MARINA DEL REY AND BALLONA CREEK

RECONNAISSANCE STUDY

(DRAFT REPORT)

Prepared for

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CHAPTER 1.0 INTRODUCTION

1.1 Authority

The authority for this report is the resolution adopted by the U.S. Senate resolution, July 25, 1969 and House of Representatives, 17 December, 1970.

1.2 Purpose and Scope

The purpose of the study at Marina del Rey and Ballona Creek is to investigate alternatives to improve or modify the existing Federal projects to mitigate shoaling and contamination problem at the Marina del Rey Harbor entrance. The reconnaissance phase is conducted in order to accomplish the following essential objectives:

• The definition of problems and opportunities, and identification of potential solutions; and

• A determination whether the planning should proceed further into a feasibility phase, based on a preliminary appraisal of the Federal interest, cost, benefits, and environmental impacts of the identified potential solutions.

The specific scope of work of this study includes collection and review of existing data that are pertinent to the shoaling and sediment contamination at Marina del Rey Harbor, definition of the problems, and recommendation of potential mitigation alternatives. The service includes performing engineering and environmental analyses and economic evaluation consistent with the established criteria for conducting such studies, and preparing a draft report and appendices for the reconnaissance study for the shoaling and sediment contamination at Marina del Rey Harbor and Ballona Creek.

1.3 Study Conduct

The Reconnaissance Report recommending a Feasibility Study is forwarded by the District to the South Pacific Division for review upon completion. The review by the Division will be limited to 30 days from submission of the report or the negotiated Feasibility Cost-Sharing Agreement (FCSA), whichever is later.

If approved by the Division Engineer, the Reconnaissance Report will be submitted to Washington for certification of accord with current policies and budget priorities. The report must be accompanied by the negotiated FSCA with a Scope of Study (SOS) including the Feasibility Phase cost estimate and a Letter of Intent (LOI) from the local sponsor stating that the sponsor is ready, willing, and able to execute the agreement.

Following certification, the Reconnaissance Report will be sent back to the Los Angeles District where the FCSA willl be signed.

1.4 Public Involvement

The following public parties were consulted during the course of this study:

- County of Los Angeles Department of Public Works
- County of Los Angeles Department of Beaches and Harbors
- Los Angeles Regional Water Quality Control Board
- State of California Water Resources Control Board
- Santa Monica Bay Restoration Project
- City of Los Angeles Department of Public Works

These public and government organizations/agencies were contacted for the purposes of this study including data input, their interests in the project and specific comments relative to their jurisdictional or professional concerns.

CHAPTER 2.0 EXISTING CONDITIONS

2.1 Study Area Description

The project site for this study includes Marina del Rey Harbor and Ballona Creek Watershed. The site plan is shown in Figure 2.1.

2.1.1 Marina del Rey Harbor

Marina del Rey Harbor is located in Santa Monica Bay, California, south of Venice and north of Playa del Rey, and about 15 miles southwest of downtown Los Angeles (Figure 2.1). Constructed in 1960, Marina del Rey Harbor is the largest artificial small-craft harbor in the world accommodating more than 6,000 private pleasure boats. The marina is protected at its entrance by two jetties and a detached breakwater, and is adjacent to the Ballona Creek flood control channel to the south. Major characteristics of the harbor system are shown in Table 2.1.1.

Table 2.1.1 Major Characteristics of the Constructed System of Marina del Rey Harbor

Feature	Completion Date	Design Depth (ft below MLLW)	Width (ft)	Approximate Length (ft)
Offshore Breakwater	1965			2,300
Entrance Jetties:				
Middle	1959			2,000
North	1959			2,000
South Jetty	1946			1,350
Entrance Channel		20	700-1,000	5,100
Entrance Channel Revetment:				
South Side				2,700
North Side				2,600
Main Channel:				
South Portion		15	1,000	1,300
North Portion		10	1,000	2,600
Side Basins (8)		10	450-600	1,200-2,400
Intervening Moles (6)			350	1,200-2,400

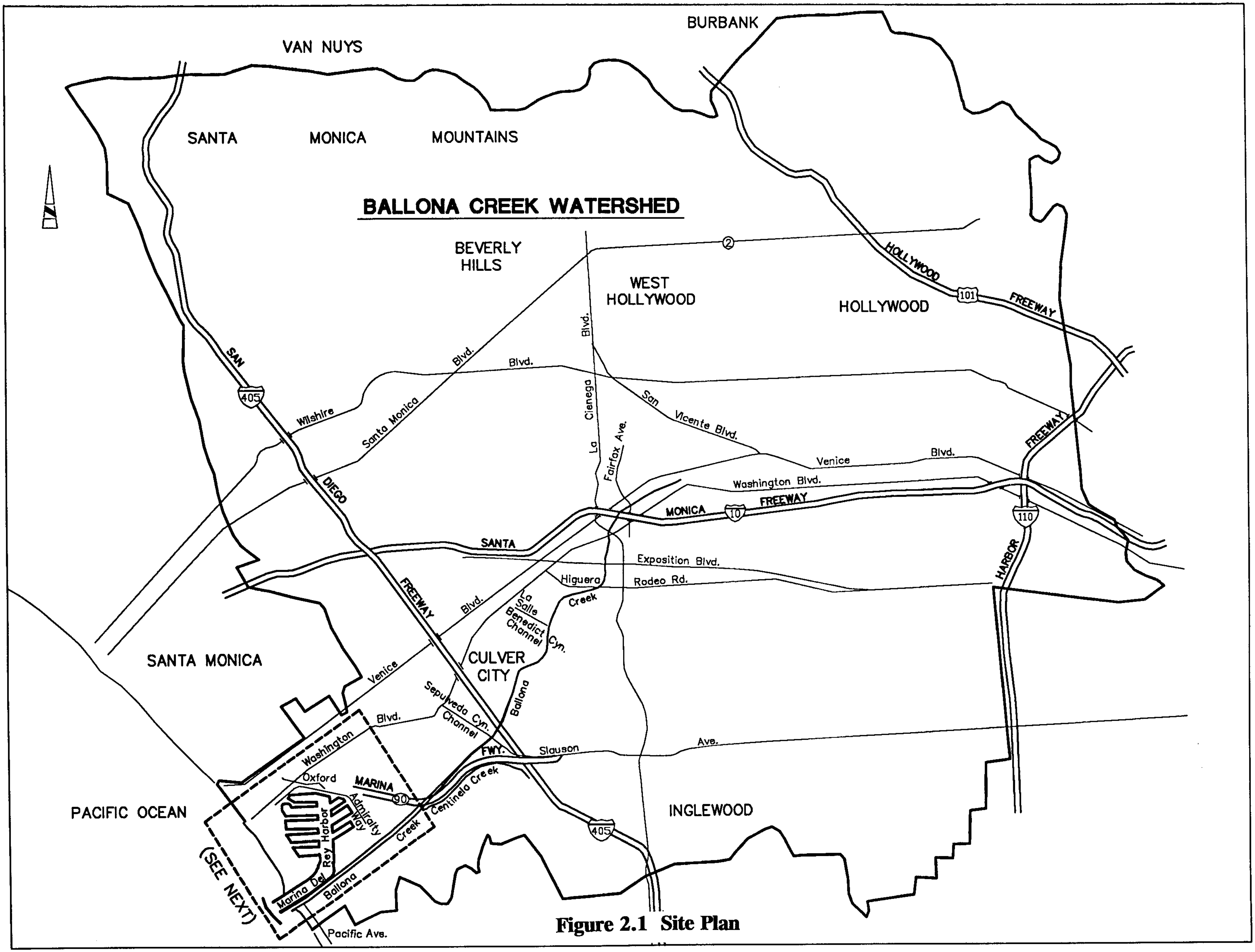

Figure 2.1 Site Plan

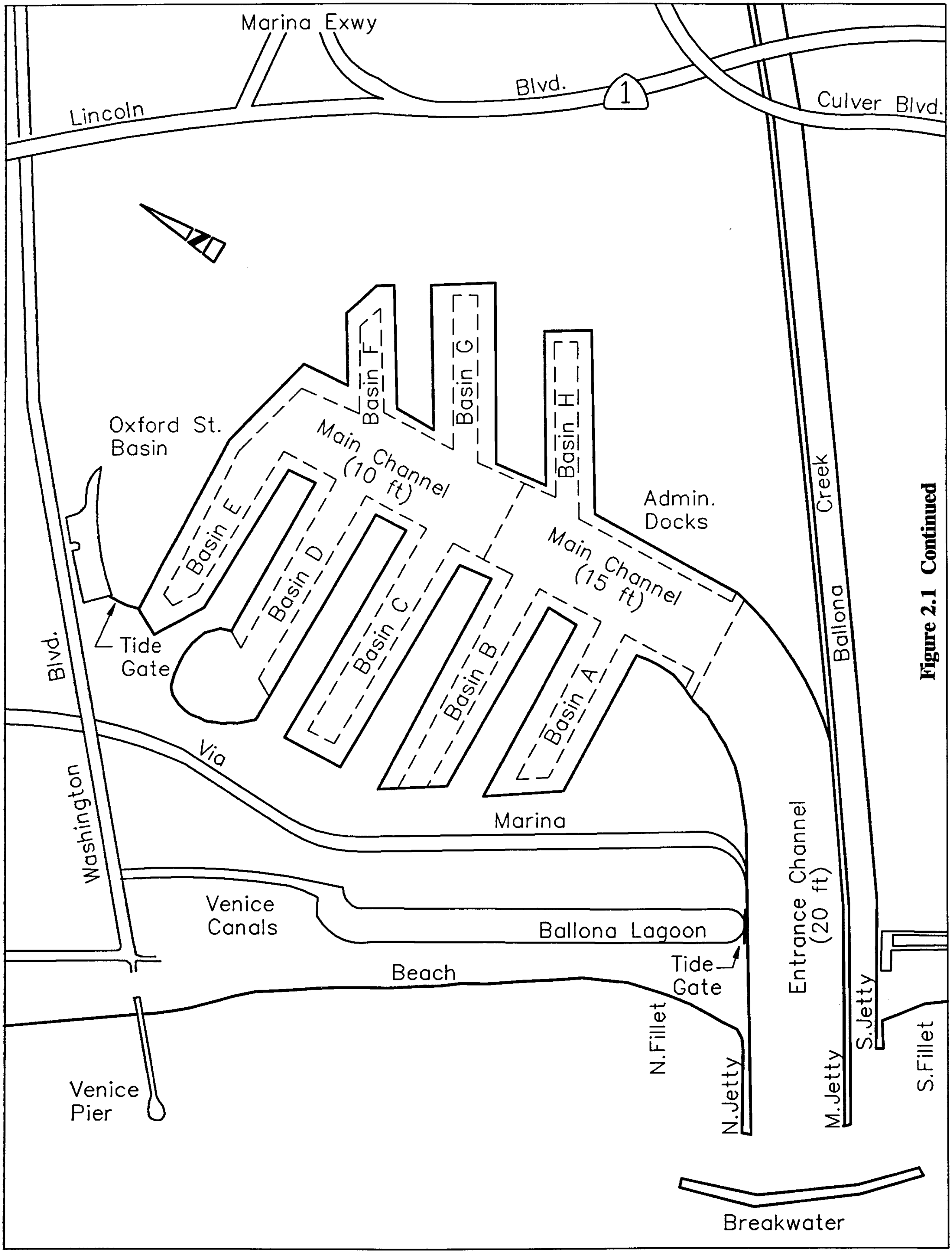

Figure 2.1 Continued

2.1.2 Ballona Creek

Ballona Creek drains from the Ballona Creek watershed with a drainage area of about 130 square miles. The boundary of the watershed is shown in Figure 2.1. The drainage into Ballona Creek is provided by its tributaries including Centinela Creek, Sepulveda Canyon Channel and Benedict Canyon Channel, and storm drains. The collected water is discharged into Santa Monica Bay at the mouth of Ballona Creek immediately south of Marina del Rey Harbor. The land uses of Ballona Creek Watershed consist of residential, commercial, light industrial, public land and other urban usages. There is, however, substantial natural/open land in the northern part of the watershed and south of Ballona Creek.

2.1.3 Federal Projects

The Federal projects include a navigation channel, two entrance channel jetties, upper channel bank protection, a detached entrance channel breakwater and a flood control jetty.

The navigation channel commences at the gaps between the entrance jetties and the offshore breakwater and extends about 2 nautical miles into the harbor with eight lateral basins on the sides of the main channel. The design depth of the entrance channel is 20 ft MLLW (Mean Lower Low Water) with a width of about 700-1,000 ft and a length of about 5,100 ft. The main channel is maintained at a depth of 15 ft MLLW for the south portion and 10 ft MLLW for the north portion. The middle and the north jetties at the harbor entrance (both completed in 1959) extend about 2,000 ft into the ocean. The breakwater, built in 1965, is about 2,330 ft in length oriented parallel to the shore, and about 300 ft offshore of the tips of the entrance jetties.

In addition, it is also Federal responsibility to maintain the Ballona Creek Flood Control Channel seaward of Pacific Avenue (near the mouth) and between La Cienega Boulevard and La Salle Avenue (upstream).

Define Federal Flood Control Project and non-Federal limits

2.2 Physical Environment

This section presents a characterization of the physical environment at Marina del Rey and Ballona Creek. A more detailed description is contained in Appendix A.

