition, a recent review of bacteria data identified an impairment of the LAR Estuary from Willow Street, to the mouth of the estuary (refer to Appendix A). These impaired segments (Figure 3-1) are located in the jurisdiction of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB).

These TMDLs comply with 40 Code of Federal Regulations (CFR) 130.2 and 130.7, Section 303(d) of the Clean Water Act (CWA) and USEPA guidance for developing TMDLs in California (USEPA, 2000). Information used by USEPA to develop TMDLs for bacteria is summarized throughout this document. USEPA was assisted in this effort by the LARWQCB. Because an implementation plan is not considered a required element of a TMDL established by USEPA, these TMDLs do not include an implementation plan to achieve the waste load allocations (WLAs) and attain water quality objectives (WQOs). Alternatively, USEPA expects an implementation plan will be developed by the LARWQCB when it incorporates these TMDLs into its Water Quality Control Plan (Basin Plan).

2.1 REGULATORY BACKGROUND

Section 303(d) of the CWA requires that each State "shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality objective applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters. 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 the USEPA guidance (USEPA, 2000). 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. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (CWA 303(d)(1)(C) (USEPA, 2000).

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). USEPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. In California, the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards are responsible for preparing lists of impaired waterbodies under the 303(d) program and for preparing TMDLs, both subject to USEPA approval. If USEPA disapproves a TMDL submitted by a state, it is required to establish a TMDL for that waterbody. The California Regional Water Quality Control Boards (Regional Boards) hold regulatory authority for many of the instruments used to implement the TMDLs, such as the National Pollutant Discharge Elimination System (NPDES) permits and state-specified Waste Discharge Requirements (WDRs).

As part of its 1996 and 1998 regional water quality assessments, the LARWQCB identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree approved between USEPA and several environmental groups on March 22, 1999 (Heal the Bay Inc., et al. v. Browner, et al. C 98-4825 SBA). The consent decree was revised in the spring of 2010, extending the deadline of the TMDLs to be established, and adding the LBC Beach Bacteria TMDLs among others. Under the consent decree, USEPA must establish LBC Beach Bacteria TMDLs by March 2012. The State is unlikely to complete adoption of these TMDLs in time to meet the consent decree deadline; therefore, USEPA is establishing these TMDLs.

2.2 OVERVIEW OF TMDL APPROACH

To establish this TMDL, a reference system/antidegradation approach was used. Although somewhat unique, this method has been utilized for other bacteria TMDLs such as the Santa Monica Bay Beaches Bacteria TMDL (LARWQCB, 2002a, 2002b) and, more recently, the Los Angeles River Watershed Bacteria TMDL (LARWQCB, 2010a). The reference system/antidegradation approach permits a number of single sample exceedances, based on historical monitoring data from a local reference beach. For these TMDLs, Leo Carillo Beach is selected as the reference system since, with 98% open space and little evidence of human impact, it represents an undeveloped watershed in the region (LARWQCB, 2002a).

The reference system/antidegradation approach is appropriate for bacteria TMDLs since the approach recognizes the fact that there are natural sources of bacteria that likely contribute to elevated concentrations of bacteria. To account for natural sources, this approach allows a certain number of days (based on historical levels at a reference location) when the single sample bacteria objective may be exceeded. To ensure that anthropogenic sources of bacteria do not cause or contribute to exceedances in bacteria water quality standards, this TMDL establishes WLAs for all controllable point sources identified impacting the impaired drainages and load allocations for all identified nonpoint sources of pollution. Finally, in compliance with state and federal antidegradation policies, this method requires that if water quality is better than that of the reference system, then no degradation of existing conditions is permitted. This approach is discussed in more detail in Section 4.

2.3 ORGANIZATION OF THIS DOCUMENT

Guidance from USEPA (1991) identifies several elements of a TMDL. Sections 3 through 7 of this document are organized such that each section describes one of the elements, with the analysis and findings of these TMDLs for that element. Additionally, implementation and monitoring recommendations are provided in Section 8. TMDL sections are as follows:

- **Section 3: Problem Identification.** Describes the geographical setting and discusses the risk associated with the presence of indicator bacteria, and applicable WQOs designed to protect beneficial uses present in the impaired waterbodies.
- **Section 4: Numeric Targets.** Sets numeric targets based upon the WQOs described in the Los Angeles Regional Water Quality Control Plan (Basin Plan).
- **Section 5: Source Assessment.** Describes what is currently understood about the sources of bacteria to the LBC beaches and LAR Estuary and discusses the number and type of permitted sources located in the watersheds.
- **Section 6: Linkage Analysis.** Provides an analysis of the relationship between sources and the receiving water quality impairment. The linkage analysis addresses the critical conditions, loading, and water quality parameters.
- **Section 7: TMDLs and Pollutant Allocations.** Identifies the quantitative load of bacteria that can be delivered to LBC beaches and LAR Estuary without causing a violation of water quality standards and apportions WLAs to permittees and LAs to nonpoint sources.
- **Section 8: Implementation and Monitoring Recommendations.** Not considered a required element of a TMDL established by USEPA; contains recommendations to the State regarding implementation and monitoring for this TMDL.

3 PROBLEM IDENTIFICATION

The LBC Beaches and LAR Estuary are contaminated by fecal pollution. This section provides background information on the waterbodies and confirms their impairments through an explanation of the applicable water quality standards and waterbody-specific data analyses. Specifically, Section 3.1 provides a description of the geographical setting, Section 3.2 presents a brief summary of health risks associated with the presence of indicator bacteria, Section 3.3 identifies the water quality standards and beneficial uses, and Section 3.4 describes the water quality conditions along the impaired segments.

3.1 GEOGRAPHICAL SETTING

The LBC beaches and LAR Estuary are located within Los Angeles County in southern California. Jurisdictions draining directly to these impairments include the cities of Long Beach and Signal Hill. Other surrounding jurisdictions, such as Los Angeles County and several incorporated cities within the County, drain to the Los Angeles River (LAR) which ultimately drains to the LAR Estuary. Additionally, parts of Orange County and, specifically, the City of Seal Beach drain to the San Gabriel River (SGR), which discharges southeast of the LBC beaches. The general location of the impairments and jurisdictions within the region are shown in Figure 3-1.

Located along the shorelines of the San Pedro Bay, the LBC beaches and LAR Estuary serve as an important recreation and tourism resource for the City of Long Beach and the greater Los Angeles region. In total, the impairment of the LBC beaches affects 13 beaches and extends 4.7 miles along the coastline between the LAR Estuary and SGR Estuary. The impaired segment of the LAR Estuary includes lands draining south of Willow Street to the mouth of the estuary (note: this TMDL applies to the LAR Estuary segment as defined in the Basin Plan). The LBC beaches and LAR Estuary are further defined by hydrological unit 405.12 in the Basin Plan.

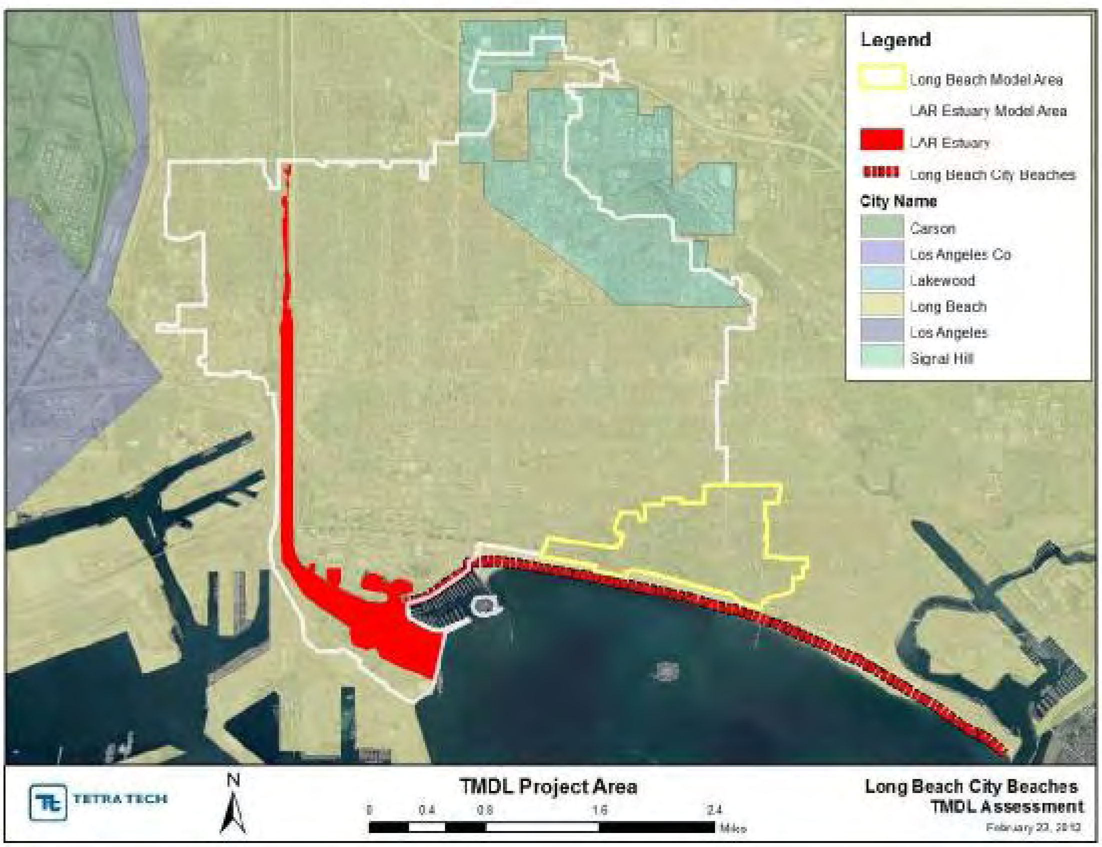

Figure 3-1. General location of the Long Beach City Beaches and Los Angeles River Estuary

3.1.1 Drainage Area Delineation

Figure 3-2 and Figure 3-4 define the drainage areas within the TMDL project area, based on detailed subwatershed boundaries provided by the County of Los Angeles and the City of Long Beach. There are two primary drainages addressed by this TMDL: referred to as the ***direct drainages***, these include the LAR Estuary direct drainage and the LBC beaches direct drainage. In addition to the direct drainages, adjacent drainages include the SGR and LAR drainages. The SGR discharges to the San Pedro Bay southeast of the impairments addressed in this TMDL. When conditions (e.g., winds from the southeast) result in currents flowing north-northwest towards the LBC beaches, the SGR may contribute bacteria concentrations to the impaired segments. More directly, the LAR drains to the LAR Estuary and directly contributes both flow and bacteria loads to the LAR Estuary and, ultimately, the LBC beaches. A TMDL was recently developed to address bacteria in the LAR watershed (LARWQCB, 2010a). However, that TMDL did not consider land draining directly to the LAR Estuary. Although implementation efforts to minimize the effects of the LAR on the LBC beaches were given highest priority and scheduled to be completed within eight years of the LAR TMDL effective date, discharges to the LAR Estuary, unless otherwise addressed, will likely continue to cause, or contribute, to impairment of the estuary itself, and the LBC beaches. Source loading potential from the rivers is discussed in Section 5.1, while the direct drainages are discussed here.

3.1.1.1 LBC Direct Drainage

The impaired stretch of recreational, open coast beach sits within the San Pedro Bay and is nestled between the LAR on the west, and Alamitos Bay and SGR to the east. As shown in Figure 3-2, only a small area drains directly to the LBC beaches; this area is referred to as the LBC beaches direct drainage. In total, this direct drainage covers an area of approximately 505 acres, and is entirely within the jurisdiction of the City of Long Beach. The LBC direct drainage is situated within a predominately residential area with an economically important commercial region centered on the shoreline and Belmont Pier (Figure 3-3). This area in particular, serves as an important recreational and tourism resource for the City of Long Beach since tens of thousands of people visit the beach during summer months.

Within the LBC beaches direct drainage, there are five sewersheds, or storm drain basins, that collect, convey and discharge stormwater and dry weather flows from these basins, to the impaired beaches. Storm drain outlets are located on the beach 100-200 feet above the water's edge. Flows from other, adjacent areas are directed away from the LBC beaches. Corresponding to discharge locations, the five storm drain basins are: Molino Avenue, Redondo Street, 9th Place, 36th Place, and West Belmont Pier. Figure 3-2 identifies each of the five sewersheds.

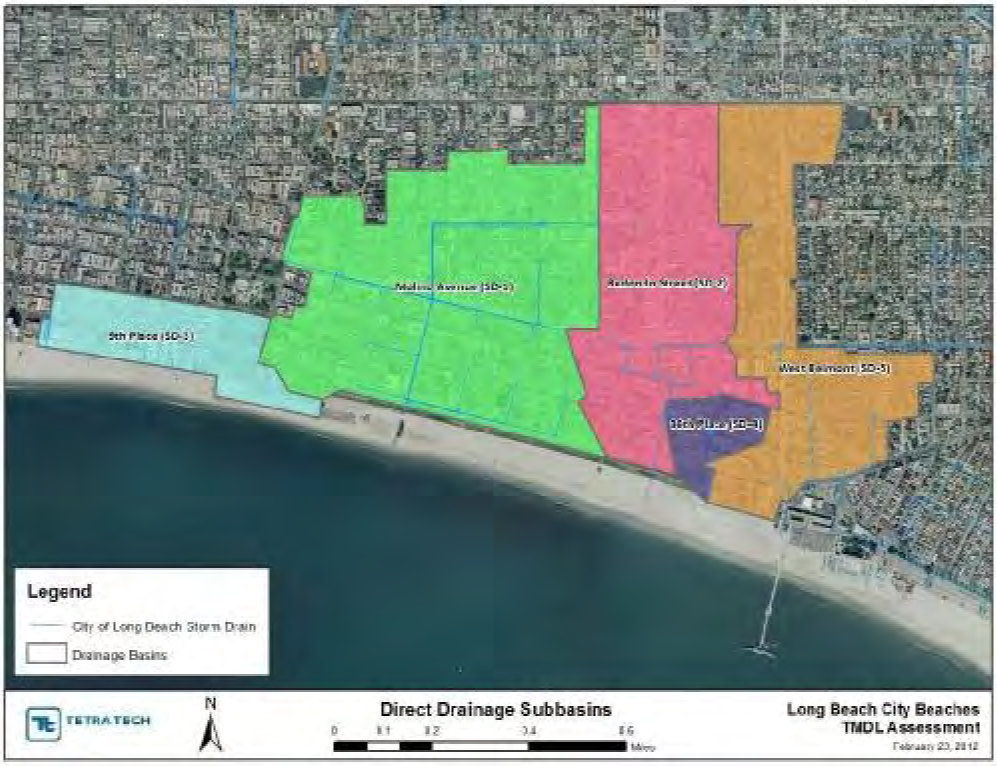

Figure 3-2. LBC beaches direct drainage delineation of storm drain basins

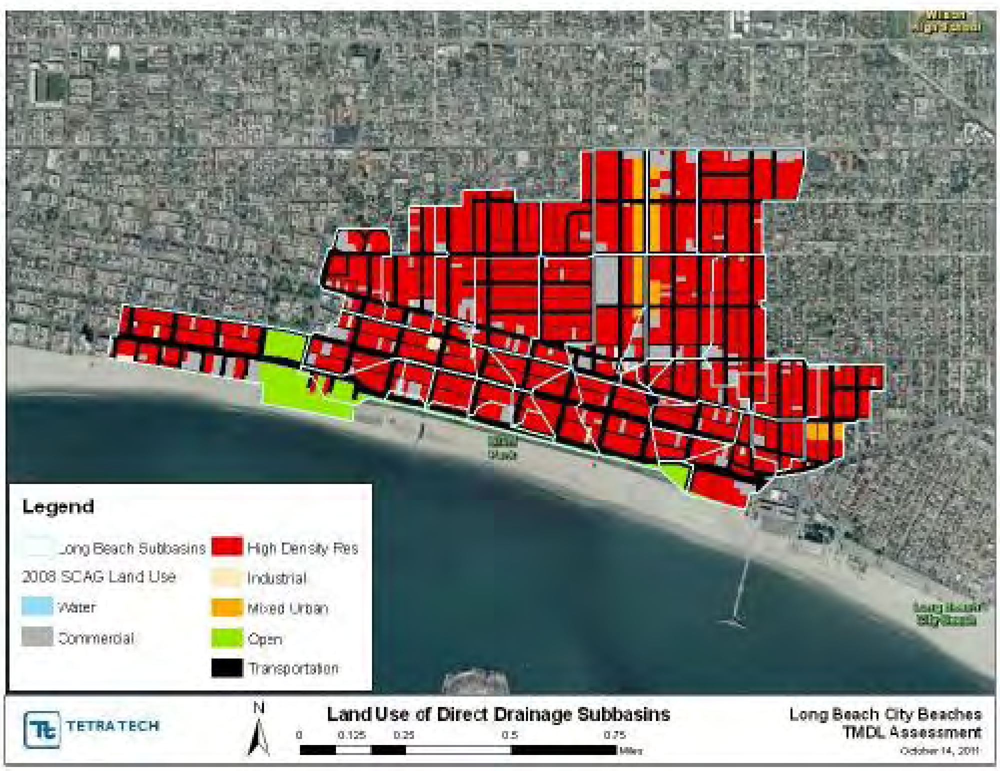

Figure 3-3. Land uses in the LBC beaches direct drainage

3.1.1.2 Los Angeles River Estuary

The LAR Estuary connects the Los Angeles River to San Pedro Bay. It begins where the concrete-lined river ends near Willow Street and flows to Queensway Bay before entering San Pedro Bay (see the Basin Plan for additional waterbody description) . Estuaries are transition zones between freshwater and salt water (including both intertidal and sub-tidal lands). Due to this diverse environment, estuaries provide habitat to a wide variety of wildlife. In the LAR Estuary, the soft bottom and rock rip-rap used to stabilize banks, offer one of the more diverse environments within the LAR system. For this reason, bird watching is a common activity in the estuary, particularly in the Golden Shore Marine Biological Reserve, located along the eastern bank of the LAR Estuary. This nine-acre reserve, developed in 1997 as mitigation for surrounding development, offers unique habitat and has been identified as one of the best bird-watching locations in the region.