2.2.1 Geology

The geomorphology and geology of Marina del Rey Harbor area is part of the geological setting of Santa Monica Bay, which features Palos Verdes, Malibu Coast and Dume Faults, gas/oil seeps parallel to the Malibu coastline and on the mid/central shelves, and Santa Monica and Redondo Canyons. On the shelf off Marina del Rey, the thickness of quaternary sediments was observed to increase with distance offshore. Zones of potentially active short discontinuous faults and gas/oil seeps are significant features of the mid-shelf region off Marina del Rey (Moffatt & Nichol, 1993).

Shelf sediments near Marina del Rey are predominantly sand (0.063-2 mm). Silt/clay content increases from about 0.6% upcoast of Marina del Rey to about 13% downcoast, and is about 49% in mid-shelf region and about 28% farther offshore (CLA, 1993).

2.2.2 Bathymetry

The offshore bathmetry of Marina del Rey features relatively regular, nearly shore-parallel contours. The typical slope directly offshore of the breakwater is about 1:130. This feature extends approximately 5 nautical miles upcoast beyond Santa Monica Pier and about 3 nautical miles downcoast to El Segundo area. Inshore of the breakwater, the bathymetry is modified by the development of sand fillets on the upcoast and downcoast sides of the north and the south Jetties, respectively. The shallow contours bend offshore at the jetties to intersect the breakwater, forming a nearly symmetrical, crescent-shaped shallow area around the entrance of Marina del Rey Harbor.

2.2.3 Precipitation

The mean annual precipitation in the region is typically about 12 inches, although large year-to-year variations are common. Most rainfall events are associated with winter cold fronts. Summer rainfall rarely occurs due to the blocking effects of the Pacific High on frontal systems. Precipitation is significantly low in the dry season (May-October) compared with that in the wet season (November-April). The average total rainfall during a wet season in the area is about 11 inches whereas that during a dry season is about 0.8 inches based on historical data from Los Angeles Airport.

2.2.4 Winds

Data recorded at the Los Angeles Weather Bureau Airway Station indicate that the prevailing winds are westerly and west-southwesterly seabreezes with a mean speed of about 8 knots. The predominant wind speed is about 4-10 knots which occurs about 57% of the time.

2.2.5 Tides

Tides in Marina del Rey are of mixed type consisting of diurnal and semidiurnal constituents, which is typical of Southern California Coast. Data derived from observations near Los Angeles Outer Harbor are shown in Table 2.2.1.

Table 2.2.1 Tide Levels

Tide	Water Elevation (Feet,MLLW)
Highest Tide (Jan. 27,1983)	7.96
Mean Higher High Water	5.52
Mean High Water	4.77
Mean Tide Level	2.80
Mean Low Water	0.95
Mean Lower Low Water	0.00
Lowest Tide (Dec. 17,1933)	-2.59

2.2.6 Waves and Nearshore Currents

2.2.6.1 Waves

The Marina del Rey area is exposed to waves generated by Northern Hemisphere extratropical and tropical storms and Southern Hemisphere winter storms, and by local winds. The principal direction of the prevailing waves is about 266 degrees azimuth. The prevailing wave height and period are about 3 ft and 13 sec, respectively.

The extreme wave climate at Marina del Rey consists of extratropical, tropical and Southern Hemisphere winter storms with waves heights being about 12, 8 and 2 ft for the 5-year events and 19, 12 and 5 ft for the 50-year events, respectively. The wave climate at Marina del Rey is dominated by the influence of extratropical storms. Southern swells are also important during summer. In addition, waves associated with the pre- and post-frontal winds of extratropical storms may also be a mechanism in generating currents and sedimentation if strong and persistent.

Numerical modeling results showed that the breakwater-jetty complex of the Marina del Rey Harbor entrance reduces the incoming wave energy by about 90-100%, creating effectively a low-energy zone inside the harbor. Local wind chop and boat waves thus become important components in wave climate within the harbor.

2.2.6.2 Nearshore Currents

Nearshore currents consist of tidal and subtidal currents as well as wave-induced longshore currents in the surf zone. Oceanographic data analysis on currents in this region indicates that the typical short-term current speed on Santa Monica Shelf is about 0.7-1.0 fps depending on the time scale of interest. The mean subtidal currents are typically about 0.7 and 0.2 fps on the time scales of a week and a month, respectively.

The general surface flow is onshore in late winter and a southward flow in spring and summer times near Marina del Rey. The longshore current is predominantly southward in the vicinity of Marina del Rey. Seasonal, short-term northward reversals of longshore current, however, may occur when, *e.g.*, southern swells approach this part of shoreline.

2.2.7 Littoral Transport and Barriers

Marina del Rey is located in the Santa Monica littoral cell which extends from Point Dume to Palos Verdes Point and contains Dume and Redondo Submarine Canyons. Development of this part of coastline with the contruction of a significant number of structures along the shore has essentially stabilized the beach and prevented significant longshore transport. Shoreline erosion has been found non-critical from Santa Monica to Redondo Beach.

2.2.7.1 Littoral Barriers

In general, estimates of littoral transport quantities are strongly influenced by coastal construction. Major coastal structures may act as littoral barriers that affect the longshore transport of sediment by impounding sediments and/or rerouting sedimentation, whereby altering the sediment budget along the neighboring shoreline. Hence, littoral drift must be evaluated within the context of the distribution and the history of coastal structures in the study area. Table 2.2.2 presents a list of major structures up-/downcoast of Marina del Rey (Tekmarine, 1985; Shaw, 1980).

Table 2.2.2 Major Structures Influencing Littoral Drift near Marina del Rey

Location	Structure	Construction Date	Status
Sunset Blvd to Santa Monica Pier	10-20 groins	1928 (earliest)	4 groins exist
Santa Monica	Santa Monica Pier	1909 & 1912	Exists
Santa Monica	Santa Monica Breakwater	1934	Exists
Santa Monica Pier to Venice Breakwater	3 groins	1938 (earliest)	2 groins exist
Ocean Park	Ocean Park Pier	Pre-1935	No longer exists
Venice Beach	Venice Pier & Breakwater	1904	Breakwater only
Venice Beach	1 groin	Post-1946	Exists
Marina del Rey	Entrance channel jetties	1958 (initial construction 1946)	Exist
Marina del Rey	Entrance channel breakwater	1965	Exists
Ballona Creek	Jetties	1938 (completed 1946)	Exist
Old Ballona Creek	Jetties	1909	No longer exist
Ballona Creek to Redondo Beach	4-8 groins	Pre-1946 (earliest)	4 groins exist
Redondo Beach	Redondo Beach Breakwater	1939	Exists

2.2.7.2 Longshore Transport

The net longshore transport in the study area has been observed to be southward. This is consistent with the prevailing wave directions as discussed earlier. Previous studies on the longshore transport quantities span a period during which new structures were added along this stretch of shoreline. No estimates are available for the Marine del Rey Harbor vicinity.

For lack of long-term nearshore/beach profiling data and complete dredging records, estimates of longshore transport quantities along this part of coast have been inconclusive. Because of structural alterations and/or the largely qualitative nature of some of the studies, many of the earlier results are either not quantitatively reliable or out of date.

Based on a review of the approaches of the more recent studies and the times they were conducted, it appears that the longshore transport upcoast of Marina del Rey near Santa Monica is typically about 95,000 cy/yr.

2.2.7.3 Cross-Shore Transport

Cross-shore transport is in general associated with the seasonal variation of the beaches. Little information exists on the cross-shore transport near Marina del Rey. Its magnitude and effects, however, can be inferred from the beach/shoreline profile records or sediment budgeting.

2.2.8 Ballona Creek Watershed

Ballona Creek Watershed has a drainage area of about 130 square miles and is one of the largest drainage basins in the Santa Monica watershed. The watershed drain through Ballona Creek (including its tributaries Centinela Creek, Sepulveda Canyon Channel and Benedict Canyon Channel) and discharges into Santa Monica Bay. The watershed land use consists primarily of residential, commercial, light industrial, public land and other urban usages. There is, however, a substantial strip of open/undeveloped land along the downstream stretch of Ballona Creek extending to the coast south of Marina del Rey (SMBRP, 1992, 1993).

2.2.8.1 Runoff Discharge

The flow discharge from Ballona Creek has been recorded by Los Angeles County Department of Public Works (LACDPW, 1994) at its station near Sawtelle Boulevard. Typical discharges based on a frequency analysis are summarized in Table 2.2.3. (The daily discharges are defined as the daily-mean flows).

Table 2.2.3 Characteristics of Flow Discharge from Ballona Creek (1928-1992)

Median Discharge (cfs)				Most Frequent Discharge (cfs)				Seasonal Occurr. of Peak Flow	
Mean Daily	Min Daily	Max Daily	Ann'l Peak	Mean Daily	Min Daily	Max Daily	Ann'l Peak	Most Freq.	Least Freq.
42	5.5	2,250	12,400	33	3.5	1,110	8,723	Dec-Feb	Jun-Aug

It is noted that the maximun daily flow is about 400 times the minimum daily flow, which is suggestive of the dominant influence of stormwater runoff.

The peak flows in Ballona Creek, which are often associated with the largest amount of sediment discharge, appear to be the most frequent in winter times and rarely occur during summer months. Table 2.2.4 shows the results of a frequency analysis on the annual peak flows in Ballona Creek.

Table 2.2.4 Return Periods of Extreme Discharges from Ballona Creek

Return Period (Year)	Discharge (cfs)
10	22,000
25	27,500
50	32,000
100	36,000

2.2.8.2 Sediment Production

Existing studies on Ballona Creek sediment production suggested that Ballona Creek yields about 46,000 cy of sandy material and about 5,300 cy of silt. These numbers, however, are subject to significant changes due to their dependency on the land use, water management and hydrological conditions in the Ballona Creek Watershed.

Based on the large difference in the annual mean and the annual maximum daily flows and the concentration of large discharge events in the wet months, it appears that the sediment production through Ballona Creek to the coast is predominantly associated with large rainfall runoff events during months from November to April.

2.2.9 Air Quality and Noise Level

Air quality is generally better in Marina del Rey than inland locations due to the consistant onshore wind. In 1992, the state standard for ozone (0.09 ppm) was exceeded 45 days and the Federal standard of 0.12 ppm was exceeded twelve days, which was an improvement over 1989 when the state standard was exceeded 65 days and the Federal standard 15 days. Carbon monoxide and sulfur dioxide were below both the state and Federal standards, whereas nitrogen dioxide exceeded the state standard one day. Major sources of air pollution at the harbor are motor vehicles and boats. Noise levels are relatively high for a coastal area, with principal sources being motor vehicles, and assorted recreational and commercial establishments. Air quality decreases and noise levels increase during summer months due to less favorable atmospheric conditions and increased recreational use, respectively.

2.3 Harbor Shoaling

This section presents a characterization of the existing condition of shoaling in Marina del Rey Harbor. Expanded analyses are contained in Appendix A.

2.3.1 Historic Dredging Needs

A history of major maintenance dredging and disposal activities at Marina del Rey after the completion of the offshore breakwater in 1965 is shown in Table 2.3.1 based on the data furnished by the USACE (1994a). Note that the Ballona Creek mouth is herein defined as the channel maintenance area fronting the outlet of Ballona Creek.

Table 2.3.1 Dredging/Disposal History at Marina del Rey (USACE, 1994)

Year	Dredging Location	Dredging Quantity (cy)	Disposal Location
1969	Ballona Creek mouth	452,000	Del Rey Beach
1973	Shoal along south side of north jetty	11,000	Upcoast of north jetty
1981	Entrance shoal; Ballona Creek mouth	233,000	South of Dockweiler Beach
1987	Jetty tips; Ballona Creek mouth	131,000	Dock "
1992	Ballona Creek mouth	17,000 (Knockdown)	Local

The average annual dredging/maintenance rate is about 31,000 cy/yr after the breakwater contruction. It is noted that the Ballona Creek mouth has been the most frequently dredged since the breakwater was built. The accumulation of Ballona Creek sediments at the Creek mouth increases the availability of sediments to be transported into the harbor through tides and sand wave migration.

Dredging rates, however, do not necessarily represent shoaling rates since the maintenance dredging operations often differ in area, ~~and~~ depth, and frequency.

2.3.2 Harbor Shoaling

Shoaling at Marina del Rey Harbor is the composite result of deposition of sediments primarily from littoral drift and Ballona Creek discharge. It corresponds to the quantity of sediment deposits that need to be removed in order to maintain the federally defined channel. Thus sediment deposition in places away from the maintained areas is by definition excluded in quantifying harbor shoaling.

More recent rates of shoaling were obtained in this study based on the USACE condition surveys for entrance channel and vicinity, which include the post-dredge survey of December, 1992 and the most recent condition survey of June, 1994. The shoaling pattern in the vicinity of the entrance is presented in Figure 2.2, which shows the locations that shoaled and the depths of shoaling. Table 2.3.2 shows the calculated shoaling rates. These rates and the corresponding areas are also shown in Figure 3.3.

Table 2.3.2 Shoaling Rates of Marina del Rey Entrance Channel Maintenance Area

Area	Shoaling Rates (cy/yr)
Entrance Channel Maintenance Area Total	92,000
Outer Entrance Channel Maintenance Area	81,600
Between Breakwater and North Fillet	6,500
Ballona Creek Mouth	18,000
Entrance Channel	57,100

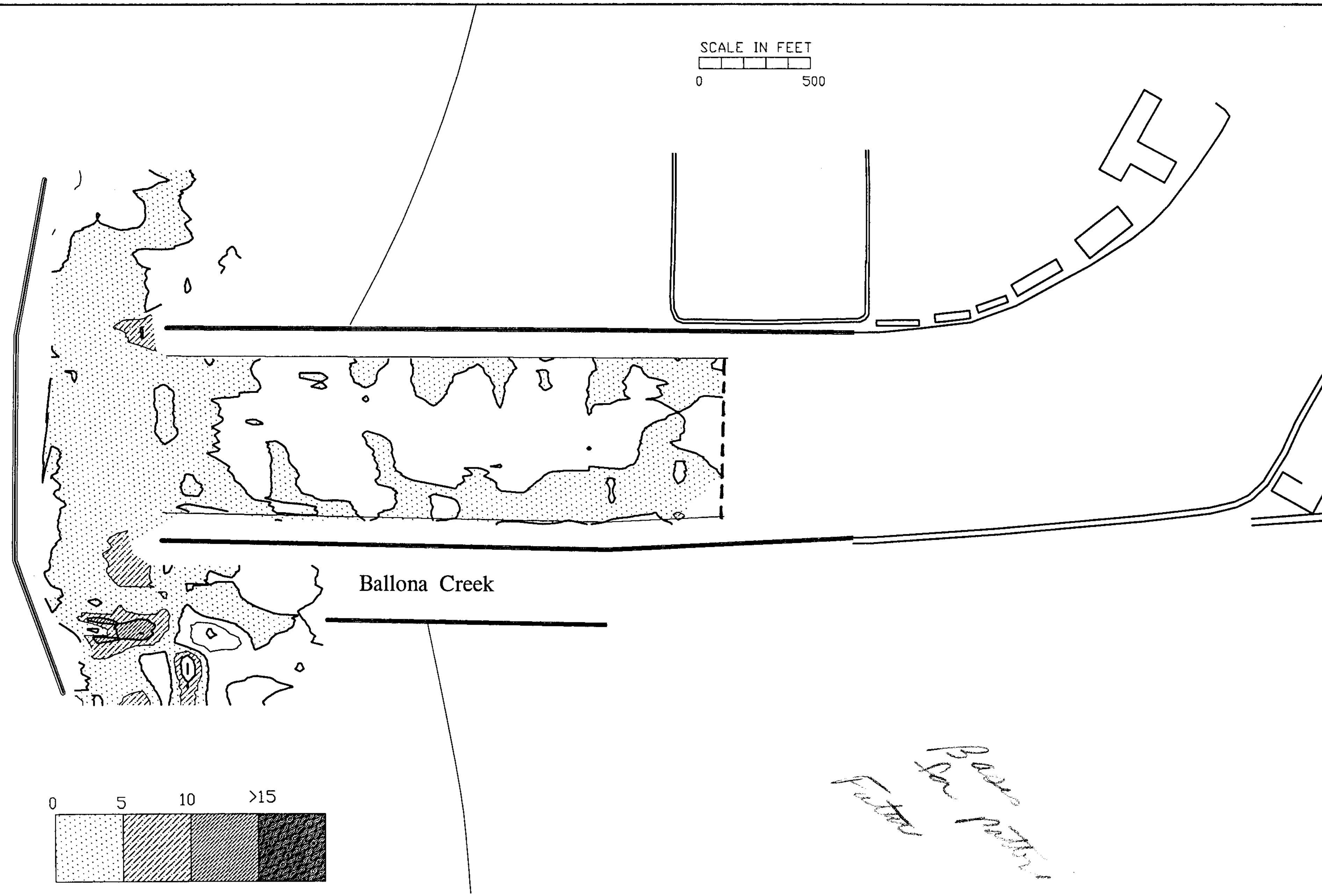

Figure 2.2 Shoaling Pattern

2.4 Marine Contamination

This section presents a characterization of the marine contamination in Marina del Rey Harbor and the potential contamination sources. A detailed description is provided in Appendix A.

The existing condition of marine contamination at Marina del Rey consists of benthic contamination and water column contamination. While the former pertains to pollution in seabed sediment layers, the latter is primarily associated with pollutants that are dissolved in water or bound on nonsettleable colloids/fines in the water body above the seabed.

2.4.1 Benthic Contamination

For practical purposes and the nature of data available, the sedimentary condition in Marina del Rey Harbor was analyzed for two relatively distinct parts of the harbor, namely, the entrance channel areas (including entrance channel, approach channels and the area fronting the Ballona Creek) and the basin areas (including the main channel and the seven berthing basins).

2.4.1.1 Grain Size Distributions

2.4.1.1.a Entrance Channel Areas

Bulk physical tests on samples from 29 borings in the vicinity of Marina del Rey harbor entrance were conducted by the USACE South Pacific Division Laboratory (Moffatt & Nichol, 1993; USACE, 1994b). The distribution pattern of the median grain size is shown in Figure 2.3. It was observed that:

- Sediments in the shoals adjacent to the inner sides of the jetties along the entrance channel are substantially similar to those in the sand spits near the tips of the middle and north jetties. These sediments are sand with a typical size of about 0.2 mm;

- Sediments progressively finer near the centerline of the entrance channel with a typical grain size of 0.02 mm; the transverse gradation from fine to coarse as approaching the channel sides appears to result from the fact that the side shoals are in appreciably shallower water and thus more exposed to persistent wave-induced extraction of fines resulting in a coarser composition;

- Sediments at the Ballona Creek mouth are slightly coarser near the middle jetty with a typical grain size of about 0.3 mm, but are elsewhere similar to those from the middle jetty spit with a median of about 0.2 mm. Especially, there is a coarse-to-fine gradation away from the outlet of Ballona Creek, suggesting a progressive deposition from a sediment-laden discharge from Ballona Creek;

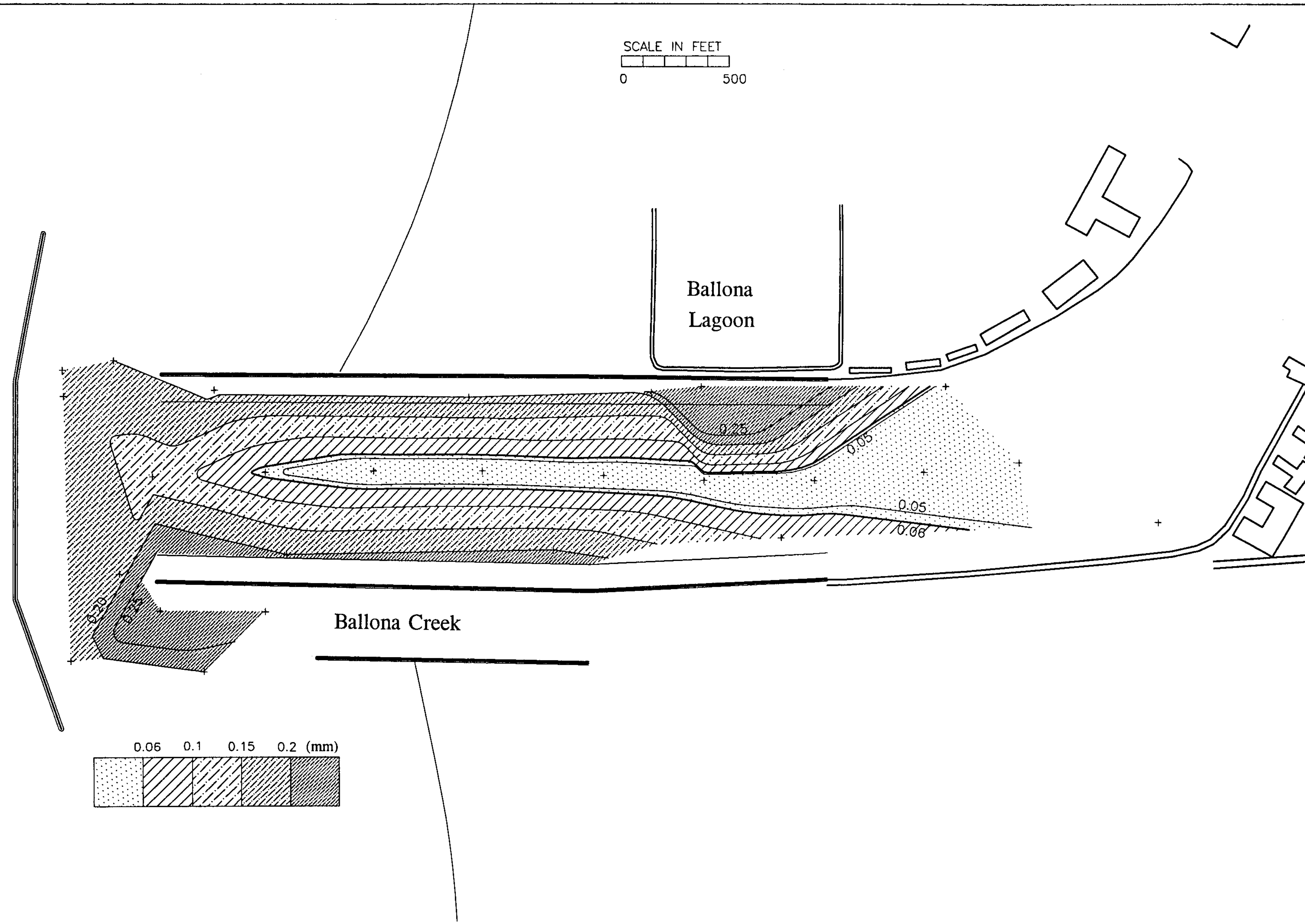

Figure 2.3 Median Grain Size Distribution

• Sediments near Ballona Lagoon on the north side of the entrance channel exhibit a clear coarse-to-fine gradation away from the lagoon outlet, which suggests the presence of a sediment-laden discharge from the lagoon into the entrance channel;

• Sediments near the bend of the navigation channel are predominantly silt/clay.

The sedimentary composition and depositional pattern in the area fronting Ballona Creek mouth suggest that the sediments in the shoals in this area have been primarily produced by Ballona Creek. This observation is further substantiated by a strong correlation between the stormwater runoff from Ballona Creek and the increase in sand fraction.

There appears to be an appreciable sediment discharge from Ballona Lagoon due to bank erosion in the lagoon during stormwater runoff events. Part of the sediments may also come from storm drains, which have no sediment traps, during runoff. The weekly flushing of Venice Canals through Grand Canal tide gates on Washington Boulevard and Ballona Lagoon is another potential source of sedimentation.

2.4.1.1.b Basin Areas

Based on data presented in Soule *et al.* (1993), the surface sediments in the basin areas are predominantly silt/clay as shown in Table 2.4.1.

Table 2.4.1 Silt/Clay Contents in Sediments in Basin Areas

Location	Silt/Clay Content (%)
Basin F	100.0
Basin E	97.7
End of Main Channel	99.9
Basin D	80.6
Main Channel	98.9
Basin H	97.8
Basin B	59.9
Administration Docks	97.5
Mean of Inner Areas (Basins E, F and End of Main Channel)	99.2
Mean	91.5

The low-energy environment in the inner harbor basin areas is apparently condusive to the deposition of fine sediments in large quantities. It is difficult, however, to determine the origins of the silty deposits due to the fact that the fine particles normally stay in suspension for a relatively long time during which they are transported away from their sources while mixing with particles from other sources. This eventually confounds the physico-chemical signatures they bear of their origins. Potential sources include Ballona Creek, Oxford St. Basin, Washington Bl. Drain and major storm drains, Ballona Lagoon. Longshore drift around the north jetty may also have contributed but probably is not a major source considering the level of contamination associated with the silty sediments.

2.4.1.1.c Comparison with Nearby Beaches and Upstream Ballona Creek

Sediments from Dockweiler Beach to the south of Marina del Rey Harbor have median size of about 0.14 mm (Toxcan, 1991), and consist of about 98% sand and 2% fines with about 69% between 0.062 and 0.125 mm. It appears that the median size is appreciably smaller than that at the Ballona Creek mouth which is typically about 0.3 mm.

Sediments trapped on the north fillet bear the signature of those on the upcoast beaches. These sediments have a median size of about 0.2 mm, which is finer than those at the Ballona Creek (0.3 mm) but about the same as those in the side shoals along the inner sides of the jetties in the outer part of the entrance channel (0.2 mm). Detailed distributions are presented in Appendix A.

No long-term data on sediments in the upstream reaches of Ballona Creek are available. In fact, characteristics of sediments in the upstream reaches are in general transient because of their dependence on runoff events. Therefore any short-term data are not meaningful in characterizing the sediments in the stream. On the other hand, the deposits at the Ballona Creek mouth consists of sediments from repeated deposition from Ballona Creek discharges and thus provide a valid indication of the characteristics of upstream sediments, at least for the sandy loads, over numerous runoff discharge events.

2.4.1.2 Contamination Levels

2.4.1.2.a Entrance Channel Areas

The bioassay tests of sediments from Marina del Rey Harbor indicated significant mortality of test animals. The bioaccumulation tests also showed that heavy metals, lead, copper and chromium in particular, are the contaminants of potential threat.

Bulk chemistry tests of Marina del Rey sediments were recently conducted by the USACE based on samples taken from 29 borings in the approach channel, entrance channel and the Ballona Creek mouth. The complete test data are shown in Appendix A.

Results of dilution tests suggested that the most prominent comtaminant in Marina del Rey sediments is lead since it requires the largest dilution due both to the relatively high concentration in the sediments and to the relatively restrictive water quality standard. Chromium, copper and PCBs are also of concern compared with other species.

It should be noted, however, that the final selection of the *contaminants of concern* for a specific project should be based on multi-agency consultation as well as the testing results.