During high tide, the LAR Estuary receives most of its flow from either the LAR or San Pedro Bay. A relatively small area along either bank drains directly to the LAR Estuary (approximately 6,000 acres in total land area). This area, referred to as the 'LAR Estuary direct drainage', is shown in Figure 3-4. Within this drainage, storm water is collected, conveyed, and discharged to the estuary through the MS4 system shown in Figure 3-4. MS4 jurisdictions in this area include the cities of Long Beach and Signal Hill (Figure 3-1), which encompass approximately 90 percent and 10 percent of the direct drainage area, respectively. Land use in the area is largely residential and commercial (Figure 3-5).

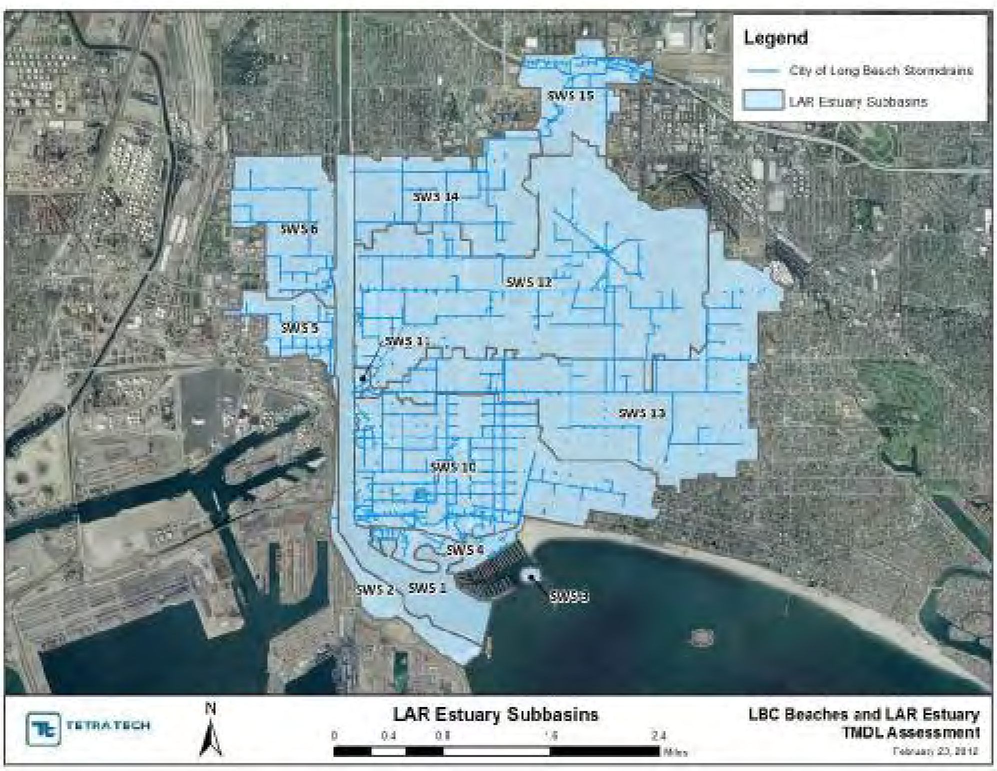

Figure 3-4. LAR Estuary direct drainage delineation of storm drain basins

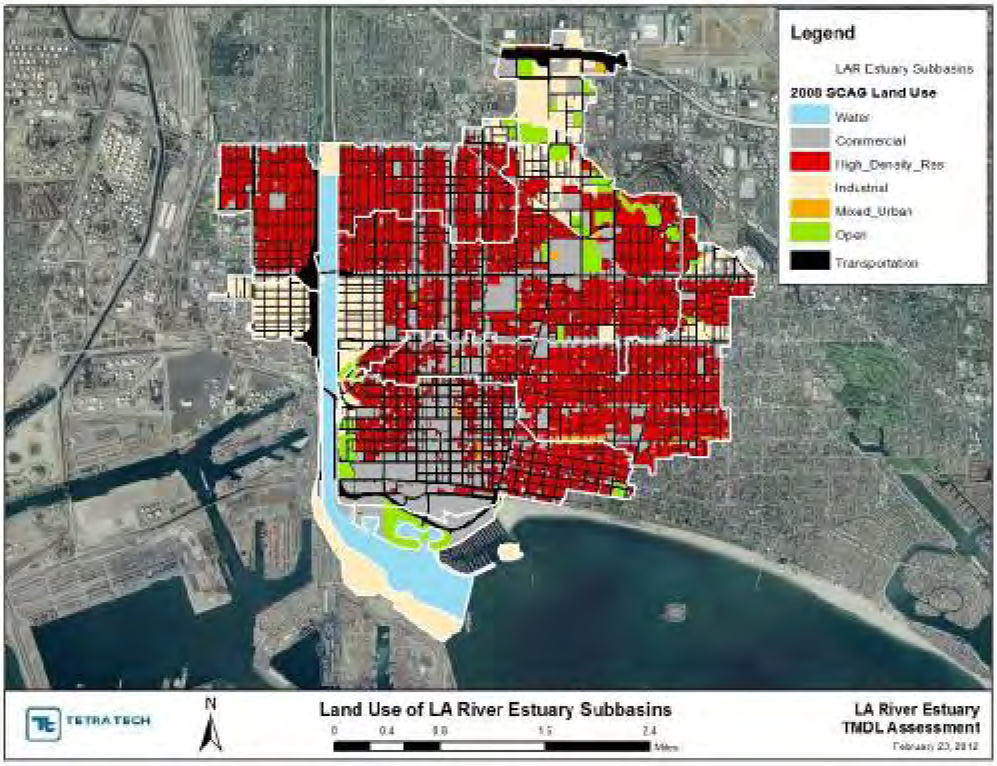

Figure 3-5. Land uses in the LAR Estuary direct drainage

The LAR Estuary is heavily impacted by the LAR, so much that large booms have been installed with the intention to collect trash before LAR flow enters the estuary. Along with the flow, it can be assumed that the LAR contributes significant concentrations of bacteria to the estuary and ultimately, the LBC beaches. Other than the LAR, sources of bacteria to the estuary include wildlife (predominately birds and waterfowl) and MS4 dischargers. Although the estuary has not been identified as impaired by the LARWQCB, it has been confirmed as impaired through data analyses (Appendix A) and is included in this TMDL as an unaddressed source of bacteria that has the potential to impact the LBC beaches.

3.1.2 Climate

The Los Angeles region has a mild, Mediterranean climate defined by three dominating weather patterns: wet weather (any day with 0.1 inches of rain or more and the following three days), winter dry (any non-wet weather day from November 1st through March 31st), and summer dry (any non-wet weather day from April 1st through October 31st). On average, fewer than 13 inches of rainfall occurs in the City of Long Beach, primarily between the months of November and March. To represent loading capacities of these seasons, this TMDL includes separate allocations for summer dry, winter dry, and wet weather conditions. This process, discussed in more detail in Section 4, is consistent with other TMDLs completed in the Los Angeles region (LARWQCB, 2002a, 2002b, 2007).

3.2 HEALTH RISKS ASSOCIATED WITH INDICATOR BACTERIA

Exposure to water contaminated with human sewage has long been associated with gastroenteritis including symptoms such as fever, vomiting, stomach pain and diarrhea and other negative health effects such as eye, ear, and skin infections, and respiratory disease. Numerous epidemiological studies investigating the association between the risk of illness and density of FIB have been conducted (Cabelli, 1983; USEPA, 1986; Haile et al., 1999; Wade et al., 2006; USEPA, 2009). It is important to note that most of these studies investigated waters impacted or influenced primarily by wastewater effluent, yet the weight of evidence indicates that FIB are able to predict gastrointestinal and respiratory illnesses (USEPA, 2009).

More recently, epidemiological studies have sought to evaluate the health risk of marine waters contaminated by urban runoff discharged from storm water outfalls. Two particular studies, the Santa Monica Bay epidemiological study and the Southern California Coastal Water Research Project (SCCWRP) epidemiological study, have been conducted along beaches in southern California. Due to their close proximity to the LBC beaches, these studies offer an indication of the risks associated with bacteria concentration in storm drain discharges to the LBC beaches. The two studies are summarized here.

The Santa Monica Bay epidemiological study was the first large epidemiological investigation to evaluate the risk associated with urban runoff rather than effluent discharged from sewage treatment plants. To do so, the study compared people swimming near storm drain discharges to other swimmers 400 yards away from the storm drain. Results from this study included a statistically significant increase in fever, chills, ear discharge, cough and phlegm, and respiratory disease in people who swam at a storm drain compared to those over 400 yards away (Haile et. al., 1999). An increased health risk was associated with increasing densities of bacteria. In conclusion, the authors indicated that there may be an increased risk of a broad range of adverse health effects associated with swimming in ocean water impacted by urban runoff (USEPA, 2009).

SCCWRP is also currently conducting a series of epidemiological studies to assess the risk in recreational waters in California with various sources of bacteria other than wastewater effluent. Preliminary results from research conducted at Dohney State Park, located south of the LBC beaches in Orange County, offers potential indication of the risks associated with water contact recreation along southern California’s beaches. Preliminary results indicate an increased chance of diarrhea with increased water contact, as well as increased incidence of skin rash, and earache with varying levels of water (or storm water) contact (Griffith, 2011).

3.3 WATER QUALITY STANDARDS

California state water quality standards consist of the following elements: 1) beneficial uses; 2) narrative and/or numeric WQOs; and 3) an antidegradation policy. In California, the Regional Boards define beneficial uses in their respective Basin Plans. Numeric and narrative objectives designed to be protective of these beneficial uses are specified in each Region’s Basin Plan, or State Water Quality Control Plans. These three elements are described below.

3.3.1 Beneficial Uses

According to the Basin Plan, beneficial uses form the cornerstone of water quality protection since, once beneficial uses are designated, appropriate WQOs can be established. The Basin Plan for the Los Angeles Regional Board (LARWQCB, 1994) defines eight existing (E) beneficial uses for the LBC beaches and one potential (P) and 12 existing (E) beneficial uses for the LAR Estuary. Loading of indicator bacteria to the impaired segments can result in impairments of these beneficial uses. Table 3-1 presents all beneficial uses.

Table 3-1. Beneficial Uses at the Long Beach City Beaches and Los Angeles River Estuary

Waterbody Name	Hydrologic Unit	Beneficial Uses[1]
Long Beach City Beaches	405.12	REC 1 (E); REC 2 (E); NAV (E); COMM (E); MAR (E); WILD (E); SPWN (Eas)[2]; SHELL (E)
Los Angeles River Estuary	405.12	IND (E); REC 1 (E); REC 2 (E); NAV (E); COMM (E); EST (E); MAR (E); WILD (E); RARE (Ee)[2]; MIGR (Ef)[2]; SPWN (Ef)[2]; SHELL (P); WET (E)

[1] Beneficial uses include: Industrial Service Supply (IND), Navigation (NAV), Contact (REC-1) and Non-contact Recreation (REC-2), Commercial and Sport Fishing (COMM), Estuarine Habitat (EST), Marine Habitat (MAR), Wildlife Habitat (WILD), Rare, Threatened, or Endangered Species Habitat (RARE), Migration of Aquatic Organisms (MIGR), Spawning, Reproduction and/or Early Development (SPWN), Shellfish Harvesting (SHELL) and Associated Wetlands (WET).

[2] Eas: Early spawning; Ee: one or more rare species utilize for foraging and/or nesting; Ef: aquatic organisms utilize for spawning and early development (including migration areas which are heavily influenced by freshwater inputs).

The bacterial impairment in the LAR Estuary and the LBC beaches is of great concern as it poses a potential health risk to those recreating in these waterbodies. The Basin Plan has designated existing contact (REC-1) and noncontact recreation (REC-2) designated uses for the LAR Estuary and LBC beaches. Specifically, the REC-1 beneficial use is designated to protect: *uses 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*. An example of a REC-1 activity is shown in Figure 3-6. In addition, the REC-2 beneficial use protects: *uses of water for recreational activities involving proximity to water, but not normally involving body contact, where ingestion of water is not reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities* (LARWQCB, 1994).

Figure 3-6. Fishing on a pier in the Golden Shore Marine Biological Preserve

3.3.2 Water Quality Objectives

As stated in the Basin Plan, WQOs are intended to protect the public health and welfare and to maintain or enhance water quality in relation to the designated existing and potential beneficial uses of the water. The Basin Plan contains bacteria water quality objectives to protect the REC-1 and REC-2 beneficial uses and the Ocean Plan also contains bacteria water quality objectives. On October 25, 2001, the LARWQCB adopted a Basin Plan Amendment updating the bacteria objectives for waters designated as REC-1 (LARWQCB, 2001). The SWRCB approved the LARWQCB's Basin Plan amendment on July 18, 2002 (State Board Resolution 2002-0142), the Office of Administrative Law approved the amendment on September 19, 2002 (OAL File No. 02-0807-01-S), and the USEPA approved the amendment on September 25, 2002. The amended objectives include geometric mean limits and single sample bacteria indicator limits: including total coliform, fecal coliform, the fecal-to-total coliform ratio, and *enterococcus*.

The Ocean Plan's standards for "Water-Contact" are: "within a zone bounded by the shoreline and a distance 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline and in areas outside this zone used for water contact sports, as determined by the Regional Board (i.e., waters designated as REC-1) but including all kelp beds, the following bacteria objects shall be maintained throughout the water column…"

The 2005 Ocean Plan (SWRCB, 2005) mirrors the Basin Plan water quality objectives (LARWQCB, 2001). These objectives are the same as those contained in state regulations (17 CCR §7958) implementing state Assembly Bill No. 411 (1997), which relied upon the Santa Monica Bay epidemiological study (see Section 1.3.1). AB411 resulted in changes to Department of Health and Safety regulations for public beaches and public water contact sports areas. These changes included (1) setting minimum protective bacteriological standards for waters adjacent to public beaches and public water contact sports areas based on four bacteria indicators (total coliform, fecal coliform, *enterococcus*, and fecal-to-total coliform ratio) and (2) altering the requirements for monitoring, posting, and closing certain coastal beaches based on these four single sample bacteria indicator limits. The objectives are also consistent with, but augment, USEPA guidance (1986), which recommends the use of *enterococcus* in marine water based on national epidemiological studies (LARWQCB, 2001; Cabelli, 1983).

An update to bacteria objectives for freshwaters designated for water contact recreation was provided in the Basin Plan Amendment-Resolution No. R10-005 (LARWQCB, 2010b). This resolution removed redundancy in sampling and selected *Escherichia coli* (*E. coli*) as the sole indicator bacteria for freshwater. Both marine and freshwater Basin Plan WQOs are shown in Table 3-2. It should be noted that all four indicator bacteria are used in analyses throughout this report. In most cases, the selection of the appropriate indicator bacteria is associated with the type of waterbody being assessed. Specifically, discussion of beach or marine water conditions focus on *enterococcus* (and, to a lesser extent, fecal coliform and total coliform), while freshwater characterization or loading analyses are based on *E. coli*. While concentrations of the different indicator bacteria are not necessarily directly comparable, it is assumed their sources are similar.

The REC-1 bacteria objectives also state that "[t]he geometric mean values should be calculated based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period)" (LARWQCB, 2001). Single sample bacteria exceedances are used to determine impairments. This method is practical and appropriate in issuing warnings and postings. 30-day rolling geometric mean limits are also used to determine impairments. Protecting REC-1 beneficial uses will result in the protection of REC-2 beneficial uses because REC-1 bacteria objectives are more stringent than REC-2 bacteria objectives.

Table 3-2. Water Quality Objectives Established for the Long Beach City Beaches and LAR Estuary

Water Quality Objectives	Marine REC-1	Freshwater REC-1
Single Sample		
E. coli	N/A	235 CFU/100 mL
Fecal coliform	400 CFU/100 mL	N/A
Enterococcus	104 CFU/100 mL	N/A
Total coliform*	10,000/100 mL	N/A
30-day Geometric Mean		
E. coli	N/A	126 CFU/100 mL
Fecal coliform	200 CFU/100 mL	N/A
Enterococcus	35 CFU/100 mL	N/A
Total coliform	1,000 CFU/100 mL	N/A

*Total coliform shall not exceed 1,000/100 mL, if the ratio of fecal to total coliform exceeds 0.1 (this is an additional single sample limit for REC-1 marine waters; presented in the Basin Plan).
N/A: not applicable

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

"The geometric mean values should be calculated based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period).