2.4.1.2.b Basin Areas

Data of contaminant concentrations in surface sediments from harbor basin areas were obtained from a long-term monitoring study by University of Southern California. Based on the analysis of the sampling data, it was found that the harbor basin areas are more contaminated than the entrance channel areas except for oil/grease and PCBs.

2.4.1.2.c Comparison with Santa Monica Bay

Comparison of the benthic contamination levels in Marina del Rey entrance channel areas with those in Santa Monica Bay were made based on data of the Environmental Monitoring Program maintained by the City of Los Angeles (Appendix A).

It was found that the mean concentration levels of arsenic, lead, zinc, oil/grease, sulfides and TOC (total organic carbon) in Marina del Rey exceed the background levels in the Santa Monica Bay. Of particular concern, again, is the lead concentration in Marina del Rey sediments which is about four times the background lead level in the Bay. Oil/grease and zinc levels in Marina del Rey are also significantly elevated than the baywide means. PAHs (polynuclear aromatic hydrocarbons), however, were found to be insignificantly low in the Bay and detected only at a few spots in Marina del Rey Harbor.

2.4.1.3 Contamination Pattern

Spatial patterns of contamination can be determined from the USACE 29-boring sampling and testing data (Moffatt & Nichol, 1993; USACE, 1994b). Figures 2.4 presents a composite map of the depth-averaged concentrations of four typical contaminants, *i.e.*, oil/grease, TOC, total PCBs (polychlorinated biphenyls) and lead, for the upper 2 ft of sediments from the mud lines. The distributions of concentrations averaged over the total depths of measurements exhibit similar patterns. The following characteristics are noted:

- Contamination levels are consistently high at the following locations:

- Shoals near the entrance channel centerline;

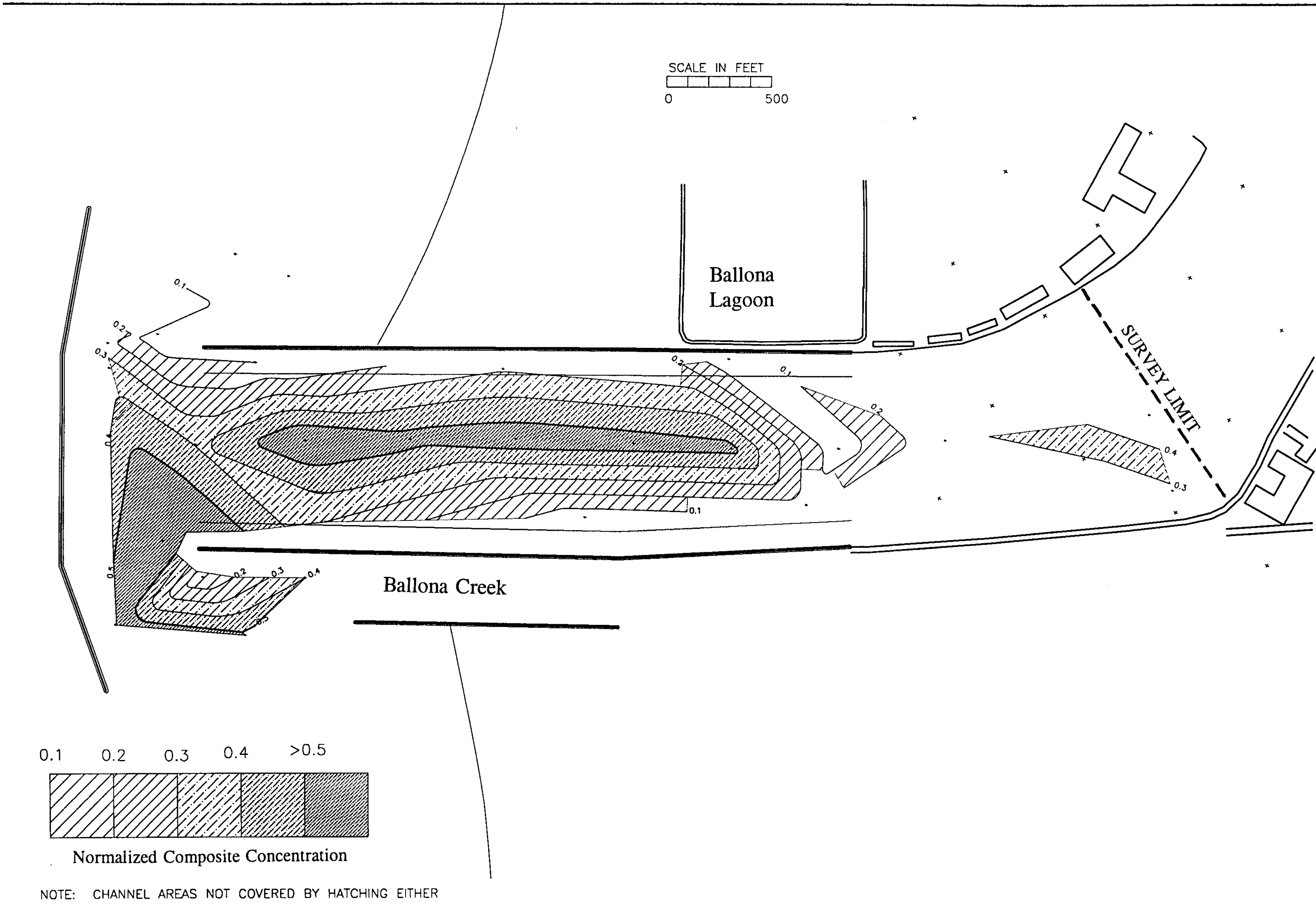

Figure 2.4 Composite Contamination Pattern

- Shoals near the foot of breakwater fronting the Ballona Creek mouth;
- Ballona Creek mouth (before discharge plume expands);

• Contamination levels are low along the entrance channel sides near the jetties, consistent with the relatively coarse material present in these places;

• Contamination levels at the north fillet (north of the north jetty) are significantly lower than those in the channel (typically by an order of magnitude);

• Contamination levels in the entrance channel near the outlet of Ballona Lagoon are low.

The contaminant distribution also suggests that the sediment load carried by the discharge plume from Ballona Lagoon is less contaminated than the sediments in the entrance channel. Hence Ballona Lagoon does not appear to be a major and persistent source for contaminated sediments.

2.4.2 Water Column Contamination

2.4.2.1 Water Quality

The analysis of data on the existing condition of water quality in Marina del Rey indicates the following:

• The influence of the terrestrial stormwater runoff on water quality in Marina del Rey is apparent from the relatively robust correlation between the wet season and the elevated concentrations of BOD, nutrients, bacteria counts and the responses of physical water quality parameters;

• The inverse relationship between salinity and nutrient concentrations in the harbor suggests that the nutrients are derived from terrestrial origins (Soule *et al.*, 1993), which further substantiates the observation of stormwater runoff as the primary source of contamination in Marina del Rey Harbor;

• The water quality within Marina del Rey Harbor may deteriorate considerably during the wet season posing potential public health problems as indicated by the appreciable exceedances of the public health standards in bacteria counts during months of significant stormwater runoff.

Since the terrestrial stormwater influx into Marina del Rey Harbor originates predominantly from Ballona Creek, Oxford St. Basin, Washington Bl. Drain and Ballona Lagoon, they appear to be the most significant potential sources of water column contamination in Marina del Rey.

2.4.2.3 Flushing Ability

The flushing characteristics of Marina del Rey Harbor under the influence of Ballona Creek discharge was analyzed based on an analytical flushing model.

It was found that, when the contaminant mass emission from Ballona Creek is negligible (*e.g.* during dry seasons), a contaminant released in Marina del Rey Harbor take about 5 days to be diluted by 10 times from its initial concentration by tidal flushing. The time required for the same flushing effect, however, increases dramatically as the external loading from Ballona Creek contaminant increases (*e.g.* during wet seasons) which implies that the flushing effeciency becomes much lower. Figure 2.5 presents the flushing characteristics of Marina del Rey as influenced by Ballona Creek. For example, the contaminant concentration in the harbor is only reduced by half 5 days after the release when the contaminant mass discharged from Ballona Creek is about twice that from Marina del Rey Harbor.

It can therefore be deduced that the contamination levels in Marina del Rey Harbor are highly sensitive to contaminant discharges from Ballona Creek.

2.4.3 Contamination Sources

2.4.3.1 Point Sources

A point source is a discernible, confined and discrete conveyance from which pollutants are or may be discharged (Section 502 (14), Clean Water Act). Typical point sources that affect marine environment include municipal wastewater and industrial effluent discharges. A point source discharge is subject to the permit requirements of the Clean Water Act (CWA). All legally defined point sources that discharge into Santa Monica Bay have been issued NPDES (National Pollutant Discharge Elimination System) permits by the Regional Water Quality Control Board with the concurrence of the USEPA.

2.4.3.1.a NPDES Municipal/Industrial Discharges

Major point sources along the coastline near Marina del Rey and their potential effects on contamination in Marina del Rey are listed and analyzed in Table 2.4.2.

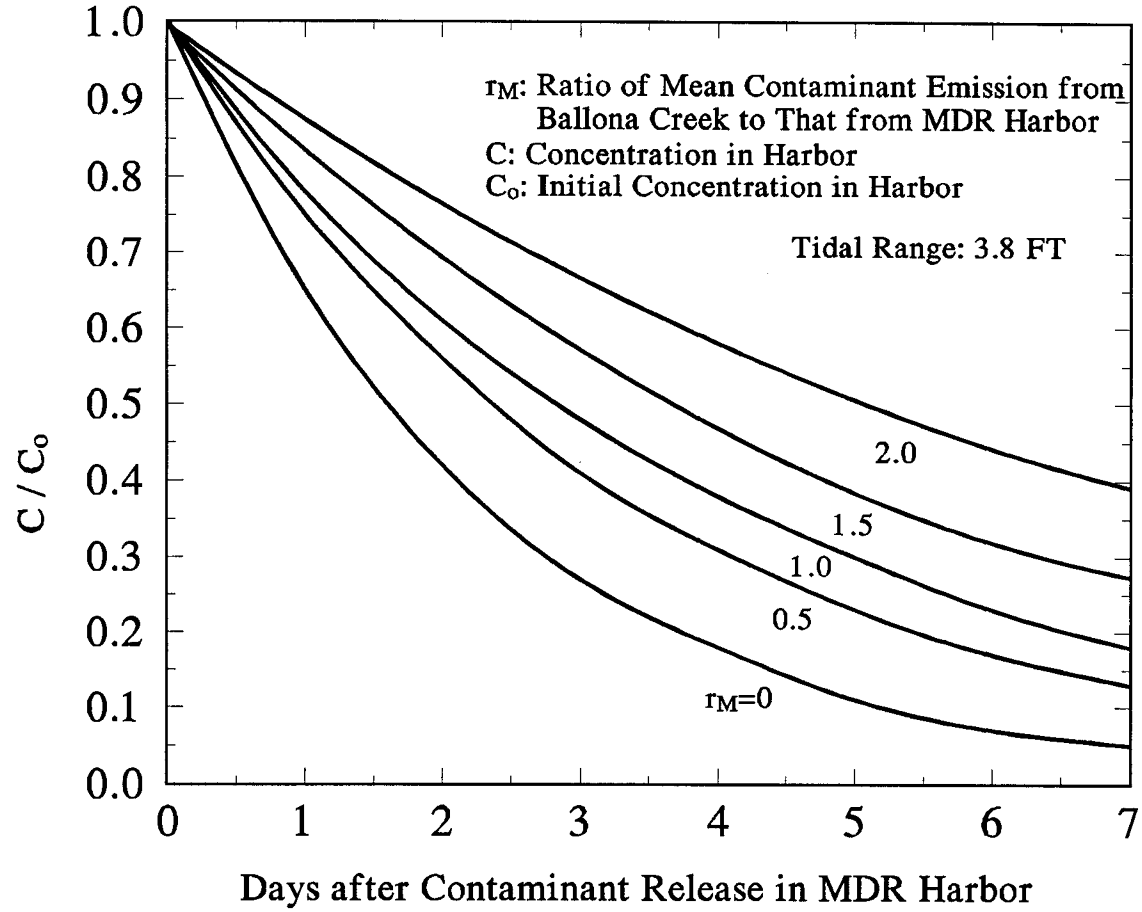

Figure 2.5 Flushing Characteristics

Table 2.4.2 Major Point Sources near Marina del Rey

Source	Operator	Location of Primary Outfall Terminus	Discharge Type	Primary Pollutants in Mass Emission
Hyperion Sewage Treatment Plant	City of Los Angeles	5 miles southwest of Marina del Rey in about 180 ft of water	treated sewage	nutrients, conventionals, metals, phenols
Scattergood Generating Station	City of Los Angeles	3 miles downcoast of Marina del Rey in about 15 ft of water	thermal	total suspended solids (TSS) and oil/grease (no longer limited by permit), trace amounts of zinc and chromium
El Segundo Refinery	Chevron	3.5 miles downcoast of Marina del Rey in about 20 ft of water	treated wastewater	TSS, COD, BOD
El Segundo Generating Station	Southern California Edison	4 miles downcoast of Marina del Rey in about 16 ft of water	thermal	TSS, oil/grease

2.4.3.1.b NPDES Storm Drains

There are 84 permitted non-stormwater effluents that discharge through storm drains into Ballona Creek system (82) and Marina del Rey Harbor (2) based on data of the Regional Water Quality Control Board. A list of these discharges is given in Appendix A. Typical discharges include cooling water and drained groundwater for construction site preparation. The two drains that directly discharge into Marina del Rey include a groundwater discharge (permitee GBW Properties) and a boat washing waste water discharge (permitee Windward Yacht & Repair).

2.4.3.2 Nonpoint Sources

A nonpoint source is a pollution source that does not meet the legal definition of a point source in Section 502 (14) of the CWA. Typical nonpoint sources that affect marine environment include stormwater runoff and marine activities. A nonpoint source is not subject to Federal permit requirements under CWA. In Southern California, stormwater discharges are not regulated.

2.4.3.2.a Stormwater Runoff

Harbor Drainage Characterization

Stormwater runoff contributes to the contamination of Marina del Rey Harbor primarily through stormwater discharges from

- Oxford Street Flood Control Basin
- Washington Boulevard Drain
- Ballona Lagoon
- Marina del Rey Harbor Area
- Ballona Creek

The first four sources constitute the direct drainage into Marina del Rey Harbor. Runoff discharge from Ballona Creek enters Marina del Rey Harbor primarily on flood tides and is thus an indirect drainage. A characterization of the drainage system is shown in Table 2.4.3. The definitions of land uses are as follows:

- Residential: single-family units, duplex, etc.;
- Commerical: shopping districts, multi-family complexes, etc.;
- Industrial: industrial fascilities;
- Open: natural open spaces, agricultural lands.

The subbasin IDs are named after the drains of the individual subbasins as defined by LACDPW (LACDPW, 1994). Information on the locations, sizes and land uses of these subbasins is given in Appendix A and the attached drainage map.

Table 2.4.3 Characterization of Stormwater Drainage into Marina del Rey Harbor

Drainage Basin	Oxford St Basin	Washington Bl Drain	Ballona Lagoon	Marina del Rey Harbor	Ballona Creek
Basin ID	BI5243 BI3872	BI86	GRCNL1	MDREY1	80 basins
Size (sq.mi.) %Watershed	0.07 <0.1%	0.11 <0.1%	0.51 0.4%	0.61 0.5%	127.1 99.0%
Land Use: Residential Commercial Industrial Open	 70% 21% 9% 0%	 55% 36% 9% 0%	 39% 61% 0% 0%	 88% 0% 0% 12%	 53% 40% 4% 2%
%Impervious	54%	56%	60%	74%	49%
RCRA Site	Western Circuits Inc.	No	No	No	5 sites incl. Hughes Helicopter Inc. south of Basin H
Waste Dump	Thatcher Ave Street Maint./ Transfer Yard	No	No	Celery Dump Venice Dump	17 Dumps
Discharge Location	Basin E	Basin E	Entrance Channel	Harbor-wide	Entrance channel
Drain Type	A 6.8'circular and a 6'x6' box culverts with flap gates, open if water in pond is higher	Underground storm drain	A 7' culvert with a slide gate, open/ close at 1.35'/2.65' MSL on Harbor side	Surface drain	On flood tides
Sediment Discharge Potential	Fines only due to weak flow in pond during runoff; relatively insignificant in volume	Fines/sand; relatively insignificant in volume	Fines/sand from bank failure due to runoff	Fines/sand	Fines on flood tides and sand through accretion

Mass Emission from Ballona Creek

Mass emission for selected water quality parameters from Ballona Creek based on land use and runoff characteristics in Ballona Creek Watershed are presented in Table 2.4.4.

Table 2.4.4 Annual Contaminant Emission from Ballona Creek

Parameter	Load (m.tons/yr)
TSS	12,200
BOD	750
COD	6,100
Phosphorus	33
Nitrite/Nitrate	70
Copper	4
Lead	17
Zinc	22
Oil/Grease	662

2.4.3.2.b Marine Activities

Marine activities in Marina del Rey Harbor include primarily recreational boating activities. Major sources for contaminant releases due to boating and related activities include oil spills, antifouling paints, sacrificial zinc anodes and boat wash and overboard waste disposal. Typical contaminants include lead, copper, zinc, PAHs, TBT and bacteria.

2.5 Economic Resources

2.5.1 Commerce

Marina del Rey area is part of the Santa Monica Bay region which has been witnessing significant development in demand for housing and business locations with coastal amenities. The commercial land use is about 13% in Ballona Creek Watershed, which is close to the Santa Monica Bay average of 14%. Commerce in the Marina del Rey Harbor area is, however, much more active with about 60% of commerical land use.

Entertainment and tourism have been important factors in regional commerce with attendant hotels, rental lodgings, bars, restaurants, shops, galleries and convention facilities. Proximity to Los Angeles Airport further increases the potential of the area for future commerical development.

2.5.2 Recreation

Marina del Rey Harbor is the largest small-craft harbor in the world with more than 6,000 private pleasure boats. Major marine recreation activities are sport fishing and boating. Special recreational events include the Christmas Boat Parade, the annual boat show at Burton Chace Park, and the California Cup Race. The beaches in the area are often heavily used, especially on weekends and in summer months. Harbor structures such as the jetties are also regularly used by pedestrians and fishermen.

2.6 Environmental Resources

This section summarizes the environmental resources in Marina del Rey Harbor. An expanded description is given in Appendix B.

2.6.1 Marine Resources

The benthic fauna in Marina del Rey is typical of areas with shallow warm waters, a fine grained, silty bottom and with limited circulation. The most common benthic species in the harbor are roundworms which account for about 30% of the total benthic population and found primarily in the channel entrance. Polychaete is also common in the poorly-circulated inner marina. The fish population has limited diversity due to the less favorable physical and environmental conditions inside the harbor. Certain seabirds are seasonally common in the harbor. The species found here are those that occur in sheltered waters of shallow depths (e.g. grebes and scooters), or those generalists species (e.g. gulls). The only marine mammals expected to occur in the project area are the California sea lion and the harbor seal.

A list of the federally defined threatened, endangered, and candidate species that may occur in Marina del Rey is provided in Appendix B. The species that are potentially sensitive to environmental disturbances include California least tern, California brown pelican and western snowy plover.

2.6.2 Cultural Resources and Aesthetics

No prehistoric cultural resources nor historic properties are present within the Marina del Rey area.

Principal Aesthetics resources include the harbor and the beaches. Certain portions of the entrance channel offer clear views along the shoreline and low hills surrounding Santa Monica Bay.

3.0 PROBLEM IDENTIFICATION

This chapter presents the findings of the analysis on the existing contamination and shoaling conditions in Marina del Rey Harbor. Expanded analyses are provided in Appendix A.

3.1 Potential Sources of Contaminants

3.1.1 Point Sources

The point sources that potentially affect Marina del Rey Harbor include NPDES municipal and industrial discharges and NPDES storm drains.

3.1.1.1 NPDES Municipal/Industrial Discharges

Since all major municipal and industrial discharges are located downcoast of Marina del Rey, their emissions do not have significant potential to influence the contamination levels in Marina del Rey Harbor because of the prevailing southward nearshore and littoral currents. In other words, contaminated discharges can only be swept farther away from Marina del Rey under prevailing conditions; occasional reversals of nearshore circulation due to local wind forcing or summer time southern swells are not expect to carry elevated pollutant concentration because of miles of dilution before reaching Marina del Rey. Indeed, the bulk sediment data for the sediments north of El Segundo Hyperion Treatment Plan indicated appreciably lower contamination levels than those in Marina del Rey Harbor. In addition, seasonal variations of water column contamination in Marina del Rey Harbor was also found to be decoupled from ambient ocean. It therefore appears that the municipal and industrial discharge facilities located on the coast are not significant sources of contamination for Marina del Rey Harbor.

It is noted, however, that there have been sewage overflows that occur on daily basis in the Ballona Creek watershed area. There has been no quantitative study of these overflows according to Los Angeles County Department of Public Works. These overflows are drained by storm drains and therefore contribute to contaminant loads in Ballona Creek discharge. The effects of the overflows on Marina del Rey Harbor, however, can not be characterized until the data on seasonal magnitudes and chemical characteristics are available.

3.1.1.2 NPDES Storm Drains

The 84 permitted discharges of non-stormwater effluents through storm drains into Ballona Creek and Marina del Rey Harbor have a combined discharge that is about 4% of the discharges from stormwater runoff. Therefore this type of point sources do not appear to consititute a significant part of the total contaminant loads in Marina del Rey Harbor.

3.1.2 Nonpoint Sources

The nonpoint sources that potentially affects Marina del Rey Harbor include stormwater runoff and marine activities.

3.1.2.1 Stormwater Runoff

Stormwater runoff appears to be the single most important source of contamination in Marina del Rey Harbor and was thus investigated comprehensively for its magnitude, quality and routing in Ballona Creek Watershed which includes Marina del Rey Harbor area. The overall drainage is categorized into direct and indirect drainages. While the former pertains to basins where runoff disharges directly into the harbor waters, the latter is defined as the basins from which the runoff enter the harbor indirectly through other mechanisms such as tides.

Direct Drainage: Oxford Basin, Washington Basin, Ballona Lagoon and Harbor Area

The four direct drainage areas are located immediately to Marina del Rey Harbor as shown in Figure 3.1 and drain stormwater directly into the Harbor. Analysis of these drainages indicated the following:

- The direct drainage into Marina del Rey Harbor constitutes only about 1% of the total drainage area of Ballona Creek Watershed. The volume of stormwater Marina del Rey Harbor receives therefore originates primarily from Ballona Creek drainage.

- Areas drained by Oxford Basin and Washington Drain are significantly more industrialized than Ballona Creek average, and thus are potentially significant sources of industrial contaminants such as heavy metals in Basin E of the harbor.

- Areas drained by Oxford Basin contains a RCRA remediation site (Western Circuits Inc.) and those drained by Ballona Creek have 5 such sites with one (Hughes Helicopter Inc.) near the Ballona Creek mouth and adjacent to the harbor. The presense of these sites heightens the potential for contaminating stormwater discharged into the harbor by toxicants prevalent at these sites.

- Areas drained by Oxford Basin, Marina del Rey Harbor area and Ballona Creek contain waste dumps and therefore are potential sources for added level of contamination with the species of contaminants depending on the types of the dumps.

- Areas drained by Oxford Basin, Washington Drain and Ballona Lagoon are highly residential and thus are potentially significant sources of contaminants from human activities such as bacteria (coliforms/enterococcus), especially in Basin E.

• Surface drainage of Marina del Rey Harbor area has a high percentage of commercial drainage and thus is a potentially significant source for contaminants such as oil/grease in the harbor. Similar but to a lesser degree are the areas drained by Oxford Basin and Ballona Lagoon.

• Areas drained by Oxford Basin, Washington Drain and Ballona Lagoon have negligible open land and therefore are not likely to be significant sources of sediments that would contribute to shoaling in the harbor, although Ballona Lagoon does contribute sediments to entrance channel from lagoon bank failure during runoff events. Nevertheless, sediementation of fines is expected in heavy runoffs.

• Surface drainage of the harbor area is a potential source for sediments in the harbor due to its high percentage of open land. The predominant source of sediments in the harbor, however, appears to be Ballona Creek in view of its appreciable open land acreage and large volume of flow discharge.

The major observations are summarized in Table 3.1.1.

Table 3.1.1 Characterization of Impacts of Direct and Indirect Stormwater Drainages

Drainage Basin	Primary Sources of Water Column Impacts	Primary Sources of Benthic Impacts	Primary Locale of Impacts in Harbor	Typical Potential Benthic Contaminants	Significant Effect on Harbor Shoaling
Oxford Basin	•industrial •RCRA site •dump site •residential	•industrial •RCRA site •dump site	Basin E	•heavy metals •site-dependent toxicants	no
Washington Drain	•industrial •residential	•industrial	Basin E	•heavy metals	no
Ballona Lagoon	•commericial •residential	•commercial	Entrance Channel	•oil/grease	moderate (from bank failure)
Marina del Rey Habor	•commercial •open	•commercial	harbor-wide	•oil/grease	no
Ballona Creek	•industrial •RCRA sites •dump sites •commercial •residential •open	•industrial •RCRA sites •dump sites •commercial	harbor-wide through Entrance Channel	•heavy metals •site-dependent toxicants •oil/grease	yes

It appears that the four direct drainage areas are potentially significant sources of contamination of Marina del Rey Harbor, although they do not contribute a significant amount of sediments. The runoff, especially from Oxford St. Basin which drains an industrialized area containing a

RCRA site, is expected to carry relatively high contaminant concentrations although the volume of runoff is small compared with runoff discharge from Ballona Creek. When discharged into sheltered, low energy areas such as Basin E, the contamination level they cause can be significantly high *locally* due to poor flushing.

Although direct runoff has potentially significant contamination effects, the total contaminant loads are expected to originate from Ballona Creek due to large runoff volumes.

Indirect Drainage: Ballona Creek

It is noted from the delineation of Ballona Creek Watershed (Figure 2.1) that the stormwater runoff discharges into the sea through Ballona Creek and Marina del Rey Harbor area. The location and configuration of the offshore breakwater is such that the discharged stormwater from both outlets be reflected and carried into the harbor on flood tides. This implies that Marina del Rey Harbor bears a substantial part of the total contaminant loading of Ballona Creek Watershed on Santa Monica Bay. This is consistent with the relatively robust correlations between water column contamination levels and rainfall events.

Ballona Creek Watershed consists of a total of 110 subbasins. Detailed zoning and land use characterization of these subbasins are given in Appendix A and the attached drainage map. These subbasins collect rainfall and route it into Ballona Creek through 48 major confluences located along the stream. A runoff quality analysis was performed for the 48 discharges into Ballona Creek. In the analysis, three typical water quality parameters, *i.e.*, metals (lead/copper/zinc), oil/grease and total suspended solids, were taken as the indicators of the runoff quality.