If any of the single sample limits are exceeded, the Regional Board may require repeat sampling on a daily basis until the sample falls below the single sample limit or for five days, whichever is less, in order to determine the persistence of the exceedance.

When repeat sampling is required because of an exceedance of any one single sample limit, values from all samples collected during that 30-day period will be used to calculate the geometric mean."

In addition, implementation provisions for the water contact recreational bacteria objectives associated with Basin Plan Resolution 2002-22 are as follows (LARWQCB, 2001):

"The single sample of bacteriological objectives shall be strictly applied except when provided for in a TMDL. In all circumstances, including the context of a TMDL, the geometric mean objectives shall be strictly applied. In the context of a TMDL, the Regional Board may implement the single sample objectives in fresh and marine waters by using a 'reference system/antidegradation approach' or 'natural sources exclusion' approach subject to the antidegradation polices as discussed below. A reference system is define as an area and associated monitoring point that is not impacted by human activities that potentially affect bacteria densities in the receiving water body.

These approaches recognize that there are natural sources of bacteria, which may cause or contribute to exceedances of the single sample objectives for bacterial indicators. They also acknowledge that it is not the intent of the Regional Board to require treatment or diversion of natural water bodies or to require treatment of natural sources of bacteria from undeveloped areas. Such requirements, if imposed by the Regional Board, could adversely affect the valuable aquatic life and wildlife beneficial uses supported by natural water bodies in the Region.

Under the reference system/antidegradation implementation procedure, a certain frequency of exceedance of the single sample objectives shall be permitted on the basis of the observed exceedance frequency in the selected reference system(s) or the targeted water body. The reference system/antidegradation approach ensures that bacteriological water quality is at least as good as that of a reference system and that no degradation of the existing bacteriological water quality is permitted where existing bacteriological water quality is better than that of the selected reference system(s).

Under the natural sources exclusion implementation procedure, after all anthropogenic sources of bacteria have been controlled such that they do not cause or contribute to an exceedance of the single sample objectives and natural sources have been identified and quantified, a certain frequency of exceedance of the single sample objectives shall be permitted based on the residual exceedance frequency in the specific water body. The residual exceedance frequency shall define the background level of exceedance due to natural sources. The ‘natural sources exclusion approach subject to the antidegradation policies may be used if an appropriate reference system cannot be identified due to unique characteristics of the target water body. These approaches are consistent with the State antidegradation requirements (State Board Resolution No. 68-16) and with federal antidegradation requirements (40 CFR 131.12).”

3.3.3 Antidegradation

Both the State of California and the federal government have antidegradation policies for water quality. State Board Resolution 68-16, “Statement of Policy with Respect to Maintaining High Quality Water in California,” known as the "Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12). The proposed TMDLs will not degrade water quality, and will in fact improve water quality by not setting any wasteload allocations and load allocations above existing numbers of exceedance days.

3.4 OVERVIEW OF CONDITIONS IN IMPAIRED DRAINAGES

As discussed in Section 3.1.1 (and illustrated in Figure 3-2 and Figure 3-4), two primary drainage areas are considered in these TMDLs, the LBC beaches direct drainage and the LAR Estuary direct drainage. Available water quality data were compiled and analyzed during the early stages of TMDL development. Three primary datasets (shown in Table 3-3) were used to evaluate general trends, extent of impairment, and to identify potential sources of bacteria (discussed in further detail in Section 5). A summary of findings is included below for both impaired segments, while a full analysis of data is included in Appendix A.

Table 3-3. Data Sources Used to Evaluate Trends and Extent of Impairment

Data Source	Available Data
City of Long Beach	Routine weekly monitoring conducted at select locations along the LBC beaches during dry and wet weather (2000 - 2010 data).
City of Long Beach and Kinnetic Laboratories Inc.	Microbial source tracking (MST) conducted in 2008-2009, including dry weather storm drain outfall monitoring and analysis of 24-hour and 30-day bacteria concentrations and flow (e.g., fecal coliform, total coliform, *enterococci*, and *E. coli*) and salinity levels. Concentrations of *Bacteroidales* were also monitored during both high and low tide.
Council for Watershed Health	Routine monitoring conducted several days per week at a single location in the LAR Estuary from May to September (2009-2010 data) for total coliform, *E. coli*, and *enterococci*.

3.4.1 LBC Beaches Data Review and Overview of Conditions

Analysis of weekly beach monitoring conducted by the City of Long Beach identified spatial and temporal trends of impairment. Spatially, monitoring sites located closer to the Los Angeles River and Estuary generally had higher bacteria (*enterococcus*, fecal coliform and total coliform) geometric means compared to monitoring sites farther from the Los Angeles River and Estuary. Temporally, wet months of September through February were found to have higher geometric means when compared to March through October, suggesting that rainfall-runoff contributes significant concentrations of bacteria to the LBC beaches. Exceedance rates ranged from 36 to 81 percent during wet weather periods, 6 to 23 percent during summer dry periods, and 6 to 25 percent during winter dry periods when compared to the single sample maximum WQOs. Appendix A includes a detailed review of the weekly monitoring data and Figure 3-7 illustrates the spatial distribution of *enterococcus* geometric mean exceedances along the LBC beaches.

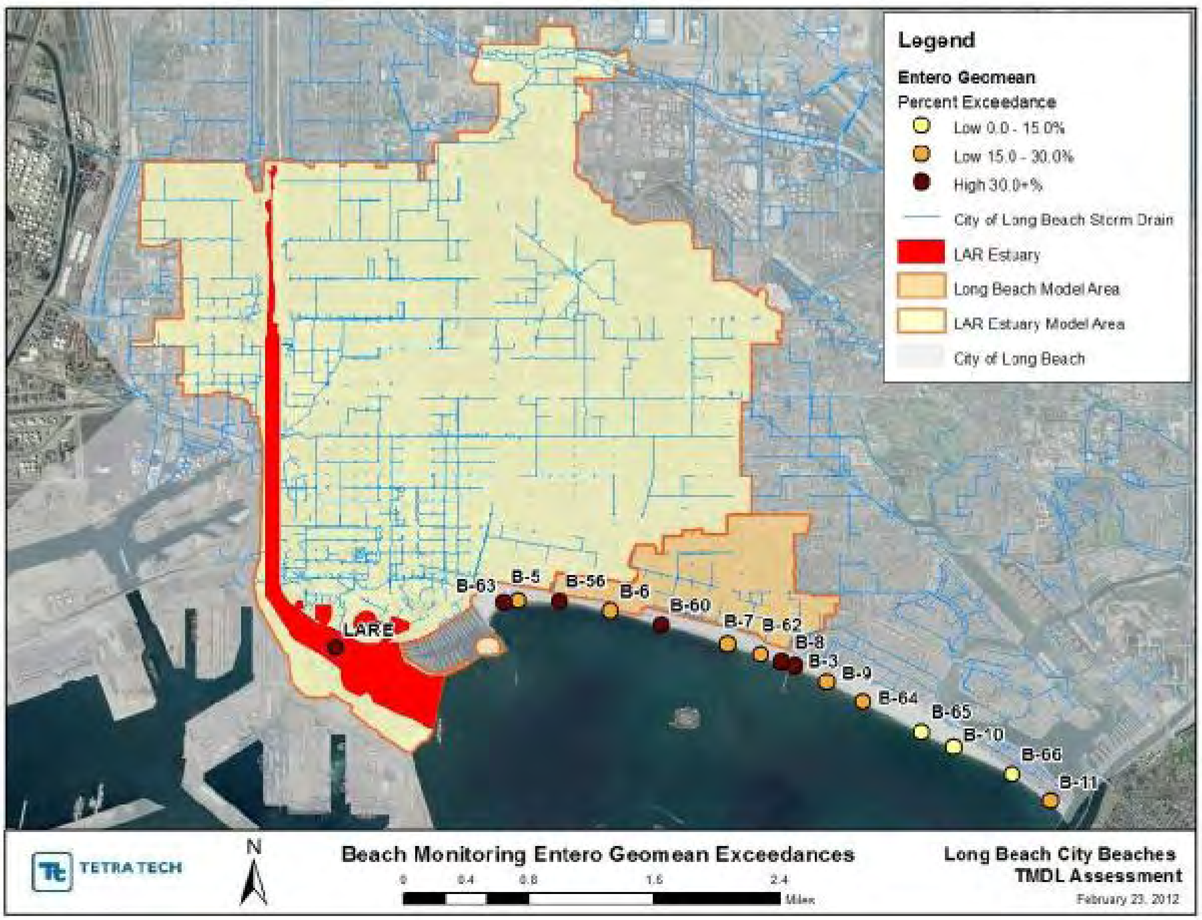

Figure 3-7. *Enterococcus* exceedances of the geometric mean standard at beach monitoring stations

A microbial source tracking (MST) study conducted by the City of Long Beach, in collaboration with Kinnetic Laboratories Inc., also identified a general spatial trend with monitoring locations closer to the Los Angeles River being more impacted by FIB compared to those sites farther east (southeast). Additionally, concentrations of *E. coli* within storm drains ranged from approximately 1,300 CFU/100 mL to nearly 9,000 CFU/100 mL and concentrations of *E. coli* measured in ponding water in front of the Molino storm drain were roughly ten times higher than water coming directly out of the storm drain, likely due to bird activity (City of Long Beach, 2009). Furthermore, *E. coli* geometric means were elevated at beach locations near major storm drains (these results are generally corroborated by the data analyses on other bacteria types presented in Appendix A). As part of the MST study, sampling included the analysis of trends over a 24-hour period. Through decreased levels of salinity, this investigation confirmed freshwater intrusion from the Los Angeles River, to select locations along the LBC beaches. In comparison to the eastern sites, a trend of decreasing salinity was seen in the western-most sampling locations. Finally, the MST study included screening for *Bacteriodales* during both high and low tide conditions; however, neither of the two initial water quality surveys showed evidence of human, dog, or cow markers. It should be noted that screening for *Bacteriodales* corresponded with conditions of high salinity, suggesting that the contribution of Los Angeles River was minimal during this specific study period (City of Long Beach, 2009).

3.4.2 LAR Estuary Data Review and Overview of Conditions

Bi-weekly (or more frequent) data for the LAR Estuary were provided for May – September in 2009 and 2010 by the Council for Watershed Health. These data represented a single monitoring location, near the lower end of the estuary. This site represents the overall contribution of bacteria from the watershed and is not within a recreational swimming area; however, the LAR Estuary does have a REC-1 beneficial use. All sampling was conducted during the summer dry period and had a 57 percent exceedance probability based on the single sample maximum WQOs. The total coliform geometric mean WQO was exceeded 100 percent of the time, while the *enterococcus* geometric mean WQO exceedance rate was 31 percent. Data were also provided for *E. coli*, which is the basis of the freshwater WQO. Even though the marine WQOs apply to the LAR Estuary, the *E. coli* data were compared to the freshwater WQO for comparison. The geometric mean *E. coli* WQO was exceeded 28 percent of the time while the single sample maximum WQO was exceeded by 16 percent of the samples. Given the limited spatial and seasonal representation of available data, trend analyses were not possible. Many storm drains contribute directly to the LAR estuary; however, flow from the LAR itself is the primary source of loading to the estuary.

4 NUMERIC TARGETS

These TMDLs include several numeric targets based on the Basin Plan bacteria objectives for marine waters designated for water contact recreation (REC-1) (LARWQCB, 2001). The objectives include geometric mean and single sample limits for indicator bacteria including fecal coliform, *Enterococcus*, and total coliform in marine waters. Both single sample and geometric mean targets apply.

The numeric targets for the Long Beach City Beaches and the LAR Estuary are the same as the adopted Basin Plan objectives for REC-1 in marine waters. All applicable numeric targets are contained in Table 3-1. These objectives are the same as those specified in the California Code of Regulations, Title 17, Section 7958 “Bacteriological Standards” and consistent with those recommended by the USEPA in “Ambient Water Quality for Bacteria – 1986” (USEPA, 1986).

Table 4-1. TMDL Numeric Targets

Water Quality Objectives	Marine REC-1
Single Sample	
E. coli	N/A
Fecal coliform	400 CFU/100 mL
Enterococcus	104 CFU/100 mL
Total coliform*	10,000/100 mL
Rolling 30-day Geometric Mean	
E. coli	N/A
Fecal coliform	200 CFU/100 mL
Enterococcus	35 CFU/100 mL
Total coliform	1,000 CFU/100 mL

*Total coliform shall not exceed 1,000/100 mL, if the ratio of fecal to total coliform exceeds 0.1 (this is an additional single sample limit for REC-1 marine waters; presented in the Basin Plan).
N/A: not applicable

For the TMDL, USEPA recommends the numeric targets apply to existing monitoring sites as well as any new monitoring locations in the ambient water. For the estuary, USEPA recommends the numeric targets apply in the ambient water. These targets should apply during both dry and wet-weather since there is water contact recreation throughout the year.

4.1 IMPLEMENTATION OF THE NUMERIC TARGETS

To implement the single sample bacteria objectives for waters designated REC-1, and to set allocations based on the single sample targets, an allowable number of exceedance days is set for marine waters. See Section 6 for exceedance day calculations. The numeric targets in the TMDLs are translated to ‘allowable exceedance days’ since bacterial density and the frequency of 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 single sample maximum 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 treat natural sources of bacteria from undeveloped areas. This approach, including the allowable exceedance levels during dry weather and wet weather, is consistent with that used in other bacteria TMDLs previously approved in this region. The geometric mean targets, which are based on a 30- day period, must be strictly adhered to and may not be exceeded at any time.

4.2 CONSIDERATION OF OTHER ALTERNATIVES

Consistent with other bacteria TMDLs previously approved in this region, the exceedance day approach is one of three alternatives considered for setting allocations to achieve the water quality standards. Some of these alternatives recognize that there are natural sources of bacteria, which may cause or contribute to exceedances of the water quality objectives for bacteria indicators (Schiff *et al.*, 2005). The Regional Board acknowledges in the implementation provisions for the bacteria objectives in the Basin Plan that it is not the intention of the Regional Board to require treatment or diversion of natural water bodies or to require treatment of natural sources of bacteria from undeveloped areas.

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

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

For this TMDL, we chose alternative (3), the exceedance day approach. Alternative (3) is the recommended alternative because this alternative allows the Regional Board to avoid imposing requirements to divert natural coastal creeks or treat natural sources of bacteria from undeveloped areas. This approach includes allowable exceedance levels during dry weather and wet weather. This approach will be explored in greater detail in latter parts of the TMDL. The number of allowable exceedance days is calculated from reference reaches while observing strict antidegradation policies. Targets will apply at compliance monitoring locations (17 CCR §7961(b)).

5 SOURCE ASSESSMENT

The objective of the source assessment is to identify potential sources of bacteria to the impaired waterbodies. Generally, sources of bacteria are consistent during both wet and dry weather conditions; however, transport mechanisms vary between the two conditions. For example, bacteria deposited on surfaces can accumulate during dry weather, but during runoff events (e.g. rainfall events or due to irrigation overspray), bacteria can wash from surfaces and ultimately into receiving waters. Pollutants can enter surface waters from both point and nonpoint sources. Point sources include discharges from a discrete human-engineered outfall. These discharges are regulated through NPDES permits. Nonpoint sources, by definition, include pollutants that reach surface waters from a number of diffuse land uses and activities that are not regulated through

NPDES permits. In Los Angeles County, urban runoff is regulated through stormwater NPDES permits and, since it is collected, conveyed and discharged through the municipal separate storm sewer system (MS4), urban runoff is considered point source pollution.

To assist with the source assessment, a regional hydrodynamic computer model, originally developed for the Los Angeles/Long Beach Harbor TMDLs (LARWQCB, 2011), was used to evaluate regional sources of freshwater (and pollutants) to the LBC beaches. This model was used to identify conditions during which nearby waterbodies have the potential to impact the impaired LBC beaches. The regional modeling analysis of adjacent watersheds is presented below, followed by a discussion of local sources of bacteria to the LBC beaches and the LAR Estuary, including an identification of point and nonpoint sources located in the direct drainage areas.

5.1 REGIONAL ANALYSIS OF ADJACENT DRAINAGES

Due to its close proximity, the LBC beaches have the potential to be impacted by other waterbodies discharging to the San Pedro Bay. Specifically, the SGR, LAR, and Alamitos Bay watersheds (collectively termed '*adjacent drainages'*) discharge not directly to, but in close proximity to, the LBC beaches, as does the LAR Estuary direct drainage (Figure 5-1 [note: Alamitos Bay watershed is located within the nearshore watershed on this map; the nearshore watershed also includes the LBC beaches and LAR Estuary direct drainages]). To evaluate this potential relationship, recent modeling efforts associated with the Los Angeles/Long Beach (LA/LB) Harbors toxics TMDLs (Tetra Tech, 2011; LARWQCB, 2011) were used to evaluate conditions in the receiving waters near the LBC beaches. Specifically, the receiving water hydrodynamics including freshwater inflows were simulated and bacteria concentrations were qualitatively evaluated to identify regional sources of bacteria to the LBC beaches for TMDL source assessment. This analysis provided an important tool in determining the conditions during which the LAR and SGR watersheds could potentially contribute bacteria loadings to the LBC beaches.

The model used in this TMDL source assessment effort was originally developed and calibrated for the LA/LB Harbor toxics TMDLs (LARWQCB, 2011) using the Environmental Fluids Dynamic Code (EFDC) (Hamrick, 1992; Hamrick and Wu; 1997; Park et al., 1995). EFDC is a general purpose modeling package for simulating one-, two-, and three-dimensional flow, transport, and bio-geochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and coastal regions. EFDC has been used extensively to support TMDL development throughout the country and it is capable of simulating hydrodynamics as well as pollutant fate and transport for bacteria as well as many other pollutants. The LA/LB Harbors model was calibrated for hydrodynamics, but not bacteria. To support these bacteria TMDLs, bacteria were added to the model using concentrations from recent monitoring by the County of Los Angeles, Department of Public Works. The purpose was to qualitatively simulate water circulation and the fate and transport of bacteria from the rivers to the beaches and identify conditions during which loads from the major rivers are influencing bacteria water quality at the LBC beaches. This process is described in more detail in Appendix D.

Figure 5-1. Watersheds draining to the Los Angeles/Long Beach Harbors and San Pedro Bay
(note: impaired LBC beaches and LAR Estuary segments shown in red)

5.1.1 Los Angeles River

Located west of the LBC direct drainage and immediately upstream of the LAR Estuary direct drainage, the LAR watershed (over 800 square miles) is a potential source of bacteria to the impaired beaches and is most certainly a source of loading to the LAR Estuary. EFDC model output was evaluated for the three different TMDL seasons (both maximum and average conditions were reviewed for the wet weather season). These results suggest that loading from the LAR passes through the LAR Estuary and can reach the LBC beaches during wet weather events (especially extremely large events), depending on wind and tidal influences (Appendix D). Figure 5-2 illustrates the extent of *enterococcus* loading from the LAR and SGR/Alamitos Bay watersheds during the maximum wet weather event, including the surface concentrations along the LBC beaches. The red and orange shades have the highest concentrations. During the maximum wet weather event, the concentrations from the LAR were high and they ultimately reached the western LBC beaches with little dilution. The dry weather model results indicate that LAR bacteria concentrations during summer- and winter-dry weather conditions are relatively small and do not appear to reach the impaired beach segment. The model was not calibrated for bacteria, consequently there is uncertainty associated with the interpretation of these results which were based on a visual evaluation of the continuous simulation periods. See Appendix D for further description of the modeling results.

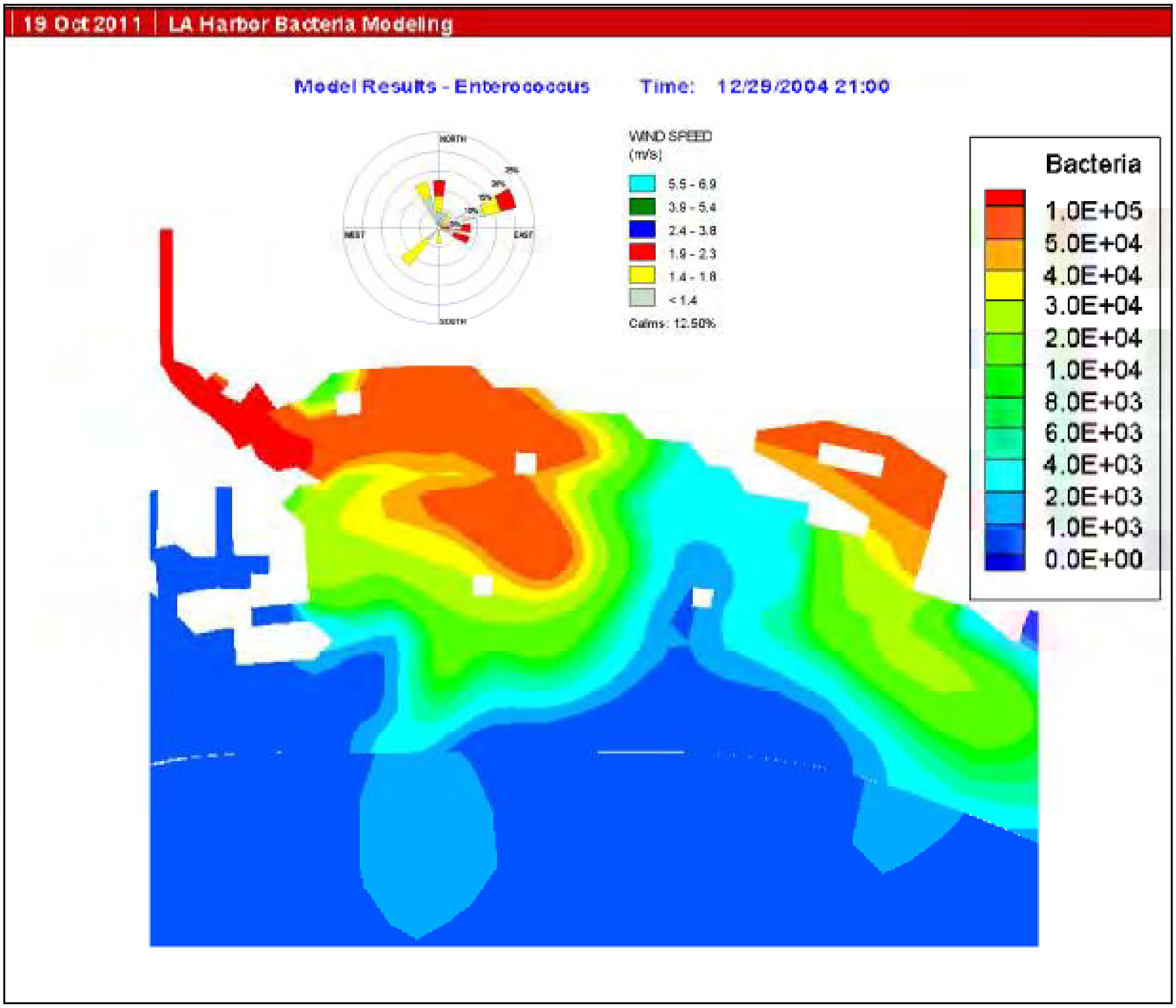

Figure 5-2. Simulated *enterococcus* concentration (MPN/100mL) during maximum wet weather event

A TMDL was recently developed for the LAR watershed to address elevated concentrations of indicator bacteria (LARWQCB, 2010a). In the LAR watershed bacteria TMDL, the potential impact by the LAR to the LBC beaches was acknowledged (note: this corroborates information presented in the City of Long Beach source tracking study [2009]) and implementation efforts to minimize its impact on the LBC beaches were given highest priority for TMDL implementation. Significantly improved water quality is expected at the LBC beaches well before the complete implementation of the LAR TMDL since implementation efforts identified to have positive impacts on the LBC beaches are scheduled to be completed within eight years of the effective Los Angeles River TMDL date (LARWQCB, 2010a). These implementation efforts are also expected to improve water quality in the LAR Estuary.

5.1.2 San Gabriel River and Alamitos Bay

The San Gabriel River discharges to the southeast of the impaired beaches and drains a watershed of nearly 500 square miles. The Alamitos Bay watershed is a relatively small drainage of approximately 30 square miles located in between the LAR and SGR watersheds (to the northwest and east, respectively), east of the LAR Estuary direct drainage, and due north of the LBC direct drainage. This watershed ultimately drains to Alamitos Bay. Alamitos Bay and the SGR Estuary discharges are adjacent to one another and are located southeast of the impaired beaches. A breakwater separates the LBC beaches from the Alamitos Bay and SGR Estuary mouths (which are located on the east side of the breakwater; Figure 5-3). Alamitos Bay and the SGR Estuary are both currently listed as impaired by indicator bacteria.

Based on the EFDC modeling results, the breakwater is shown to direct flow to the southeast, away from the LBC beaches during both summer- and winter-dry weather conditions. Even during wet weather events, the majority of the loading from the SGR Estuary and Alamitos Bay move towards the east and away from the LBC beaches. However, during extremely high flow events, especially if the wind and tidal influences are pushing towards the west and north, the loads from the SGR Estuary and Alamitos Bay may reach the eastern portion of the LBC beaches, thereby potentially contributing to the impairment. These results are discussed in more detail in Appendix D.

Figure 5-3. Breakwater and Long Beach Shoreline Marina

5.2 IDENTIFICATION OF SOURCES IN THE DIRECT DRAINAGES

A number of point and nonpoint sources have the potential to contribute bacterial loading to the impaired drainage areas. Point sources typically discharge at a specific location from pipes, outfalls, and conveyance channels (e.g., wastewater treatment plants or Municipal Separate Storm Sewer System (MS4s)). Point discharges into surface waters are regulated by the LARWQCB or SWRCB through WDRs which implement federal NPDES requirements. Nonpoint sources on the other hand are diffuse sources such as park lands or open space that have multiple routes of entry into surface waters (i.e., not through the MS4).

Specific point sources potentially impacting the impaired drainage areas include: Phase II MS4s, Caltrans MS4 facilities, facilities operating under the Statewide General Industrial and Construction Stormwater Permits, and vessel discharges. Nonpoint sources may include: a beachside dog zone, waterfowl, re-growth and re-suspension, a marina and other human sources. Each of these sources is discussed in more detail in this section.

5.2.1 Point Sources

Point source pollution is defined by the Federal CWA § 502(14) as: *any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged*.

Within the LBC beaches and LAR Estuary direct drainages, NPDES permits include MS4 permits (for the County of Los Angeles and the City of Long Beach), the California Department of Transportation (Caltrans) stormwater permit, general construction stormwater permits, general industrial stormwater permits and general NPDES permits (Table 5-1). The locations of discharges authorized under the general construction stormwater, general industrial stormwater, and general NPDES permits are shown in Figure 5-4. In addition, the Vessel General Permit (VGP) applies to certain boats that may be present in and near the impaired waters. Each point source is summarized below.

Table 5-1. NPDES Permits Located in the Direct Drainages to the LBC beaches and LAR Estuary

Type of NPDES Permit	Number of Permits	
	LBC Beaches Direct Drainage	LAR Estuary Direct Drainage
Municipal Stormwater	1	2
California Department of Transportation Stormwater	0	1
General Construction Stormwater	1	23
General Industrial Stormwater	0	20
Individual NPDES Permits (Minor)	0	0
General NPDES Permits	0	3
Vessel General Permit	1	1
Total	**3**	**50**

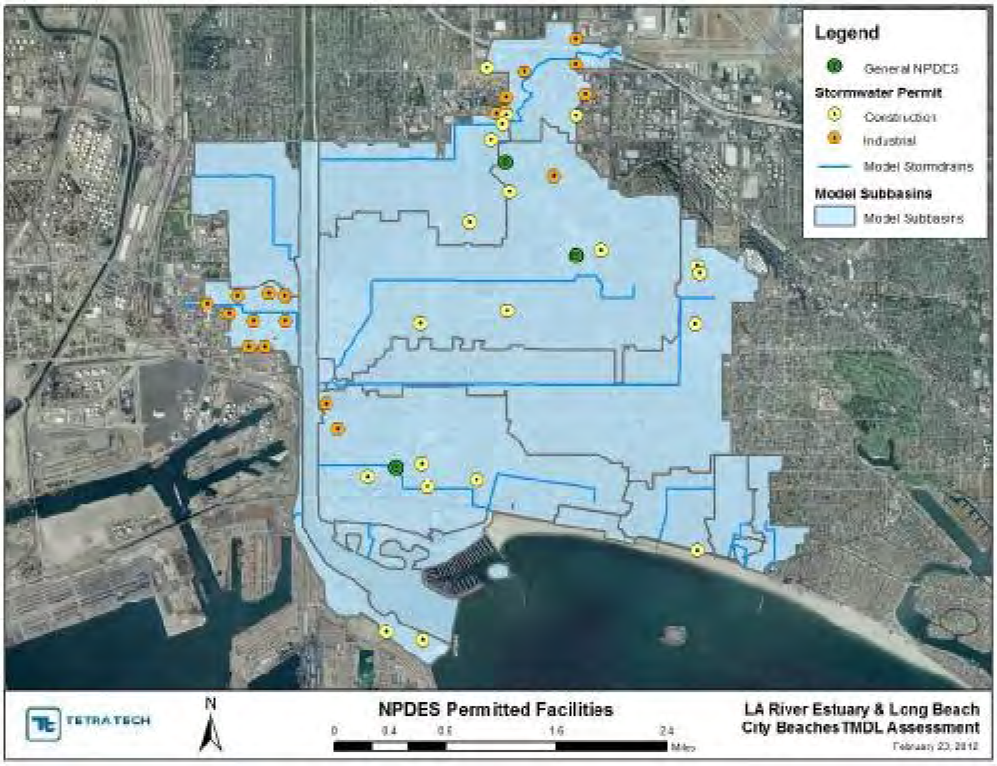

Figure 5-4. Map of point sources in the LBC beaches and LAR Estuary direct drainages

5.2.1.1 Stormwater Permits

Stormwater runoff in the direct drainages is regulated through the City of Long Beach MS4 permit, the Los Angeles County MS4 permit, the statewide stormwater permit issued to Caltrans, the statewide Construction Activities Stormwater General Permit, and the statewide Industrial Activities Stormwater General Permit. Additionally, the Los Angeles County MS4 permit regulates stormwater runoff in areas that surround the City of Long Beach and drain to either the Los Angeles or San Gabriel Rivers. The permitting process defines these discharges as point sources because the stormwater discharges from the end of a stormwater conveyance system (see Figure 5-5 for images of storm drains discharging near the LBC beaches). Since the industrial and construction stormwater discharges are enrolled under NPDES permits, these discharges are treated as point sources in these TMDLs.

Figure 5-5. Images of storm drains between South 5th Place and South 16th Place on Long Beach City Beaches from November 13, 2011

5.2.1.1.1 MS4 Stormwater Permits

In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent pollutants from being washed by stormwater runoff into MS4s (or from being discharged directly into the MS4s) and then discharged into local waterbodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a stormwater management program as a means to control polluted discharges.

Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipally owned operations, and hazardous waste treatment. Large and medium MS4 operators are required to develop and implement Stormwater Management Plans that address, at a minimum, the following elements:

- Structural control maintenance
- Areas of significant development or redevelopment
- Roadway runoff management
- Flood control related to water quality issues
- Municipally owned operations such as landfills, and wastewater treatment plants
- Municipally owned hazardous waste treatment, storage, or disposal sites

- Application of pesticides, herbicides, and fertilizers
- Illicit discharge detection and elimination
- Regulation of sites classified as associated with industrial activity
- Construction site and post-construction site runoff control
- Public education and outreach

City of Long Beach MS4 permit was revised on June 30, 1999 as Order No. R4-99-060 and is on a five-year renewal cycle. It solely covers the City of Long Beach and, therefore, all stormwater discharged within the LBC beaches direct drainage and much of the area draining to the LAR Estuary direct drainage. Additionally, the Los Angeles County MS4 Permit was renewed in December 2001 (Regional Board Order No. 01-182) and is on a five-year renewal cycle. There are 85 co-permittees covered under this permit, including 84 incorporated cities and the County of Los Angeles. The Los Angeles County MS4 permit applies to stormwater discharged within the LAR Estuary direct drainage from the City of Signal Hill.

5.2.1.1.2 Caltrans Stormwater Permit

Caltrans is regulated by a statewide stormwater discharge permit that covers all municipal stormwater activities and construction activities (State Board Order No. 99-06-DWQ). The Caltrans stormwater permit authorizes stormwater discharges from Caltrans properties such as the state highway system, park and ride facilities, and maintenance yards. Caltrans has jurisdiction of some areas in the LAR Estuary direct drainage, but not in the LBC beaches direct drainage.

The stormwater discharges from most of these Caltrans properties and facilities eventually end up in either a city or county storm drain. The loading of bacteria specifically from Caltrans properties have not been determined in the LAR Estuary direct drainage. However, USEPA can estimate the quantity of acres covered by state highways in the drainage. A conservative estimate is 128 acres, or approximately two percent of the LAR Estuary drainage area. This area represents Caltrans' right-of-way that drains to the impaired areas subject to these TMDLs. This percentage does not represent all of the areas that Caltrans is responsible for under its stormwater permit. For example, park and ride facilities and maintenance yards were not included in the estimate; however, none of these facilities have been identified in the direct drainages using the GIS layers available from Caltrans.

5.2.1.1.3 General Stormwater Permits

In 1990, USEPA issued regulations for controlling pollutants in stormwater discharges from industrial sites (40 Code of Federal Regulations [CFR] Parts 122, 123, and 124) equal to or greater than five acres. The regulations require dischargers of stormwater associated with industrial activity to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) to reduce or prevent non-conventional and conventional pollutants in stormwater discharges and authorized non-storm discharges. On December 8, 1999, USEPA expanded the NPDES program to include stormwater discharges from construction sites that resulted in land disturbances equal to or greater than one acre (40 CFR Parts 122, 123, and 124).

On April 17, 1997, State Board issued a statewide general NPDES permit for Discharges of Stormwater Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ). This Order regulates stormwater discharges and authorized non-stormwater discharges from ten specific categories of industrial facilities, including but not limited to, manufacturing facilities, oil and gas mining facilities, landfills, and transportation facilities. As of the writing of these TMDLs, there are 20 dischargers enrolled under the general industrial stormwater permit within the direct drainages (all drain to the LAR Estuary; Figure 5-4). Potential pollutants from an industrial site will depend on the type of facility and operations that take place at that facility; however, industrial facilities are generally not expected to be significant sources of bacteria.