Table 3.1.2 presents the loads and rankings of metals (lead/copper/zinc), oil/grease and total suspended solids (TSS) from 10 most polluted runoff discharges along Ballona Creek. The loads are presented in metric tons per wet season (mt/ws). The composite ranking is the overall ranking of the three parameters analyzed.

Table 3.1.2 Ranking of Runoff Quality along Ballona Creek

Confluence (Approx. Location)	Metals Load (mt/ws)	Metals Rank	Oil/Grease Load (mt/ws)	Oil/Grease Rank	TSS Load (mt/ws)	TSS Rank	Composite Rank
BI84 (Exposition Bl)	5.7	2	78.2	2	1,567	2	1
SEPUL5 (Sepulveda Cyn Channel/Slauson)	6.3	1	56.9	5	2,005	1	2
BI57-5 (San Vicente Bl)	4.7	3	101.4	1	1,003	5	3
DDI11-4 (La Cienega Bl)	4.6	4	70.1	3	1,230	3	4
BI57-10 (Venice Bl)	3.4	5	68.1	4	757	7	5
BNDCT6 (Benedict Cyn Channel/La Salle)	3.2	6	41.5	7	1,063	4	6
BI1102-3 (San Vicente Bl)	4.6	4	52.5	6	550	9	7
CNTLA2 (Centinela Crk)	2.6	7	22.3	9	836	6	8
LA1177 (Rodeo Rd/ Higuera St)	2.1	8	22.5	8	625	8	9
BI54 (Fairfax Ave)	1.6	9	22.3	9	456	10	10
Total Load of All 48 Confluences	43.4		604.1		11,486		
% Total Load of the 10 Ranked Confluences	91%		91%		90%		

Figure 3.1 shows the discharge locations of the ranked confluences listed above. The 10 discharges account for about 91% of the total heavy metal and oil/grease loads and about 90% of the total suspended solids load in Ballona Creek. Their mitigation is therefore expected to have significant effects on the contamination level in Marine del Rey Harbor. The results can be used in prioritizing potential mitigation actions in planning remedial or control measures.

It is noted that the stretch of Ballona Creek between La Salle Avenue and La Cienega Boulevard maintained by the USACE contains two major confluences that are ranked the 1st and the 9th

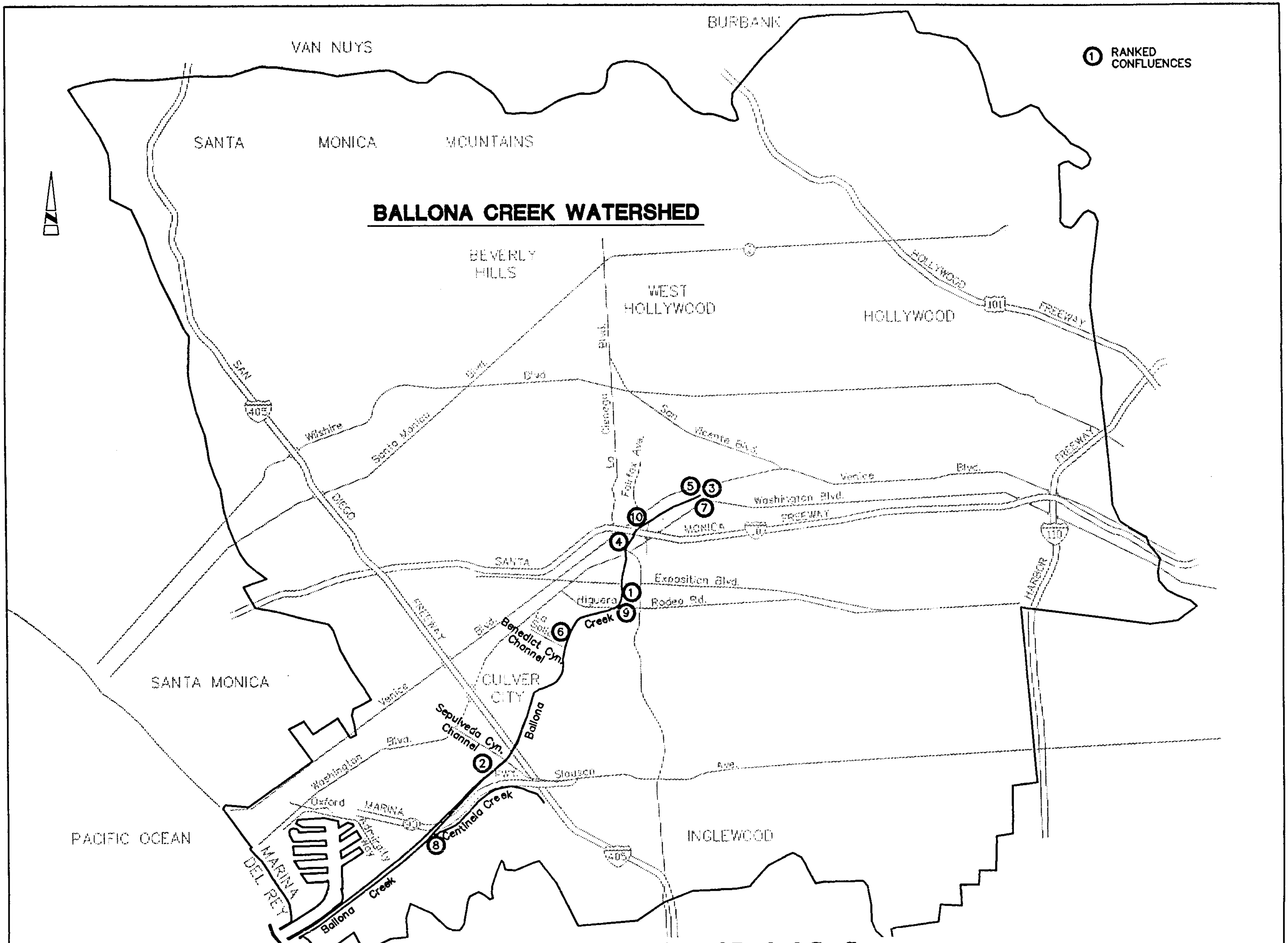

Figure 3.1 Discharge Locations of Ranked Confluences

in contaminant mass loads respectively.

It should be emphasized that the ranking analysis is preliminary in nature. A number of issues such as the site-specific conditions of RCRA/dump sites and sewage overflow are not directly addressed although they are partially reflected in the land uses. More definitive results would require implementation of comprehensive watershed-wide measurement programs.

Sediment Contamination Sources

Since both the volume and the quality of sediments produced by stormwater runoff are of concern for the purposes of this study, the ranking criteria for contaminated sediment production appear to be consistent with those for the runoff quality. Specifically, the ranking of TSS loads reflects the sediment availability and the runoff intensity whereas the rankings of metals and oil/grease loads are indicative of the levels of contamination to be expected as well as the runoff intensity.

It thus appears reasonable to consider the ranking of the composite runoff quality (Table 3.1.2) as a first-level indicator of sediment contamination sources in Ballona Creek Watershed.

3.1.2.2 Marine Activities

Contaminants due to nonpoint-source contamination from marine activities in Marina del Rey Harbor include primarily lead, copper, zinc, PAHs, TBT and bacteria. Compared with contaminant loading in Ballona Creek Watershed, lead releases due to marine activities are essentially negligible but zinc releases are comparable or higher. It is noted, however, the estimates of zinc releases due to boating were based on the assumption that the extent of zinc anode uses has remained essentially the same over the last decades.

Overall comparison with the contaminant loads from Ballona Creek indicates that the predominantly boating related marine activities as a nonpoint source potentially contribute to the contamination of Marina del Rey primarily by TBT and zinc.

3.2 Potential Sources of Shoals

Problem identification for the sources of the contaminated shoals can be approached by identifying first the potential sedimentation routes and magnitudes in the downstream harbor entrance area. The dominant sedimentation components are then identified, traced upstream and analyzed for their origins.

3.2.1 Sediment Budget

The existing sediment budget at Marina del Rey can be characterized based on rates of harbor shoaling and inputs from longshore transport, erosion due to local wave diffraction/refraction, and Ballona Creek sediment yield and other sources of supply such as wind transport. These transport modes correspond to the local wave-current system as shown in Figure 3.2. Components in the sediment budget that are unknown from available data can be evaluated by mass balance represented by the sediment budget equations.

Results of the sediment budget analysis are shown in Figure 3.3. Table 3.2.1 presents the magnitudes of the major inputs to the entrance channel maintenance area.

Table 3.2.1 Major Sediment Inputs to the Entrance Channel Maintenance Area

Origin	Input (cy/yr)
Longshore Transport/North Fillet Erosion	49,000
Ballona Creek	41,000
Wind Transport	1,600

It is clear that sediment supplies from Ballona Creek and from littoral drift are comparable. It should be noted that the area fronting the Ballona Creek may also receive sediments from the the south during episodic transport reversals. This component may become important during summer seasons when discharge from Ballona Creek is low. The overall annual shoaling in this area, however, is still expected to be primarily from Ballona Creek yield in view of the level of contamination found in the deposits.

The supply of Ballona Creek sediments to the downcoast beaches can be estimated once more reliable estimates of Ballona Creek sediment production are available.

3.2.2 Potential Upstream Sources

Upland sediment production depends primarily on surface geology, topography and precipitation. The dominant mechanisms for upland sediment production in Southern California is hydrological