During wet weather, runoff from industrial sites has increased potential to contribute pollutant loadings to the impaired areas. During dry weather, the potential contribution of bacteria loadings from industrial stormwater is low since non-stormwater discharges are prohibited or authorized by the permit only under the following circumstances: when they do not contain significant quantities of pollutants; where Best Management Practices (BMPs) are in place to minimize contact with significant materials and reduce flow; and when they are in compliance with Regional Board and local agency requirements.

On August 19, 1999, State Board issued a statewide general NPDES permit for Discharges of Stormwater Runoff Associated with Construction Activities (Order No. 99-08-DQW). On September 2, 2009 the State Board updated the permit (Order No. 2009-009-DWQ). As of the writing of these TMDLs, there are 23 construction sites enrolled under the general construction stormwater permit within the direct drainages (22 drain to the LAR Estuary and one site drains to the LBC beaches; Figure 5-4). Construction sites are generally not expected to be significant sources of bacteria; however, they are sources of sediment, which can transport bacteria. During wet weather, runoff from construction sites has the potential to contribute bacteria loadings; however, during dry weather, the potential contribution of bacteria loadings is low because discharges of non-stormwater are authorized by the permit only where they do not cause or contribute to a violation of any water quality standard and are controlled through implementation of appropriate BMPs for elimination or reduction of pollutants.

5.2.1.2 Vessel General Permit

The Vessel General Permit (VGP) was issued in response to a District Court ruling that vacated, as of February 6, 2009, a long-standing USEPA regulation that excluded the discharges incidental to the normal operation of a vessel from the need to obtain an NPDES permit (USEPA 2010). Under the VGP, all non-recreational, non-military vessels must have a NPDES permit before they can legally discharge (and operate) in waters of the State. Specifically, the VGP applies to all non-recreational vessels of less than 79 feet or commercial fishing vessels of any size that discharge ballast water. Furthermore, if a vessel is greater than or equal to 300 gross tons or, has a capacity to hold or discharge more than eight cubic meters (2,113 gallons) of ballast water, they must submit a Notice of Intent (NOI), while vessels under this limit automatically receive coverage. Ultimately, the VGP incorporates the USCG's mandatory ballast water management and exchange standards, adds additional ballast water management practices and provides effluents limits for other discharges (USEPA 2010). In total, the VGP applies to 26 discharges that are incidental to the normal operation of a vessel, including storm water run-off from the deck, graywater from showers, sinks and laundry, ballast water and bilgewater.

More recently, in 2010 the USEPA and the USCG signed a memorandum of understanding (MOU) that outlined steps the agencies would take to coordinate efforts to prevent and enforce illegal discharges of pollutants from vessels including cruise ships and oil tankers. Under the MOU, the USCG has incorporated inspection protocols and procedures to address vessel discharge including a framework for data tracking, training, monitoring, enforcement and industry outreach (USEPA, 2010).

Specific to this TMDL, the discharge of bilgewater and ballast water has the potential to contribute concentrations of bacteria to the receiving waters, and nearby beaches. Large ship docking areas are located near the southern corner of the LAR Estuary/Queensway Bay. Discharge, however, of bilgewater and ballast water to Harbor waters is prohibited.

5.2.1.3 Other NPDES Permits

There are two types of NPDES permits: individual and general permits. An individual NPDES permit is classified as either a major or a minor permit. Other than the MS4 and Caltrans stormwater permits, there are no major individual NPDES permits in the direct drainages. The discharge flows associated with minor individual NPDES permits and general NPDES permits are typically less than 1 million gallons per day (MGD). General NPDES permits often regulate episodic discharges (e.g., dewatering operations) rather than continuous flows.

5.2.1.3.1 Minor Individual NPDES Permits

There are no minor individual dischargers to the LCB beaches and LAR Estuary.

5.2.1.3.2 General NPDES Permits

Pursuant to 40 CFR parts 122 and 123, the State Board and the Regional Boards have the authority to issue general NPDES permits to regulate a category of point sources if the sources: involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations; and require similar monitoring. The Regional Board has issued general NPDES permits for six categories of discharges: construction and project dewatering; petroleum fuel cleanup sites; volatile organic compounds (VOCs) cleanup sites; potable water; non-process wastewater; and hydrostatic test water. There are 3 facilities with General NPDES permits in the direct drainages. Only one of the six categories, construction and project dewatering, apply to these facilities.

5.2.1.4 Sanitary Sewer Overflows and Private Lateral Sewer Discharges

Sanitary sewer overflows (SSOs) and private lateral sewer discharges (PLSDs) are regulated under NPDES permits, and are considered point sources. Overflows from the sanitary sewer systems, referred to SSOs, are regulated by the Statewide General Waste Discharge Requirements for Sanitary Systems (WQO No. 2006-0003-DWQ). Depending on the pattern of land use in the area serviced by the sanitary sewer system, SSOs contain domestic wastewater or industrial and commercial wastewater. Containing high levels of suspended solids, pathogenic organisms such as bacteria, toxic pollutants, nutrients, oxygen-demanding organic compounds, oil and grease and other pollutants, SSOs can cause a public nuisance, particularly when raw untreated wastewater is discharged to areas with high public exposure (SWRCB, 2006b). There are two classifications of SSOs, Category 1 and Category 2. A Category 1event is defined by a discharge of sewage which (1) equals or exceeds 1,000 gallons, or (2) a discharge of sewage to a surface water and/or drainage channel, or (3) a discharge of sewage to a storm drain that was not fully captured and returned to the sanitary sewer system. A Category 2 event is defined as any discharge of sewage which does not meet the criteria for Category 1. Category 1 spills represent a greater threat to public health relative to Category 2 spills (SWRCB, 2011). As an example of the frequency and potential impact of SSOs, from January 1, 2011 to December 31, 2011, there were a total of six SSOs reported in the LAR Estuary direct drainage (none in the LBC beaches direct drainage) (Figure 5-6 and Table 5-2). One of these was a Category 1 spill, from which 6,000 gallons of untreated sewage was discharged into surface waters, while the remaining five were Category 2 spills, totaling 1,520 gallons of untreated sewage (SWRCB, 2011).

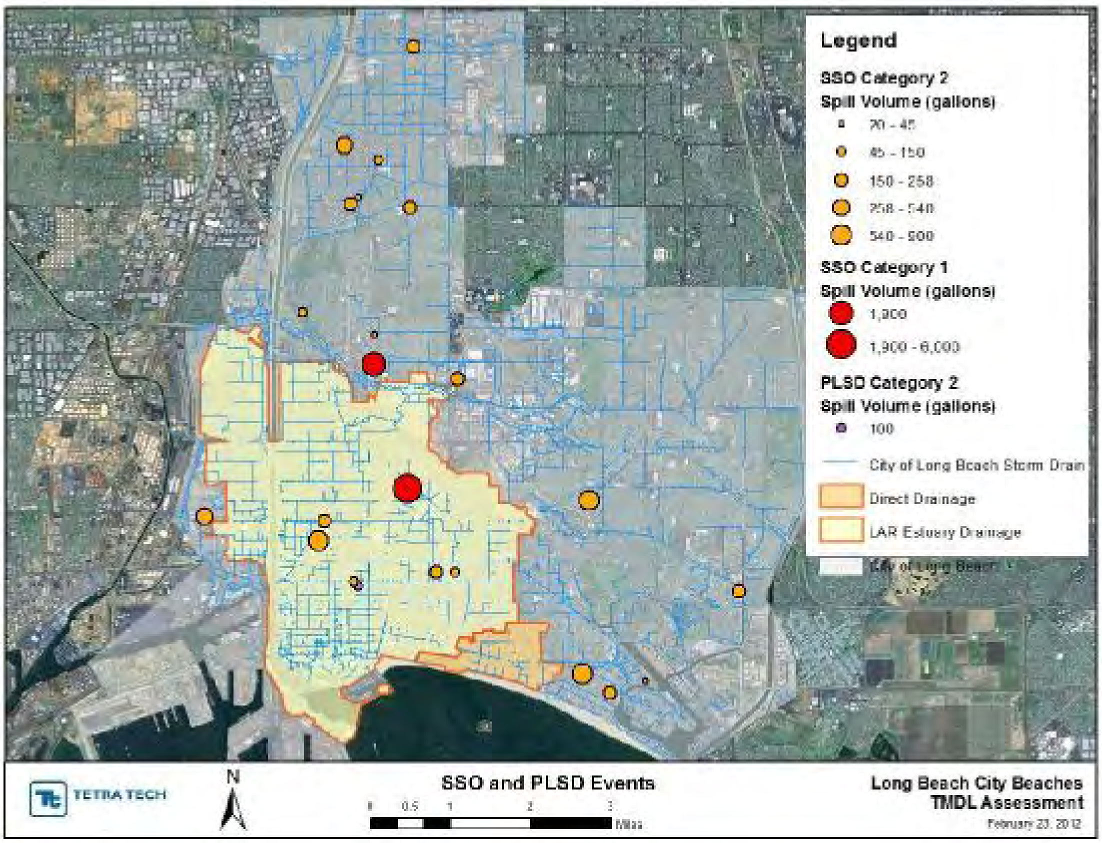

Figure 5-6. 2011 SSOs and PLSDs in the direct drainages

Table 5-2. Summary of SSO and PLSD Events in the Direct Drainages (2011)

Event Type	Event Category	Spill Date	Latitude	Longitude	Spill Volume (gallons)	Percent Recovered	Spill Cause
PLSD	2	01/09/11	33.778224	-118.187048	100	100%	Root intrusion
SSO	2	01/23/11	33.780741	-118.166016	150	100%	Grease deposition
SSO	1	01/29/11	33.795897	-118.176375	6,000	100%	Grease deposition
SSO	2	02/20/11	33.780753	-118.170318	195	100%	Grease deposition
SSO	2	04/05/11	33.786254	-118.195709	875	100%	Grease deposition
SSO	2	04/20/11	33.778872	-118.188014	100	100%	Debris-General
SSO	2	06/18/11	33.789939	-118.194444	200	100%	Grease deposition

According to the SWRCB, PLSDs are spill incidents reported by the sewer collection system operators for which the collect systems are not legally responsible (e.g. third-party source spills which enter the collection system pipelines) (SWRCB, 2011). Similar to SSOs, there are two classifications of PLSDs, Category 1 and Category 2. A Category 1event is defined by a discharge of sewage which (1) equals or exceeds 1,000 gallons, or (2) a discharge of sewage to a surface water and/or drainage channel, or (3) a discharge of sewage to a storm drain that was not fully captured and returned to the sanitary sewer system. A Category 2 event is defined as any discharge of sewage which does not meet the criteria for Category 1. Category 1 PLSDs represent a greater threat to public health relative to Category 2 spills (SWRCB, 2011). From January 1, 2011 to December 31, 2011, there was one Category 2 PLSO reported in the LAR Estuary direct drainage (none in the LBC beaches direct drainage), from which 100 gallons of untreated sewage was discharged into surface waters (Figure 5-6 and Table 5-2) (SWRCB, 2011).

5.2.2 Nonpoint Sources

A nonpoint source is a source of pollution that discharges via sheet flow or natural discharges. Nonpoint source loadings represent a diffuse form of water pollution from various natural and anthropogenic sources that accumulate in a watershed and are most often transported to the waterbody via runoff from rainfall. Examples of typical nonpoint sources include agricultural practices, atmospheric deposition, weathering and erosion of susceptible materials (including mine tailings and waste rock), animal wastes, and, street and urban debris. Nonpoint sources of bacteria identified in the LBC direct drainage to the LBC beaches include natural sources, a beachside dog zone, a marina, waterfowl, sediment re-growth and persistence and human sources (recreators or homeless persons). These potential sources are summarized below.

5.2.2.1 Dog Zone

Recreational uses within the impaired LBC beaches include a “dog zone” or dog-friendly beach area located near the Belmont Pier, between Roycroft and Argonne Avenue. The dog zone is neither fenced nor dedicated solely as a ‘dog beach’ and so, poor pet-waste management within the dog zone is a potential source of bacteria to the LBC beaches.

5.2.2.2 Recreational Vehicle Park

The Golden Shores recreational vehicle (RV) park is located next to the Golden Shore Marine Biological Preserve and offers 80 sites for RVs (Figure 5-7). The mobile home park also has a picnic area and accommodates up to two dogs per RV. Direct waste disposal from the kitchens and bathrooms of the RVs, and improper pet waste management on site is a potential source of bacteria to the LAR Estuary.

Figure 5-7. View of Golden Shores RV Park next to LAR Estuary

5.2.2.3 Marina

The Long Beach Shoreline Marina is a 1,764 slip marina for recreational boaters (Figure 5-8) located near the mouth of the LAR Estuary and immediately west of the LBC beaches (Figure 5-3). Activities at the marina can cause bacteria loading, which may impact the LAR Estuary and the LBC beaches, depending on tides, currents, wind, and freshwater inflow conditions. These activities include boat deck and slip washing, which results in washing bird feces off the docks and into receiving waters. Direct waste disposal from boats are another potential source of bacteria. Specifically, if boats do not use pump-out facilities (which are available free of charge and open 24 hours per day) to manage their septic and holding tanks, they may discharge into the marina waters, which could then contribute loading to the LAR Estuary and the LBC beaches.

Figure 5-8. Long Beach Shoreline Marina

5.2.2.4 Waterfowl

Birds were identified as a potential source of bacteria to lower reaches of the Los Angeles River. Specifically, the TMDL states that the lower seven-miles of the River are one of the most important shorebird stopover sites in southern California (LARWQCB, 2010a). In addition, bird watching is a common activity in the LAR Estuary, particularly in the Golden Shore Marine Biological Reserve, located along the eastern bank of the estuary. This nine-acre reserve, developed in 1997 as mitigation for surrounding development, offers unique habitat and has been identified as one of the best bird-watching locations in the region. Due to the proximity to these areas, it is likely that birds are also a potential source of bacteria to the LBC beaches. In addition, research has documented the presence of FIB in feces of seagulls (Grant et al., 2001) and pigeons (Oshiro et al., 1995) that tend to congregate near shorelines. Furthermore, research conducted in Avalon Bay indicated bird feces as a potentially significant source of bacteria relative to other nuisance flows (Boehm et al., 2003) and research conducted on LBC beaches concluded that ponds fronting storm drains along the impaired LBC beaches were found to be heavily utilized by birds which contributed to significant increase in concentrations of *enterococcus* bacteria (City of Long Beach, 2009). Accordingly, waterfowl are a potential source of bacteria to the LBC beaches and LAR Estuary; however, natural sources (such as waterfowl) of bacteria are accounted for under the reference system approach for bacteria.

5.2.2.5 Re-growth, Resuscitation and Persistence

Research has identified re-growth and/or persistence of FIB in beach sand in southern California as a potential source of FIB to beach water (Lee et al., 2006; Yamahara et al., 2007). Specific to the LBC beaches, concentrations of total coliform in LBC beach sand were found to be elevated relative to other published studies, and concentrations of *E. coli* were found to be consistent with these studies (City of Long Beach, 2009). Additionally, resuscitation is the process of a viable-but-nonculturalable bacteria becoming culturable. Resuscitation can occur after injury (but not death) by treatment or other environmental stressors. For example, a field study in Orange County concluded that bacteria were resuscitated to a degree after dry weather runoff was UVtreated (LARWQCB, 2010a). Moreover, the extended persistence of bacteria has also been demonstrated in beach sand and elevated concentrations found in algal mats (Whitman et al, 2003). Specific to the LBC beaches duckweed was shown to harbor concentrations of *E. coli* and *enterococcus* roughly three to six orders of magnitude greater than the respective underlying water (City of Long Beach, 2009). Although contribution from re-growth/resuscitation and persistence are a potential source of bacteria to the LBC beaches, the reference system process used to develop this TMDL considers natural sources.

5.2.2.6 Human Sources

The LBC beaches are completely accessible to the public; including both the LBC beaches and the Alamitos Bay, there are approximately seven miles of public beach that may be visited by over 50,000 people during the summer months. Water contact can wash bacteria from skin and into the receiving water. In addition, direct human waste may be discarded occasionally by recreational users, children and/or transient populations. Improperly discarded or managed trash can also contribute bacteria loading. Restroom facilities are available in several locations along the beach, but depending on the type and frequency of maintenance procedures they are a potential source of bacteria (Figure 5-9). Due to the number of beach visitors, human sources of bacteria likely contribute to elevated concentrations bacteria.

Figure 5-9. Bathroom facilities near Long Beach Lifeguard Headquarters

5.3 SUMMARY OF BACTERIA SOURCES TO THE IMPAIRED DRAINAGES

Sources contributing to the LBC beaches and LAR Estuary include MS4 permittees, Caltrans facilities, vessels covered under the VGP, facilities operating under the Statewide General Industrial and Construction Storm Water permits, general NPDES permits, and various nonpoint sources. Sources such as runoff from urban development, commercial shipping, and potential discharges from the industrial or construction permittees along the waterfront have been identified as likely sources of toxic pollutants in the impaired drainage areas. Table 5-3 provides a summary of likely sources contributing to the impairments in both shoreline areas.

Table 5-3. Summary of Sources within the TMDL Impaired Drainage Areas

Point Source	Impaired Drainage	
	LBC Beaches Direct Drainage	LAR Estuary Direct Drainage
MS4 Dischargers	w	w
Caltrans		w
Vessel Discharge Permit	w	w
General Industrial & Construction Storm Water Dischargers	w	w
General NPDES		w
Sanitary and Private Lateral Sewer Overflows	w	w
Various Nonpoint Sources	w	w

6 LINKAGE ANALYSIS

Information regarding the sources of bacteria provides but one part of the TMDL equation. To determine the effects of these sources on the quality of receiving waters, it is necessary to determine the assimilative capacity of the receiving water. The technical analysis of the relationship between pollutant loading from identified sources and the response of the waterbody to this loading is referred to as the linkage analysis. The purpose of the linkage analysis is to quantify the maximum allowable bacteria loading that can be received and assimilated at the LBC beaches and LAR Estuary, thus ensuring the beaches will still attain the WQOs associated with their applicable beneficial uses. This numeric value is represented by the TMDL.

Since the transport of bacteria to receiving waters varies between wet and dry conditions, different technical approaches were developed to be consistent with the processes occurring during either condition; this process is consistent with other TMDLs adopted in the Los Angeles Region (LARWQCB, 2002a, 2002b, 2005a, 2005b, 2006). These TMDLs are split into three weather conditions and the appropriate wet or dry weather approach is applied to each condition. Specifically, wet weather is defined as any day with 0.1 inches of rain or more and the following three days. The wet-weather linkage analysis described below for this TMDL applies to this condition and is based on computer models that simulated watershed loading based on land use (see Appendix B for additional detail). Alternatively, the dry-weather linkage presented below applies to all remaining days and is based on an area-weighted equation related to total drainage area and dry weather flow (see Appendix C for additional detail). Specifically, dry weather periods are defined as winter dry (any non-wet weather day from November 1st through March 31st) or summer dry (any non-wet weather day from April 1st through October 31st). The following sections provide a discussion regarding the approaches selected for analysis of both dry and wet conditions.

6.1 DRY-WEATHER ANALYSIS

Dry weather flows to the LBC beaches and LAR Estuary are likely dominated by groundwater inflow and discharges to the stormwater conveyance system from illicit connections, excess irrigation, and other residential and commercial practices (since no waste water reclamation plants (WWRPs) exist within the LBC direct drainage). Although dry-weather flows are substantially less than stormflows in the region, their long-term contribution of pollutants can be substantial (McPherson et al., 2005; Stein and Ackerman, 2007).

Flow measurements were non-existent at storm drains discharging to the LAR Estuary and limited at the storm drains draining to the LBC beaches. Because the available data covered such a brief period of time, a technical approach based on more data covering a broader time period was identified. The City of Long Beach provided new data associated with dry weather flow studies to the Colorado Lagoon and Belmont Pump (City of Long Beach, 2006; Stevenson, 2012). These data were originally collected to evaluate the potential installation of dry weather flow diversions. The Colorado Lagoon and Belmont Pump dry weather data were collected from 2005 (Colorado Lagoon) to 2011 (Belmont Pump had data from 2009-2011), representing a total of four dry weather seasons. The 2005 data for Colorado Lagoon were based on the sum of the daily dry weather flow collected at four stations over a 20-day period (City of Long Beach, 2006). For the Belmont Pump station, the total gallons discharged over several dry season (2009-2011) months were divided by the associated dry weather days, resulting in an average flow in gallons per day (Stevenson, 2012). Both the Colorado Lagoon and Belmont Pump data were presented on an area-weighted basis (gallons per acre per day), by dividing the average flow rates by the associated drainage areas (1,172 acres for Colorado Lagoon and 203 acres for Belmont Pump) (see Appendix C).

The median of these area-weighted flow rates is 104.3 gallons per acre per day. This value was used to calculate dry weather flows from each of the basins in the direct drainages. Specifically, dry-weather flows for all direct drainage areas were estimated based on the following equation (5.1), which uses the median area-weighted dry weather flow rate:

$$\text{Flow} = 104.3 \times (\text{Total Area}) \qquad \text{(Equation 5.1)}$$

where, *Flow* is in gallons per day and *Total Area* is in acres. Additional details regarding specific land use in the LBC beaches and LAR Estuary direct drainages are provided in Appendix C.

Using the flow estimates derived from the equation above (5.1) and bacteria concentrations associated with monitoring data, the dry weather existing bacteria loading to the LBC beaches and LAR Estuary were quantified using equation 5.2 below.

$$\text{Bacteria concentration} \times \text{Flow (cfs)} \times \text{Conversion factor} = \text{Load (CFU) per day} \qquad \text{(Equation 5.2)}$$

Where, the bacteria concentration equals the observed geometric mean (in CFU/100 mL), the Flow (in cubic feet per second [cfs]) is derived from regression above (5.1), and the conversion factor below (5.3) is used to convert the product of these values to CFU/day:

$$24{,}465{,}888 = \text{Conversion Factor} \qquad \text{(Equation 5.3)}$$

Table 6-1. Calculated Dry Weather Flows and Existing Loads for the LBC Beaches and LAR Estuary Direct Drainages

Direct Drainage (Storm Drain Outfall)	Flow (cfs)	Geomean (CFU/100 mL)	Existing Load (*E. coli* CFU/day)
LBC Beaches			
9th Place (SD-3)	0.008	8,947	1.65E+09
Molino Avenue (SD-1)	0.033	4,507	3.61E+09
Redondo Street (SD-2)	0.020	1,316	6.42E+08
36th Place (SD-4)	0.003	6,680[a]	4.68E+08
West Belmont (SD-5)	0.018	9,085	4.09E+09
LAR Estuary			
LARE-1	0.010	6,680[a]	1.66E+09
LARE-2	0.025	6,680[a]	4.10E+09
LARE-3	0.002	6,680[a]	2.89E+08
LARE-4	0.021	6,680[a]	3.39E+09
LARE-5	0.028	6,680[a]	4.59E+09
LARE-6	0.068	6,680[a]	1.12E+10
LARE-10	0.176	6,680[a]	2.87E+10
LARE-11	0.002	6,680[a]	3.78E+08
LARE-12	0.301	6,680[a]	4.91E+10
LARE-13	0.203	6,680[a]	3.32E+10
LARE-14	0.092	6,680[a]	1.50E+10
LARE-15	0.051	6,680[a]	8.28E+09

[a] Geometric mean of all available storm drain data (at four sampled locations) used to represent existing concentrations at SD-4 and LARE 1-15

The results of the analyses were used to estimate dry weather bacteria loading rates by subbasin in number of bacteria (CFU) per day, as shown in Figure 6-1 (see also Appendix C). Of concern, in the LBC beaches direct drainage, despite not having the largest flow, the West Belmont Pier drainage is estimated to discharge the greatest dry weather load due to its high geometric mean concentration. That location is followed closely, in terms of dry weather loading, by the Molino Avenue drainage. Since dry weather loading from the West Belmont Pier does not relate to flow as well as the loadings from other subbasins do, it is likely that other localized sources of bacteria exist within this drainage (e.g., dog parks, cross connections, etc.).

No monitoring data were available for the individual LAR Estuary subbasins; therefore, the loading potential is directly related to total land area. For this reason, the largest subbasins resulted in the greatest dry weather loading. As an example, subbasin 12 has the largest total area, and therefore, was simulated to create the greatest discharge of both flow and bacteria. Subbasins with the greatest loading potential are shown in dark red in Figure 6-2. It is important to note that the loading presented in this map is cumulative, so the load associated with a downstream subbasin includes the loading from all upstream subbasins; however, as previously discussed, these loads do not include loading from the freshwater Los Angeles River (which are addressed in a separate TMDL [LARWQCB, 2010]). Dry weather existing loads of *E. coli* from the LAR Estuary direct drainage are approximately 1% of the dry weather loads from the Los Angeles River, which is expected given the difference in land area (6,065 acres for the LAR Estuary direct drainage compared to 528,000 acres for the freshwater drainage of the Los Angeles River).

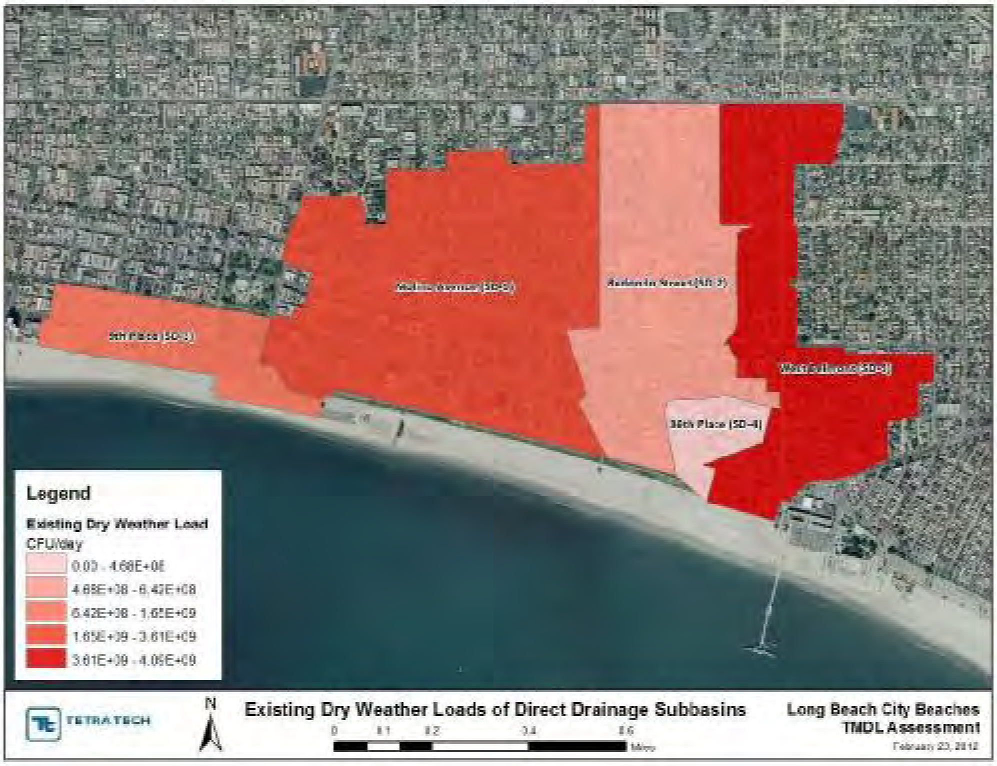

Figure 6-1. LBC beaches direct drainage dry weather loading

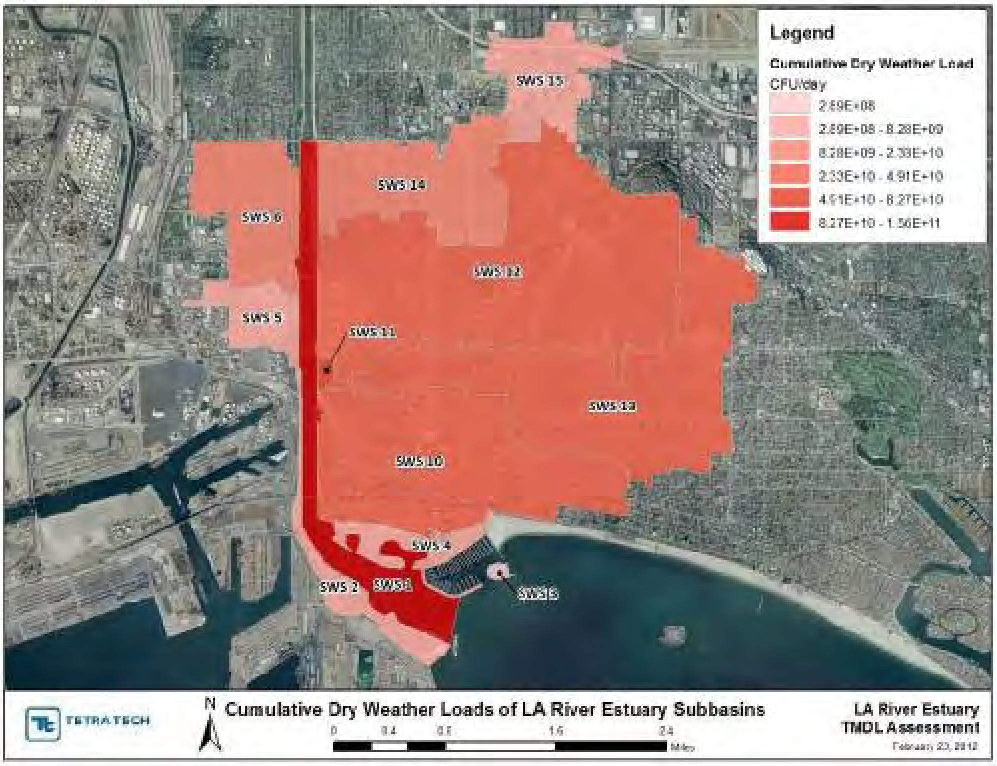

Figure 6-2. LAR Estuary direct drainage dry weather loading

6.2 WET-WEATHER ANALYSIS

Water quality monitoring data alone were not sufficient to fully characterize all sources of bacteria in the impaired watershed. Urban runoff is considered a controllable source of pollutants to the impaired LBC beaches; therefore, an accurate representation of watershed sources was an important consideration in selecting the appropriate modeling framework. The model selected to develop this TMDL addresses the major source categories for effective TMDL implementation.

To assess the link between sources of bacteria and impairment of the receiving waters, a modeling system was utilized that simulates land-use based sources of bacteria and the hydrologic and hydraulic processes that affect delivery.

USEPA's Loading Simulation Program C++ (LSPC) (Shen et al., 2004; USEPA, 2003a) was used to represent the hydrologic and water quality conditions in the LBC beaches and LAR Estuary direct drainages. LSPC is a component of USEPA's TMDL Modeling Toolbox (USEPA, 2003b), which has been developed through a joint effort between USEPA and Tetra Tech, Inc. It integrates a comprehensive data storage and management capability, a dynamic watershed model (a re-coded version of USEPA's Hydrological Simulation Program – FORTRAN [HSPF] [Bicknell et al., 2001]), and a data analysis/post-processing system into a convenient PC-based windows interface that dictates no software requirements.

LSPC is capable of representing loading, in-stream processes, and both flow and water quality from non-point and point sources. LSPC can simulate flow, sediment, bacteria, nutrients, pesticides, and other conventional pollutants for pervious and impervious lands and waterbodies. The model has been successfully applied and calibrated in Southern California for the Los Angeles River, the San Gabriel River, Dominguez Creek (original model by SCCWRP), the direct shore watersheds draining to Los Angeles/Long Beach Harbor, the San Jacinto River, and multiple watersheds draining to impaired beaches of the San Diego Region. For the LBC beaches and LAR Estuary, LSPC was used to simulate bacteria and determine loads.

Previous wet-weather watershed modeling and TMDL efforts by Tetra Tech and the SCCWRP have led to the development of a regional watershed modeling approach to simulate hydrology and pollutant transport in the Los Angeles Region. The regional modeling approach assumes that pollutant loadings can be dynamically simulated based on hydrology and fate and transport from land uses in a watershed. Both small-scale land use sites and, larger watersheds in the Los Angeles Region were used to develop the regional modeling approach. SCCWRP developed watershed models, based on HSPF (Bicknell et al., 2001), of multiple homogeneous land use sites in the region. Sufficient stormflow and water quality data were available at these locations to facilitate calibration of land-use-specific HSPF modeling parameters. These parameters were validated in an additional HSPF model of Ballona Creek (Ackerman et al., 2005; SCCWRP, 2004), and similar models of the Los Angeles River (Tetra Tech, Inc., 2004), San Gabriel River (Tetra Tech, Inc., 2005), and the Los Angeles/Long Beach Harbor (Tetra Tech, Inc., 2006) using LSPC. These models were used to calculate TMDLs for each of these waterbodies (LARWQCB, 2005a, 2005b, 2006, 2011).

The watershed model represented the variability of wet-weather runoff source contributions through dynamic representation of hydrology and land practices. It included all point and non-point source contributions. Key components of the watershed modeling include:

- Watershed segmentation/delineation
- Meteorological data
- Land use representation
- Soils
- Reach characteristics
- Point source discharges
- Hydrology representation
- Pollutant representation

These components provided the basis for the model's ability to estimate flow and bacteria loading; refer to Appendix B for complete discussion of the components. The model was configured for sub-basins draining to the LBC beaches and LAR Estuary as shown in Figure 3-2 and Figure 3-4, respectively.

Loading processes for bacteria (*E. coli*) were represented for each subbasin through the simulation of quality constituents for pervious (PQUAL) and impervious (IQUAL) land segments within each respective subbasin. Consistent with the LAR freshwater bacteria TMDL, event mean concentrations for *E. coli*, based on historical monitoring, were applied as surface outflow and interflow concentrations (LARWQCB, 2010a). Additionally, consistent with recent studies (Cleaner Rivers through Effective Stakeholder TMDLs [CREST], 2010), a decay rate of 0.2 per day was applied to bacteria concentrations to account for decay and die-off of bacteria.