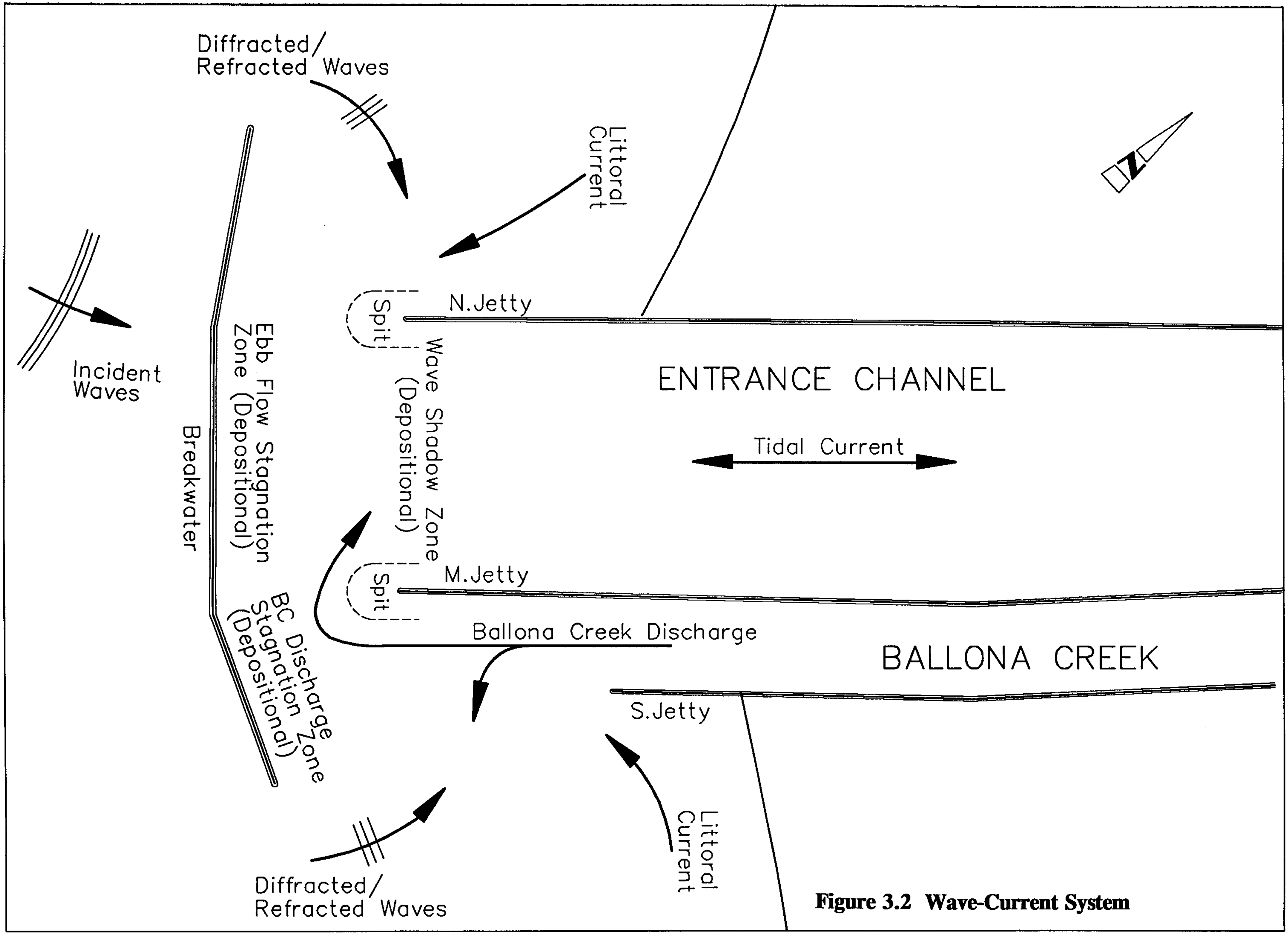

Figure 3.2 Wave-Current System

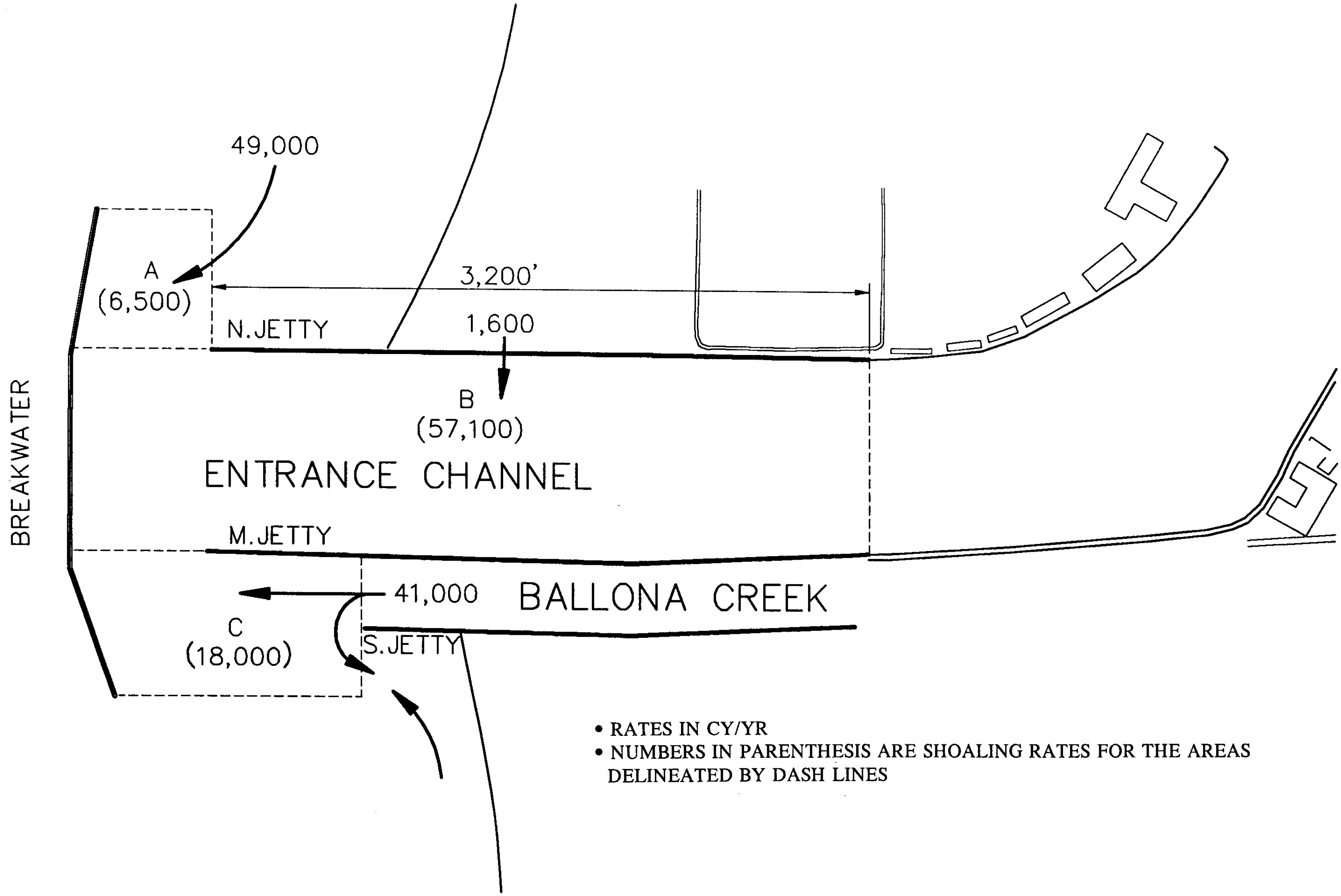

Figure 3.3 Sediment Budget

erosion and seismic activities. Studies have found that there is a constant availability and abundance of loose surface sediments in the region (Taylor, 1983). The fate of the loose surface sediments is then determined primarily by storm rainfall occurrences and vegetative cover. In open areas with relatively low vegetation, the sediments are eroded by overland runoff flows during storm rainfall events, washed into natural streams, channels and storm drains, routed into the main collecting main stream of the watershed and deposited where the carrier flows become sufficiently weak, such as at a river mouth on the coast where the energy of the discharge plume diminishes rapidly as it enters into the ocean.

In the process of overland sedimentation, the often relatively clean sediments from natural open areas such as mountain ranges may be contaminated through mixing with contaminated water and sediments from urbanized areas. When runoff is not sufficiently intense to carry sediments to the main stream or further to the coast, a significant amount of sediments may be deposited in areas with high contamination potential such as industrial/commercial areas. These sediments often become contaminated over time by local sources before being washed into the stream on the following major runoffs.

It can thus be expected that the bulk of sediments from Ballona Creek originates from upland erosional areas. Since detailed information on surface geology and vegetative covers in open areas is not available, the percentages of open areas in individual watershed subbasins can be used as a first-level indicator of potential for sediment production from these areas. Further consideration of contamination, however, requires that this indicator be balanced by the potential of contaminant production from these subbasins. The ability of a subbasin to produce significantly intense runoff is also important for the production of sandy materials as well as total sediment loads in large quantities. Hence an appropriate criterion for identifying sources of *contaminated* shoal materials must be based on a balanced consideration of potential for both volumetric production *and* contamination.

On this basis, the areas that rank high on the composite ranking category in Table 3.1.2 are also expected to have high potential for *contaminated* sediment production.

3.2.3 Sediment Quality Criteria

There have been no systematic chemical-specific sediment quality criteria (USEPA, 1994). Sediment contamination assessments have been relying on toxicity and bioaccumulation testing methods deemed appropriate by individual agencies and individual offices of the USEPA. The USEPA, however, has proposed in its recent Contaminated Sediment Management Strategy that standard tests and standard chemical-specific sediment quality criteria be used to determine whether sediments are contaminated. Currently, a *Sediment Quality Criteria User's Manual* is being drafted by the USEPA. Once the standard sediment quality criteria are promulgated, they are applicable to NPDES permits, hazardous waste site assessments (including Superfund sites) and the dredged material for open water disposal.

Presently, the contamination levels of a dredged material intended for ocean disposal are characterized by its acceptability for such disposal. The acceptability determination is based on the USEPA/USACE testing guidelines. Figure 3.4 shows the framework of the determination procedure. In the tiered evaluation, the contaminant of concern which requires the greatest dilution is identified using the bulk sediment analysis routine in the ADDAMS (Automated Dredging and Disposal Alternatives Management System) program. The identified chemical of concern is then used in disposal modeling to predict the dispersal characteristics. In compliance with 40 CFR 227.29 and following USEPA/USACE guidelines, if results indicate that the concentration of this chemical outside the site boundary does not exceed the applicable marine water quality criterion after the 4-hour initial mixing, no additional testing on water column impacts is required. Otherwise, the Tier II water column impact evaluation is conducted, which includes an elutriate analysis and a benthic bioaccumulation tests. The benthic biological effects are to be evaluated in bioassays and bioaccumulation tests under Tier III.

The USEPA and the USACE have agreed that USEPA's sediment quality criteria, when published, can be included in Tier II of the testing, and that additional applicable tests may be required for dredged sediments that pass the USEPA sediment quality criteria. The USEPA also suggested that the equilibrium partitioning methodology could be used to calculate the bioavailable fraction of contaminant in sediments at a reference site and in the dredged material. If the bioavailable fractions of the contaminants in the dredged material are less than or equal to the reference site values, the sediments can be considered as passing the sediment quality criteria; Otherwise, the material is not acceptable for disposal without special management practices such as capping.

3.3 Potential Dredging Needs

The dredging needs are in general determined by the harbor shoaling rates. The shoaling rates of 18,000 cy/yr at the Ballona Creek mouth, 57,100 cy/yr in the entrance channel and 92,00 cy/yr overall are therefore the currently expected amounts to be dredged if the design configuration of the channel is to be maintained.

It is noted, however, that these data on shoaling rates are based on the surveys of December 1992 - June 1994. Historic rainfall records indicated that the period of 1992-1993 was significantly wetter than the preceding years with heavy rainfall in January and February of 1993. The comparably wet year prior to this was about 10 years earlier in 1982-1983. Both wet years coincide with El Nino periods. Hence, the shoaling rates estimated in this study reflect the annualized dredging needs for the wet years during which significant shoaling is expected. For dryer years, the input from Ballona Creek decreases and the apparent shoaling of the harbor is primarily due to littoral transport from the upcoast and possibly transport reversals from downcoast. The shoaling rates may then be lower and sediments cleaner.

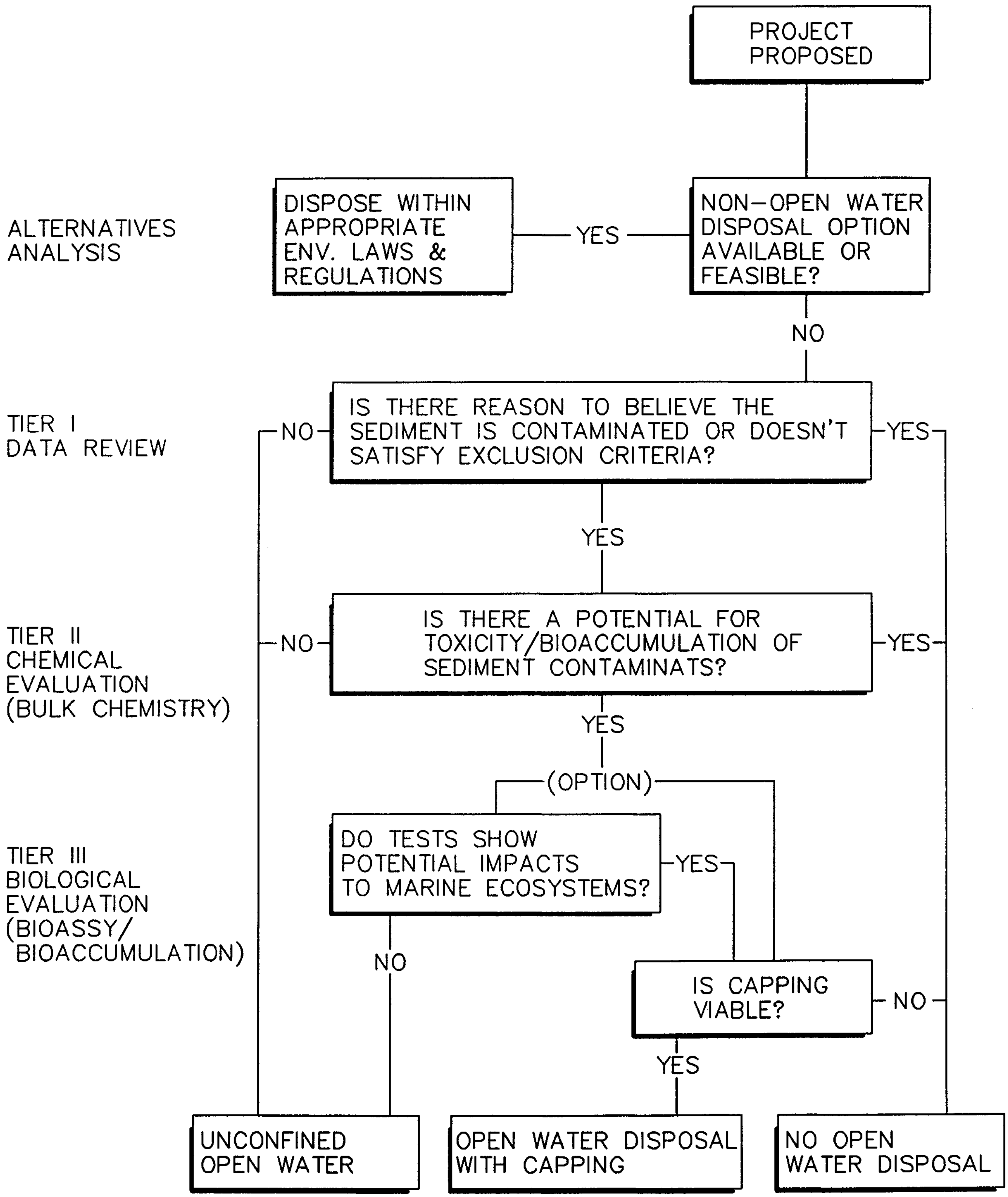

Figure 3.4 Tiered Decision Framework for Open-Water Disposal

CHAPTER 4.0 PLANNING CONSIDERATIONS

4.1 Issues of Concern

Issues of concern regarding the shoaling of the Marina del Rey Harbor entrance by contaminated sediments fall largely into the following categories:

- Potential navigation hazards posed by the shoals in the entrance channel;
- Potential environmental impacts of measures for removing the contaminated shoals;

These issues of concern have resulted from the competing needs for maintaining the economic integrity of Marina del Rey Harbor and for safeguarding the environmental integrity of the regional coastal waters.

Shoaling of the Marina del Rey Harbor entrance creates hazardous navigation conditions for boaters through both potential for grounding and inducing adverse wave conditions including wave breaking at the harbor entrance. The potentially perilous navigational condition created by shallow shoals may lead to eventual closure of the harbor. Since recreational boating is a major coastal resource, closure of Marina del Rey Harbor is expected to entail significant regional economic loss. In addition, presence of shoals reduces harbor flushing efficiency resulting in gradual worsening of water and sediment qualities inside Marina del Rey Harbor. Hence the primary issues of concern regarding shoaling include the following:

- Economic and human life losses due to navigation hazards;
- Economic loss due to harbor closure; and
- Environmental impacts due to deteriorating flushing efficiency.