The results of the model were used to estimate wet weather bacteria loading rates by sub-basin in number of bacteria (MPN) per day. Specifically, Table 6-2 presents results from the modeled daily wet weather bacteria loading rates in number of bacteria (MPN) per day (note: only the total loading to the LAR Estuary is presented because the modeled loads are cumulative to the final discharge point).

Table 6-2. Existing Daily Wet-Weather *E. coli* Load (Modeled) within Direct Drainage Subbasins

Direct Drainage	Subbasin	Wet Weather *E. coli* Load (MPN/day)
LBC Beaches	9th Place	4.40×10^{10}
	Molino Avenue	1.66×10^{11}
	Redondo Street	1.50×10^{11}
	36th Place	1.12×10^{10}
	West Belmont Pier	1.03×10^{11}
LAR Estuary	Total Direct Drainage	1.21×10^{14}

Figure 6-3 and Figure 6-4 illustrate a cumulative gradient of loading by model subbasin for the LBC beaches and LAR Estuary, respectively (see also Appendix B). As shown, for the LBC beaches the model quantified the greatest wet weather loadings from the Molino Avenue subbasin. That particular subbasin comprises the largest area and also has the highest flow; therefore, this watershed is expected to produce the greatest bacteria load of the five subbasins. Alternatively, the 36th Place drainage represents the smallest area and least amount of flow and, as expected, is modeled to produce the smallest wet weather bacteria load of the five drainages. The total existing load to the LAR Estuary is approximately three orders of magnitude above LBC beaches drainages, which is expected given its larger size (and therefore, higher flow) and greater proportion of commercial land, which had the highest *E. coli* EMC values based on historical monitoring. In addition, the LAR Estuary direct drainage loads do not include loading from the freshwater Los Angeles River (which are addressed in a separate TMDL [LARWQCB, 2010]). Similar to the dry weather loading comparisons presented above, wet weather existing loads of *E. coli* from the LAR Estuary direct drainage are approximately 1% of the wet weather loads from the Los Angeles River. This is expected due to the difference in land area between the two drainages (6,065 acres for the LAR Estuary direct drainage compared to 528,000 acres for the freshwater drainage of the Los Angeles River).

Figure 6-3. LBC beaches direct drainage wet weather loading

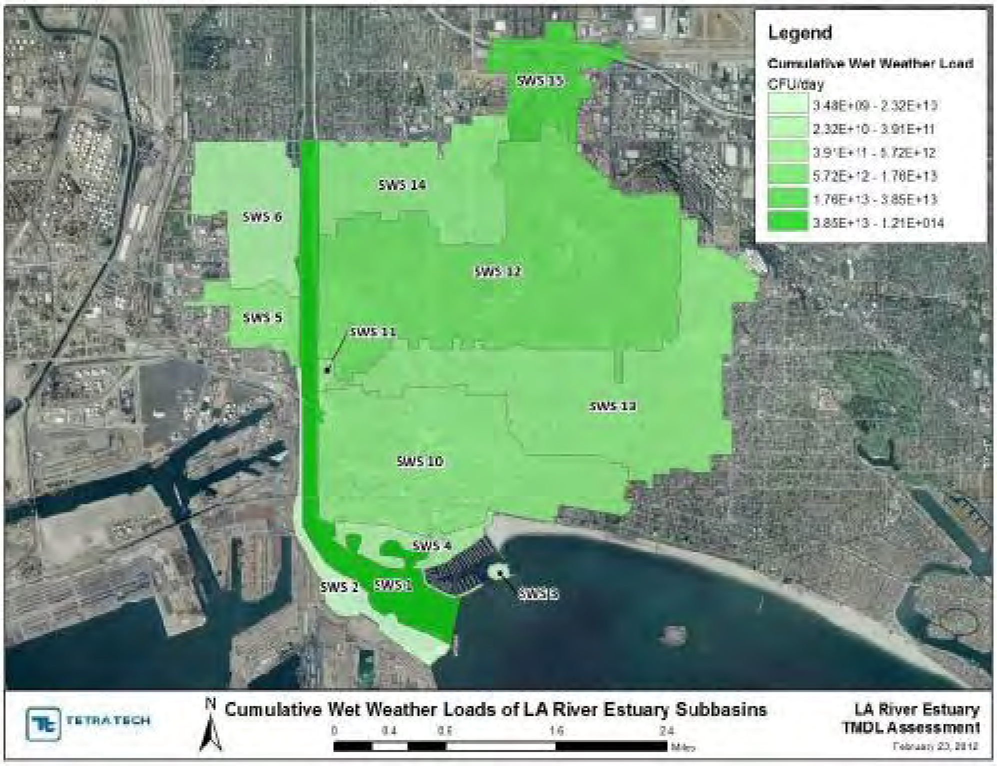

Figure 6-4. LAR Estuary direct drainage wet weather loading

7 TOTAL MAXIMUM DAILY LOADS AND ALLOCATIONS

Federal regulations (40 CFR 130.7) require that TMDLs include load allocations (LAs) and waste load allocations (WLAs), and that the individual sources for each must be identified and enumerated. The TMDL for a given pollutant and waterbody is the total amount of pollutant that can be assimilated by the receiving water while still achieving WQOs. Once calculated, the TMDL is equal to the sum of individual WLAs for point sources, and LAs for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water. Conceptually, this definition is represented by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Waste Load Allocations (WLAs) are allocations of bacteria loads to point sources and Load Allocations (LAs) are allocations of bacteria loads to nonpoint sources. WLAs and LAs are expressed as the number of daily or weekly sample days that may exceed single sample targets at appropriate monitoring sites. In this TMDL, WLAs and LAs set the allowable exceedance days for each existing or future compliance monitoring location for: 1) Summer Dry (April 1 to October 31); 2) Winter Dry (November 1-March 31) and; 3) Wet Weather (defined as days of 0.1 inch of rain or more plus three days following the rain event).

7.1 LOAD ALLOCATIONS

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

Areas near onsite waste treatment systems are assigned LAs of zero (0) days of allowable exceedances for both dry and wet weather for the single sample and rolling 30-day geometric mean limits. In addition, non-point sources such as natural sources, a beachside dog zone, a marina, waterfowl, sediment re-growth and persistence and human sources (recreators or homeless persons) are assigned LAs of zero (0) days of allowable exceedances for both dry and wet weather for the single sample and rolling 30-day geometric mean limits. These LAs are thus equal to the applicable water quality objectives listed below in Table 6-1.

Table 7-1. TMDL Numeric Targets

Water Quality Objectives	Marine REC-1
Single Sample	
E. coli	N/A
Fecal coliform	400 CFU/100 mL
Enterococcus	104 CFU/100 mL
Total coliform*	10,000/100 mL
Rolling 30-day Geometric Mean	
E. coli	N/A
Fecal coliform	200 CFU/100 mL
Enterococcus	35 CFU/100 mL
Total coliform	1,000 CFU/100 mL

*Total coliform shall not exceed 1,000/100 mL, if the ratio of fecal to total coliform exceeds 0.1 (this is an additional single sample limit for REC-1 marine waters; presented in the Basin Plan).
N/A: not applicable

7.2 WASTELOAD ALLOCATIONS

WLAs for the MS4 permittees will be equal to allowable exceedance days of the single sample maximum, discussed below and listed in Table 6-3. All WLAs for summer dry weather are zero (0) exceedance days. WLAs for winter dry weather vary by location from a maximum of 9 to 5 exceedance days. WLAs for winter wet weather are 17 exceedance days at all locations. Furthermore, the WLAs include no allowable exceedances of the geometric mean targets. There are currently three municipal separate storm sewer system (MS4) NPDES permits that cover discharges in the LBC beaches and LAR Estuary direct drainages. These include the Los Angeles County Permittees (excluding the City of Long Beach), City of Long Beach, and Caltrans permits, which are listed in Table 5-1. The Caltrans permit is a statewide storm water permit. These allocations apply during both dry and wet-weather at all existing and future monitoring sites, since there is water contact recreation throughout the year. Federal regulations require that NPDES permits incorporate water quality based effluent limitations (WQBELs) consistent with the requirements and assumptions of any available WLAs.

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, the Statewide General Waste Discharge Requirements for Sanitary Systems, and the Vessel General Permit in the Long Beach City Beaches Watershed are assigned WLAs of zero (0) days of allowable exceedances for all time periods for the single sample targets and no exceedances of the 30-day geometric mean targets because they are not expected to be a significant source of indicator bacteria. The WLAs are thus equal to the applicable water quality objectives listed above in Table 6-1. Federal regulations require that NPDES permits incorporate water quality based effluent limitations (WQBELs) consistent with the requirements and assumptions of any available WLAs.

7.3 ALLOWABLE EXCEEDANCE DAYS

This TMDL sets the number of allowable exceedance days for each monitoring site to ensure that two criteria are met (1) bacteriological water quality is at least as good as that of a largely undeveloped system, and (2) there is no degradation of existing bacteriological water quality. Previously adopted bacteria TMDLs in the Region, which include the Santa Monica Bay Bacteria TMDLs among others, have employed Leo Carrillo Beach and its drainage area, Arroyo Sequit subwatershed, as the reference system (LARWQCB, 2002a; 2002b; 2004a). The number of allowable exceedance days is based on the single sample exceedance frequency at the reference system, Leo Carrillo Beach.

The two criteria above are met by using the smaller of two exceedance probabilities for any monitoring site multiplied by the number of dry days or wet days for the critical condition (see Section 7.3.4). An exceedance probability, P(E), is simply the probability that one or more single sample limits, described in Table 4-1, will be exceeded at a particular monitoring site, based on historical data. The flow diagram below illustrates the decision-making process for determining allowable exceedance days at a monitoring site (Figure 7-1).

For any one monitoring site, two exceedance probabilities are compared and the lowest one is selected (1) the dry-weather or wet-weather exceedance probability in the reference system, P(E)R and (2) the dry-weather or wet-weather exceedance probability based on historical bacteriological data at that particular site, P(E)i. If the P(E)R is greater than P(E)i, then P(E)i will apply to that particular site (i.e., the site-specific exceedance probability would override the "default" exceedance probability of the reference system). Next, the chosen dry weather or wet weather exceedance probability is multiplied by the dry or wet days in the reference year of the reference system as measured at the LAX meteorological station if the P(E)R is lower than P(E)i.

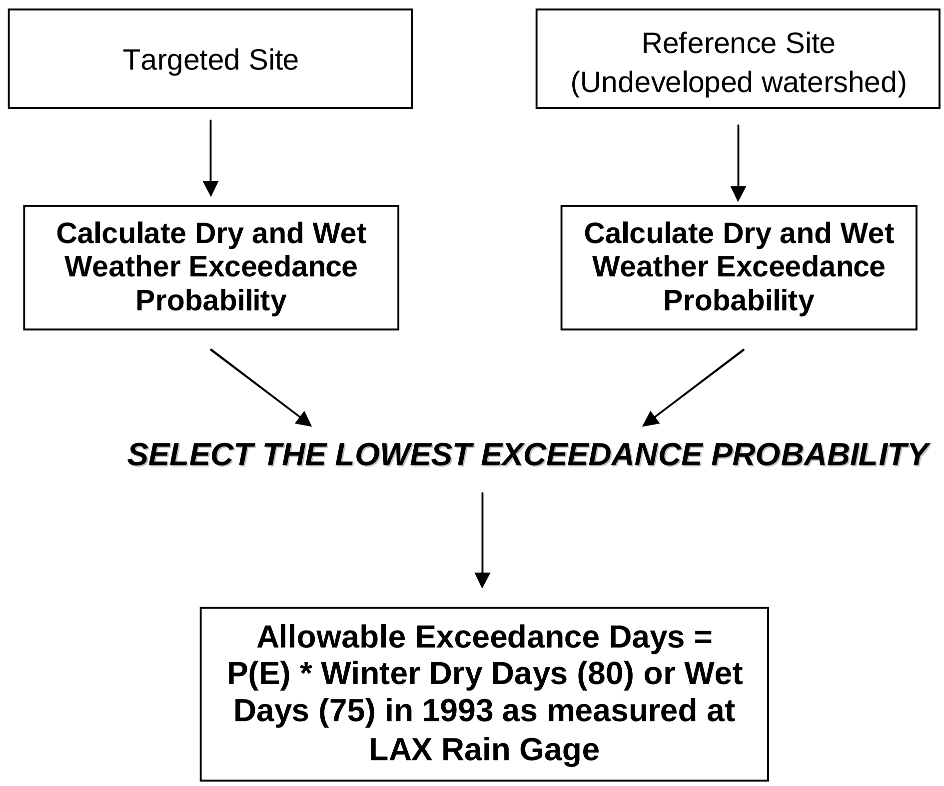

Figure 7-1. Decision-making process for determining Waste Load Allocations
(expressed as allowable exceedance days)

Listed in the following sections is the background information and justification for the two steps in the process described above. First, the dry and wet-weather exceedance probabilities for the monitoring sites were calculated. Then these exceedance probabilities were translated into allowable exceedance days for each time period at the targeted monitoring site, including justifications for the proposed reference beach and reference year.

7.3.1 Calculating dry weather and wet weather exceedance probabilities

The dry weather exceedance probability is simply the probability that the sample limit will be exceeded on a dry weather day at a particular location. The wet weather exceedance probability is simply the probability that the sample limit will be exceeded on a wet weather day (see Section 3.4) at a particular location.

Monitoring data from November 2004 to December 2010 were used to determine the exceedance probability of the Leo Carrillo Beach reference system for dry and wet weather. Samples were identified as dry or wet weather samples using rainfall data from LAX. In Table 7-2 (below) the exceedance probability of the reference system is compared to the exceedance rates of the monitoring locations

The Regional Board is in the process of revising the exceedance rates for the Leo Carrillo Beach reference system using more recent data collected from Leo Carrillo Beach. The new exceedance rates are reflective of a more accurate dataset that was collected from November 2004 through October 2012 at a "point zero" monitoring location. Exceedance rates for all three seasons increased with the new data. USEPA has incorporated the revised exceedance rates for winter dry weather and wet weather into the exceedance day calculations for this TMDL.

The 0% exceedance rate for summer dry weather and a corresponding WLAs of zero (0) exceedance days for summer dry-weather was not changed. A 0% exceedance rate is supported by the fact that the California Department of Health Services has established minimum protective bacteriological standards, the same as the numeric targets listed in this TMDL. When standards are exceeded in Summer Dry Weather, from April 1 through October 31, beaches are posted with health hazard warnings (17 § 7958(a)). In order to fully protect public health and prevent beach postings during this period, the zero exceedance rate during summer dry-weather remains in effect.

Table 7-2. Summary of Calculated Exceedance Probabilities

Exceedance Probability Rate based on Single Sample Exceedances				
Site Id	**Monitoring Location**	**Summer Dry***	**Winter Dry**	**Wet**
DHS (010)4	Leo Carrillo Beach	0.00%	10.42%	22.45%
LARE	Los Angeles River Estuary	56.82%	no data	no data
B63	Long Beach City Beach, projection of 3rd Place	16.84%	20.44%	56.76%
B5	Long Beach City Beach, projection of 5th Place	16.34%	16.03%	51.02%
B56	Long Beach City Beach, projection of 10th Place	17.09%	12.67%	48.00%
B6	Long Beach City Beach, projection of 16th Place	15.52%	20.14%	36.84%
B60	Long Beach City Beach, projection of Molino Av.	13.96%	24.84%	51.02%
B7	Long Beach City Beach, projection of Coronado Ave.	11.11%	16.03%	48.98%
B62	Long Beach City Beach, projection of 36th Place	14.14%	14.29%	45.95%
B8	LBCB - W/side of Belmont Pier	22.83%	14.29%	81.48%
B3	LBCB - E/side of Belmont Pier	14.81%	15.09%	58.82%
B9	Long Beach City Beach, projection of Prospect Av.	11.14%	10.14%	39.58%
B64	Long Beach City Beach, projection of Granada Av.	12.64%	7.59%	45.83%
B65	Long Beach City Beach, projection of 54th Place	9.71%	6.92%	36.11%
B10	Long Beach City Beach, projection of 55th Place	6.12%	5.63%	36.17%
B66	Long Beach City Beach, projection of 62nd Place	6.59%	8.53%	37.84%
B11	Long Beach City Beach, projection of 72nd Place	9.79%	15.65%	44.90%

*The Department of Health Services has established minimum protective bacteriological standards, the same as the numeric targets listed in this TMDL. In order to fully protect public health during summer months when recreation is high, USEPA has chosen to use a zero exceedance percentage rate during summer dry-weather.

7.3.2 Calculating Allowable Exceedance Days at a Targeted Location

As in previous bacterial TMDLs in the Los Angeles Region, allowable exceedance days were calculated with the smaller of the two exceedance probabilities, that of the targeted site or the reference site.

7.3.3 Reference System

As discussed above and in sections 2.2 and 3.3.2, the reference system/antidegradation approach is the recommended alternative; this approach ensures that water quality is at least comparable to that of the reference system and is also consistent with state and federal antidegradation policies. The reference system approach uses both the water quality objective exceedance probability for the reference system and reference dry and wet weather days from the reference year (see section 7.3.1) to determine the allowable number of exceedances days allocated.

7.3.4 Critical condition (reference year)

Based on an examination of historical rainfall data from the Los Angeles International Airport (LAX) meteorological station, USEPA proposes using the 90th percentile storm year in terms of wet weather days as the critical condition for determining the allowable wet weather exceedance days. The reference year of 1993 was chosen because it is the 90^{th} percentile year in terms of wet weather days, based on 54 storm years (1948-2001) of rainfall data from LAX (see Appendix A). In the 1993 storm year, there were 75 wet weather days; therefore, there were 290 dry days, 80 of which occurred during the winter months. By selecting the 90^{th} percentile year, we avoid creating a situation where the reference beach frequently exceeds its allowable exceedance days (i.e., 9 years out of 10, the number of exceedance days at the reference beach should be less than the "allowable" exceedance days at the reference beach).

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

The estimated number of exceedance days during the critical condition (reference year) was calculated for each site by multiplying the site-specific exceedance probability by the estimated number of dry or wet days in the reference year. The site-specific exceedance probability is taken directly from the historical data analysis, as listed in Table 7-2. Based on 54 storm years of rainfall data from LAX meteorological station, 1993 is the reference year for both dry and wet-weather.

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

Where E_{CC} is the estimated number of exceedance days under the critical condition and $P(E)_i$ is the average probability of exceedance for any site. The average exceedance probability is appropriate since the weekly sampling is systematic and the rain events are randomly distributed; therefore, sampling will be evenly spread over the dry-weather and wet-weather events (i.e., the rain day, day after, 2^{nd} day after, 3^{rd} day after)[1].

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

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

$$\frac{days_{1993}}{365\ \text{days}} = \frac{x}{52\ \text{weeks}} \qquad \text{(Equation 6.2)}$$

Using Equation 6.1 and Equation 6.2, the exceedance probability of the reference beach is translated to exceedance days as follows. Analysis of historical monitoring data for Leo Carrillo Beach, the reference beach, shows that summer dry-weather exceedance probability is 0.00, the winter dry-weather exceedance probability is 0.1042, and the wet-weather exceedance probability is 0.2245. Per Equation 6.1, the number of summer dry-weather exceedance days is zero (0) at LCB, therefore, no exceedances are allowed at any site during summer dry-weather. The exceedance probability of 0.1042, for winter dry-weather, is multiplied by 80 days, the number of winter dry-weather days in the 1993 storm year, per Equation 6.1 resulting in nine (9) exceedance days when daily sampling is conducted. The exceedance probability of 0.2245, for wet-weather, is multiplied by 75 days, the number of wet-weather days in the 1993 storm year at, per Equation 6.1 resulting in 17 exceedance days when daily sampling is conducted.

USEPA recognizes that the number of winter dry-weather days and wet-weather days will change from year-to-year and, therefore, the exceedance probabilities of 0.1042 for winter dry-weather and 0.2245 for wet-weather will not always equate to 9 or 17 days, respectively. However, USEPA proposes setting the allowable number of exceedance days based on the reference year rather than adjusting the allowable number of exceedance days annually based on the number of dry or wet days in a particular year. This is because it would be difficult to design diversion or treatment facilities to address such variability from year to year. USEPA expects that by designing facilities for the 90th percentile storm year, during drier years there will most likely be fewer exceedance days than the maximum allowable.

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

$$\frac{80\ days}{365\ days} = \frac{x}{52\ weeks} \qquad \text{(Equation 6.2 for winter dry-weather)}$$

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

For winter dry-weather, solving for *x* equals 11.4, which is then multiplied by 0.1042, resulting in two (2) exceedance day during winter dry-weather when weekly sampling is conducted. For wet-weather, *x* equals 10.7 multiplied by 0.2245, results in three (3) exceedance days during wet-weather when weekly sampling is conducted.

The estimated exceedance days for the sites in the project area are calculated, in the same manner as described above, using the site-specific exceedance probabilities for each time period.

Table 7-3 (below) shows the calculated allowable exceedance days, as described above, for daily and weekly sampling for each existing monitoring site. For any future monitoring sites, the calculated allowable exceedance day would be based on the reference beach allowable exceedance days for daily and weekly sampling. Table 7-4 shows the estimated exceedance day reductions for daily and weekly sampling based on the reference year.

Table 7-3. Allowable Exceedance Days of the Single Sample Maximum for Daily and Weekly Sampling based on the Reference Year

Site Id	Monitoring Location	Summer Dry*		Winter Dry*		Wet*	
		Daily	Weekly	Daily	Weekly	Daily	Weekly
DHS (010)4	Leo Carrillo Beach	0	0	9	2	17	3
LARE	LA River Estuary	0	0	9	2	17	3
B63	Long Beach City Beach, 3rd Place	0	0	9	2	17	3
B5	Long Beach City Beach, projection of 5th Place	0	0	9	2	17	3
B56	Long Beach City Beach, projection of 10th Place	0	0	9	2	17	3
B6	Long Beach City Beach, projection of 16th Place	0	0	9	2	17	3
B60	Long Beach City Beach, projection of Molino Av.	0	0	9	2	17	3
B7	Long Beach City Beach, projection of Coronado Ave.	0	0	9	2	17	3
B62	Long Beach City Beach, projection of 36th Place	0	0	9	2	17	3
B8	LBCB - W/side of Belmont Pier	0	0	9	2	17	3
B3	LBCB - E/side of Belmont Pier	0	0	9	2	17	3
B9	Long Beach City Beach, projection of Prospect Av.	0	0	9	2	17	3
B64	Long Beach City Beach, projection of Granada Av.	0	0	7	1	17	3
B65	Long Beach City Beach, projection of 54th Place	0	0	6	1	17	3
B10	Long Beach City Beach, projection of 55th Place	0	0	5	1	17	3
B66	Long Beach City Beach, projection of 62nd Place	0	0	7	1	17	3
B11	Long Beach City Beach, projection of 72nd Place	0	0	9	2	17	3

*All Exceedance Day calculations are rounded up to the next whole number (i.e., 0.2 days = 1 full exceedance day)
**No allowable exceedances of the geometric mean numeric target.
***For Permittees other than the MS4 permittees and Caltrans, they are assigned zero (0) days of allowable exceedance days for all time periods for all monitoring locations and no allowable exceedances of the geometric mean numeric target

Table 7-4. Estimated Exceedance Day Reductions for Daily and Weekly Sampling based on the Reference Year

Site Id	Monitoring Location	Summer Dry*		Winter Dry*		Wet*	
		Daily	Weekly	Daily	Weekly	Daily	Weekly
LARE	Los Angeles River Estuary	120	17	**	**	**	**
B63	Long Beach City Beach, projection of 3rd Place	36	6	8	1	26	4
B5	Long Beach City Beach, projection of 5th Place	35	5	4	0	22	3
B56	Long Beach City Beach, projection of 10th Place	36	6	2	0	19	3
B6	Long Beach City Beach, projection of 16th Place	33	5	8	1	11	1
B60	Long Beach City Beach, projection of Molino Av.	30	5	11	1	22	3
B7	Long Beach City Beach, projection of Coronado Ave.	24	4	4	0	20	3
B62	Long Beach City Beach, projection of 36th Place	30	5	3	0	18	2
B8	LBCB - W/side of Belmont Pier	48	7	3	0	45	6
B3	LBCB - E/side of Belmont Pier	32	5	4	0	28	4
B9	Long Beach City Beach, projection of Prospect Av.	24	4	0	0	13	2
B64	Long Beach City Beach, projection of Granada Av.	27	4	0	0	18	2
B65	Long Beach City Beach, projection of 54th Place	21	3	0	0	11	1
B10	Long Beach City Beach, projection of 55th Place	13	2	0	0	11	1
B66	Long Beach City Beach, projection of 62nd Place	14	2	0	0	12	2
B11	Long Beach City Beach, projection of 72nd Place	21	3	4	0	17	2

*All Exceedance Day calculations are rounded up to the next whole number (i.e., 0.2 days = 1 full exceedance day)
**Reductions unknown since winter dry and wet data do not yet exist for the Estuary

7.4 CRITICAL CONDITIONS

TMDLs are required to consider critical conditions and seasonal variation for streamflow, loading, and water quality parameters. The critical condition is the set of environmental conditions for which controls designed to protect water quality (e.g., WLAs) will ensure attainment of water quality standards for all other conditions. The intent of this requirement is to ensure protection of water quality in waterbodies during periods when they are most vulnerable.

The critical condition is wet weather and, in particular, the 90th percentile storm year is the critical wet weather year. The critical condition in a TMDL defines an extreme condition for the purpose of setting allocations to meet the TMDL numeric targets. The critical condition may also be thought of as an additional margin of safety because the allocations are set to meet the numeric target during an extreme (or above average) condition. Unlike many TMDLs, the critical condition for bacteria loading is not during low-flow conditions or summer months, but rather during wet weather. This is because intermittent loading sources such as surface runoff will have the greatest impacts at high (i.e., storm) flows (USEPA, 2001). As discussed in Section 3.4, waters tend to exceed water quality standards more frequently in wet weather compared to dry weather.

To identify the critical condition within wet weather, in order to set the allowable number of exceedance days, described in Section 7, the 90th percentile storm year in terms of wet days is proposed. 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 allow. Finally, it is expected 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 the Los Angeles International Airport (LAX) from 1947-2008. This rainfall database was chosen due to the extent of the database and to maintain consistency with the other bacteria TMDLs in the Los Angeles Region. With a 90th percentile storm year, only 10% of years should have more wet days than the 90th percentile year. The 90th percentile year in terms of wet days was 1993, which had 75 wet days. The number of wet days was selected instead of total rainfall because the TMDL's numeric target is based on number of days of exceedance, not on the magnitude of the exceedance.

7.5 MARGIN OF SAFETY

The federal statute and regulations require that TMDLs include a margin of safety to account for any lack of knowledge concerning the relationships between effluent limitations and water quality. The required MOS may be provided explicitly by reserving (not allocating) a portion of available pollutant loading capacity and/or implicitly by making environmentally conservative analytical assumptions in the supporting analysis.

The dry and wet weather TMDLs includes an implicit margin of safety. An implicit MOS was included in a number of ways:

- The TMDLs include an implicit MOS by evaluating dry-weather and wet-weather conditions separately and assigning allocations based on three associated weather conditions.
- Interpreting dry weather existing bacterial results with geometric means, decreases the variability seen in single sample grabs. In addition, no decay is included in the dry weather analyses.
- The wet weather model assumes no dilution between the storm drain and the wave wash. In addition, a conservative decay rate was also applied in the wet weather modeling analyses.

8 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Implementation measures may be developed in the future by the Regional Board through an implementation plan, NPDES permits or non-point source enforcement. This section describes USEPA's recommendations to the Regional Board as to the implementation procedures, regulatory mechanisms, and monitoring that could be used to provide reasonable assurances that water quality standards will be met.

8.1 CONSISTENCY WITH REGIONAL TMDLS

The Los Angeles River Bacteria impairment is addressed under a separate TMDL and has been incorporated into the Basin Plan Amendment with a schedule to meet compliance in 25 years (Resolution Number R10-007, approved by the State Board on November 1, 2011). USEPA recommends that waste load allocations and load allocations (expressed as allowable exceedance days) are achieved in a timeline consistent with the lower segments of the Los Angeles River Bacteria TMDL, and that the Regional Board consider options for providing time to comply, absent a state adopted implementation schedule, and consistent with the State Water Board's compliance schedule policy. Interim milestones should be linked to localized efforts to reduce bacteria loading in the direct drainage areas included in these TMDLs, and should consider the influence of upstream bacteria sources to the LAR Estuary and to the LBC Beaches.

The Regional Board is in the process of reconsidering a number of bacteria TMDLs and may revise them to include new time periods and methods. USEPA's expectation is that if adopted, the same new time periods and calculations methods will be used in the evaluation of these TMDLs.

8.2 PRIORITIZATION OF AREAS FOR IMPLEMENTATION

The TMDLs include the Long Beach dog zone as a potential source of bacteria. USEPA recommends better monitoring at this location to properly assess the impacts of the dog zone to the beach. Also, we recommend the City of Long Beach require dogs to be kept on a leash, and build an enclosed fence around the dog zone. This will help manage the dog zone as a potential source of bacteria to the beaches.

For any implementation plan, identification of appropriate management measures and prioritization of areas for implementation are critical steps prior to beginning implementation. Local stakeholder involvement and a schedule for implementation are also integral to any plan. Interim measureable milestones for assessing implementation effectiveness should be incorporated into a regular monitoring and adaptive management program aimed at determining whether load reductions are being achieved, and whether progress is being made towards attaining water quality standards. More information on watershed-based planning can be found in the EPA publication "Handbook for Developing Watershed Plans to Restore and Protect Our Waters" (2008).

8.3 COMPLIANCE MONITORING

To evaluate compliance with numeric targets, USEPA recommends that monitoring take place at existing monitoring sites as well as any new monitoring locations in the ambient water.

For beach monitoring locations, daily or systematic weekly sampling in the wave wash at all major drains and creeks, existing monitoring stations at beaches without storm drains, and freshwater outlets is recommended to evaluate compliance. At all beach locations, samples should be taken at ankle depth and on an incoming wave, consistent with 17 CCR 7961(b). At locations where there is a freshwater outlet, during wet weather, samples should be taken as close as possible to the wave wash, and no further away than 10 meters down current of the storm drain or outlet.

USEPA recommends that a robust monitoring program be developed for the LAR Estuary. Available data includes bi-weekly monitoring from May through September of 2009, and 2010. USEPA recommends that monitoring be expanded to include year round monitoring requirements, and at least three monitoring locations within the Estuary. We understand that adequate data to establish a reference estuary approach is currently not available. If in the future, adequate data from reference estuary studies become available, it may be appropriate to consider a reference estuary approach to evaluate compliance with these TMDLs.

8.4 NONPOINT SOURCES

Regional Board may regulate nonpoint pollutant sources through the authority contained in sections 13263 and 13269 of the California Water Code, in conformance with the State Water Resources Control Board's Nonpoint Source Implementation and Enforcement Policy, and the Conditional Waiver for Discharges from Irrigated Lands, adopted by the Los Angeles Regional Water Quality Control Board on November 3, 2005.

The Regional Board should consider working with municipalities to assess likely sources of bacterial loadings. Identification of specific management actions to minimize NPS inputs from beaches, marinas, animal and human, sources is required under the Nonpoint Source Implementation and Enforcement Policy. Development of education and outreach materials and consideration of local ordinances may be necessary to control NPS loads.

8.5 NON-STORMWATER NPDES PERMITS

NPDES permit limitations shall be consistent with the concentration-based WLAs established for non-stormwater point sources in these TMDLs (Table 6-1). Permit limits will need to meet the water quality targets established in these TMDLs and maintain water quality standards in the direct drainages. For permits subject to both dry- and wet-weather WLAs, USEPA expects that permit writers will write a monthly limit based on the dry-weather WLA and two separate daily maximum limits based on dry- and wet-weather WLAs.

8.6 GENERAL INDUSTRIAL STORMWATER PERMITS

Waste load allocations for the general construction stormwater permits (Table 6-1) should be incorporated into the statewide General NPDES Permit No. CAS000001 upon renewal or into a watershed-specific general permit developed by the Regional Board. The dry-weather waste load allocation equal to zero applies to unauthorized non-stormwater flows, which are prohibited by statewide General NPDES Permit No. CAS000001. We anticipate that any dry-weather discharges (allowed under special circumstances within the existing permit issued by the LA Regional Board) will be consistent with the assumptions and requirements within these TMDLs.

Wet-weather waste load allocations for the general industrial stormwater permittees should be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board. Compliance monitoring should be in the receiving water for numeric targets. The permitting agency may impose additional monitoring requirements to determine compliance in context with the appropriate permit. USEPA suggests that compliance with the WLAs for the existing Long Beach City Beach ocean sites and the estuary be demonstrated by meeting exceedance day targets at the point of discharge. These targets apply during both dry and wet-weather at all existing and future monitoring sites, since there is water contact recreation throughout the year.

8.7 GENERAL CONSTRUCTION STORMWATER PERMITS

Waste load allocations for the general construction stormwater permits (Table 6-1) should be incorporated into the State Board general NPDES permit No. CAS000002 upon renewal or into a watershed-specific general permit developed by the Regional Board. Compliance monitoring should be in the receiving water for numeric targets. The permitting agency may impose additional monitoring requirements to determine compliance in context with the appropriate permit. USEPA suggests that compliance with the WLAs for the existing Long Beach City Beach ocean sites and the estuary be demonstrated by meeting exceedance day targets at the point of discharge. These targets apply during both dry and wet-weather at all existing and future monitoring sites, since there is water contact recreation throughout the year.

8.8 MS4 AND CALTRANS STORMWATER PERMITS

Dry-weather and wet-weather waste load allocations apply to the MS4s and Caltrans permits (Table 6-3). These exceedance day-based waste load allocations should be incorporated into the Caltrans permit and all NPDES-regulated municipal stormwater discharges in the direct drainages, including the City of Long Beach MS4 permit and the City of Signal Hill, enrolled under the Los Angeles County MS4 permit. Compliance monitoring should be in the receiving water for numeric targets. The permitting agency may impose additional monitoring requirements to determine compliance in context with the appropriate permit. USEPA suggests that compliance with the WLAs for the existing Long Beach City Beach ocean sites and the estuary be demonstrated by meeting exceedance day targets at the point of discharge. These targets apply during both dry and wet-weather at all existing and future monitoring sites, since there is water contact recreation throughout the year.

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