Mitigation of entrance shoals normally involves periodic dredging and disposal. Since the shoals at Marina del Rey Harbor entrance are found contaminated, dredging and disposal of the material may have significant environmental impacts. Primary issues of concern include the following:

- Increased bioavailability of contaminants due to disturbances from dredging operation;
- Cumulative impacts of periodic dredging and disposal operations;
- Effects on endangered species due to turbidity and contaminant bioavailability; and
- Impacts of dredging on neighboring areas such as Ballona Lagoon.

These environmental concerns have been addressed by the USACE (1994b).

4.2 Planning Considerations

The planning objectives for mitigating the contaminated shoaling problem at Marina del Rey Harbor should reflect the principle of minimizing the potential for adverse environmental impacts while effectively maintaining the function of Marina del Rey Harbor as a major coastal resource.

Mitigation objectives can potentially be accomplished by focussing on one or more of the following:

- Reduction of the total volumetric shoaling rate;
- Upstream abatement of sediment contamination level; and
- Trapping/rerouting of the contaminated sediments.

A reduction in harbor shoaling rate reduces the dredging frequency, whereby minimizing the potential cumulative impacts on the environmental resulting from repeated dredging and disposal of the contaminated shoals. The total shoaling rate can be reduced by reducing the sediment contributions from some relatively clean sources. This strategy may be appropriate in the absence of effective upstream mitigation of contamination sources.

Upstream abatement of sediment contamination level reduces the contaminant concentrations in the harbor shoals. This can be achieved by identifying and mitigating the sources that cause the contamination of sediments. This strategy requires coordination among Federal, State and local agencies to develop and execute effective point/nonpoint source and sediment management programs such as the Best Management Practices (BMPs) program. It is noted that, in general, this approach addresses the contamination problem but does not alleviate the shoaling problem.

Trapping/rerouting of the contaminated sediments removes the contaminated fractions from the sediment loads that enter the Marina del Rey navigation channels. This strategy reduces the contamination concentrations in the shoals and, depending on the amounts being trapped/rerouted, reduces the shoaling rate. It is necessary, however, to find means for disposing or treating the removed contaminated sediments, which may incur appreciable additional costs.

It appears that a long-term solution would inevitably involve upstream sediment quality management in Ballona Creek Watershed. Major focusses of management may include

- sedimentation in highly urbanized areas;
- sedimentation areas containing RCRA sites and dumps.

Availability and transport of contaminated sediment can be mitigated by implementing BMP programs. Such programs are already in place in Los Angeles County which includes the Ballona Creek watershed. Effectiveness of these programs, however, has not been definitively determined due to the fact that most areas have installed the BMPs only recently.

The status of the RCRA sites and waste dumps within the Ballona Creek watershed should be assessed in terms of the existence of leachate and the potential for contaminating sediments. Since it is under the authority of the EPA to asssess hazardous waste facilities that have RCRA permits, the involvement of the EPA is necessary in mitigating the potential contamination from RCRA sites. EPA normally conducts RCRA facility assessments (RFA) and can require facility owner/operator to conduct RCRA facility investigation (RFI) if the RFA determines the existence of leachate, and sediment remediation if the RFI determines that the contamination is caused by the facility.

4.3 Potential Mitigation Alternatives

The following is a preliminary evaluation of potential mitigation alternatives on a conceptual level for the shoaling of Marina del Rey Harbor by contaminated sediments.

4.3.1 No Action

The "no action" alternative would result in continued significant shoaling by contaminated sediments in the entrance channel maintenance area. Periodic maintenance dredging and disposal of the contaminated material may have potentially significant impacts on the environment in violation of applicable laws including the Clean Water Act (CWA) and the Marine Protection, Research and Sanctuaries Act (MPRSA). This alternative is therefore not feasible.

4.3.2 Structural Alternatives

4.3.2.1 Sediment Basin and Deflector for Ballona Creek

A sediment basin for Ballona Creek could be provided to impound the contaminated sediments from upstream whereby reducing the contaminated sediment yield from Ballona Creek. The effectiveness of such a structure varies depending on the sediment load composition and the location of installation. In general, sediment basins are more effective for coarser sediments than for fines. Noting that contaminants are largely associated with the finer fraction of the sediment load, the sediment basin alternative is more effective as a measure for reducing the harbor shoaling rate by reducing the coarser sediment input, than a measure for mititgating harbor contamination. Further, the impounded sediments may require treatment before being disposed of as a fill. In this regard, it is noted that a reduction in sediment yield from Ballona Creek may lead to net erosion of downcoast shoreline which it currently nourishes. This impact can be minimized by placing the impounded sediments on the downcoast beaches. This may require an attendant sediment testing program to ensure the acceptibility of the fill for each bypass event.

A sediment deflector can be used to prevent sediment loads from entering the entrance channel. Potential plans include a modification of the configuration/orientation of the middle jetty so that the exiting sediment-laden discharge be deflected downcoast instead of westward into the entrance channel maintenance area. This alternative, if properly designed, may reduce both the shoaling rate and the contamination level in Marina del Rey Harbor. The disadvantage is, however, that the contaminated sediments are supplied to the downcoast beaches creating a new contamination problem. Therefore, the deflector alternative may not be feasible if not implemented in combination with other mitigation measures such as upstream management.

4.3.2.2 Sediment Trap or Deflector for Littoral Drift

Sediment trap (or deflector) may be used to impound (or deflect to the deeper water) the southward littoral loads north of Marina del Rey Harbor so that the sediment contribution from the north is minimized, whereby reducing the harbor shoaling rate and consequently the dredging frequency. While the effectiveness of this alternative in mitigating harbor shoaling is relatively well proven technically, it does not address the contamination problem in the harbor.

4.3.3 Non-Structural Alternatives

4.3.3.1 Upstream Nonpoint Source Management

This alternative focusses on the mitigation of potential upland urban contamination sources as to eliminate the causes of contamination in the bulk of sediment yield from Ballona Creek. The effectiveness of this alternative relies on an adequately definitive identification of contamination hotspots in the watershed. This can be achieved by performing a systematic analysis of hydrologic conditions and land uses in the watershed and establishing a ranking of contamination potentials for different areas, such as the one presented in this study, which enables prioritizing actions and concentrating resources. Effective and full implementation of BMP programs and mitigation of potential releases from RCRA and dump sites are expected to significantly reduce the contamination levels in sediment loads from Ballona Creek. In view of the potentially extensive benefits for parties on local, State and Federal levels, this alternative has the potential of receiving a high level of coordination among government agencies and the public.

4.3.3.2 Dredging and Disposal

Dredging and disposal of the contaminated shoals in Marina del Rey Harbor without substantial mitigation measures has been considered environmentally unacceptable.

The environmental effects of dredging operation can be significantly abated by using appropriate control technologies such as the watertight clamshell. The turbidity plumes generated during dredging may temporarily affect the water column quality but the effects tend to be local and short-term.

The environmental effects of disposal vary with disposal alternative adopted. The following have been assessed by the USACE (1994b) for the disposal of the contaminated material from Marina del Rey Harbor:

- Nearshore/beach disposal;
- Open ocean disposal;
- Sanitary landfill;
- Upland disposal;
- Capping in Santa Monica Bay;
- Capping in Marina del Rey Harbor;
- Utah landfill.

Table 4.1.1 summarizes the alternatives and their evaluation by the USACE Los Angeles District for feasibility for dredged material from Marina del Rey.

Table 4.1.1 Assessment of Current Feasibility of Disposal Alternatives

Disposal Alternative	Assessment	Current Feasibility
Nearshore/Beach Disposal	Grain sizes and contamination levels incompatible with those on Dockweiler Beach	No
Ocean Disposal	Sediments failed EPA/USACE testing protocol for open ocean disposal	No
Sanitary Landfill	No adequately large sanitary landfill in vicinity; haul costs potentially high for farther landfills	No
Upland Disposal	Status similar to sanitary landfill alternative	No
Capping in Santa Monica Bay	Potentially feasible but not available until completion of EIS	No
Capping in Marina del Rey Harbor	Incompatible with potential expansion of MDR Harbor	No
Utah Landfill	Haul distance/time long and costs high; interim storage difficult	No

The availability of disposal alternatives may change in the future as the result of on-going efforts by the USEPA and the USACE on contaminated sediment management. At present, however, it appears none of the above disposal alternatives are feasible for the dredged material from Marina del Rey. Before a long-term solution is found, an interim alternative of using geotextile containers and placing within the Port of Los Angeles Shallow Water Habitat area has been proposed and approved as a short-term solution.

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APPENDIX A: ENGINEERING ANALYSES

CONTENTS

A.1 PHYSICAL ENVIRONMENT

A.1.1 Geology

The geomorphology and geology of Marina del Rey area is part of the geological setting of Santa Monica Bay, which features Palos Verdes, Malibu Coast and Dume Faults, gas/oil seeps parallel to the Malibu coastline and on the mid/central shelves, and Santa Monica and Redondo Canyons. On the shelf off Marina del Rey, the thickness of quaternary sediments was observed to increase with distance offshore. Zones of potentially active short discontinuous faults and gas/oil seeps are significant features of the mid-shelf region off Marina del Rey (Moffatt & Nichol, Engineers, 1993). Shelf sediments near Marina del Rey are predominantly sand (0.063-2 mm). Silt/clay content increases from about 0.6% upcoast of Marina del Rey to about 13% downcoast, and is about 49% in mid-shelf region, and about 28% farther offshore (CLA, 1993).

A.1.2 Bathymetry

The offshore bathmetry of Marina del Rey features relatively regular, nearly shore-parallel contours. The typical slope between 30 feet (where the offshore breakwater locates) and 60 feet MLLW contours is about 1:130. This feature extends approximately 5 nautical miles upcoast beyond Santa Monica Pier and about 3 nautical miles downcoast to El Segundo area. Inshore of the breakwater, the bathmetry is modified by the development of sand fillets on the upcoast and downcoast sides of the north and south jetties, respectively. The shallow contours bend offshore at the Jetties to intersect the breakwater, forming a nearly symmetrical, tombolo-shaped shallow area around the entrance of Marina del Rey Harbor.

A.1.3 Precipitation

The mean annual precipitation in the region is typically about 12 inches, although large year-to-year variations are common. Most rainfall events are associated with winter cold fronts. Summer rainfall rarely occurs due to the blocking effects of the Pacific High on frontal systems. Results of a frequency analysis on precipitation at Marina del Rey is shown in Table A.1.1.

Table A.1.1 Storm Precipitation at Marina del Rey

Return Period (Year)	24-Hr Precipitation (Inch)
1	0.4
5	4.0
10	4.8
50	6.8
100	7.8

A.1.4 Winds

Wind data (1947-1965) for Marina del Rey recorded at the Los Angeles Weather Bureau Airway Station are shown in Table A.1.2 (SCRA, 1978). The prevailing winds are westerly and west-southwesterly seabreezes with a mean speed of about 8 knots.

Table A.1.2 Frequency of Wind Speed and Direction (Hourly Observation)

Speed (kt) Direction	Calm	1-3	4-10	11-21	22-27	%	Mean Speed
N		1.0	1.3	0.3		2.7	6.0
NNE		1.0	1.5	0.1		2.6	4.9
NE		1.6	2.6	0.1		4.2	4.6
ENE		1.8	3.1	0.1		5.0	4.6
E		2.5	4.2	0.1		6.8	4.6
ESE		1.8	3.0	0.1		4.9	4.7
SE		1.8	2.5	0.1		4.5	4.6
SSE		1.0	1.5	0.1		2.6	4.9
S		0.9	1.3	0.1		2.3	4.6
SSW		0.8	1.4	0.2		2.4	5.6
SW		1.3	4.1	0.7		6.1	6.6
WSW		1.6	13.7	4.1		19.4	8.2
W		1.8	11.5	4.2	0.1	17.8	8.3
WNW		1.1	3.1	0.5		4.6	6.2
NW		0.9	1.0	0.2		2.1	5.0
NNW		0.8	0.9	0.5	0.1	2.3	7.3
Calm	9.8					9.8	
Total	9.8	21.7	56.7	11.5	0.3	100	5.8

A.1.5 Tides

Tides in Marina del Rey are of mixed type consisting of diurnal and semidiurnal constituents, which is typical of Southern California Coast. Data derived from observations near Los Angeles Outer Harbor are shown in Table A.1.3.

Table A.1.3 Tide Levels

Tide	Water Elevation (Feet,MLLW)
Highest Tide (Jan. 27,1983)	7.96
Mean Higher High Water	5.52
Mean High Water	4.77
Mean Tide Level	2.80
Mean Low Water	0.95
Mean Lower Low Water	0.00
Lowest Tide (Dec. 17,1933)	-2.59

A.1.6 Waves and Nearshore Currents

A.1.6.1 Waves

The Marina del Rey area is exposed to waves generated by Northern Hemisphere extratropical and tropical storms and Southern Hemisphere winter storms, and by local winds.

The operational waves at Marina del Rey were obtained from USACE Wave Information Studies (WIS) Phase II hindcast station 18 about 4 miles upcoast of Marina del Rey in about 60 ft of water (USACE, 1992). Application of data from this station to Marina del Rey is reasonable in view of the proximity and the nearly uniform bathymetry in this segment of inner Santa Monica Shelf. The prevailing waves are from two 12.5-degree directional bands centered around 247.5 and 275.0 degrees azimuth. The principal direction based on a weighted average of wave occurrences within these two bands is 266 degrees azimuth. The characteristics of prevailing waves are shown in Table A.1.4.

Table A.1.4 Prevailing Waves off Marina del Rey

Wave Height (ft)	Wave Period (sec)	Principal Direction (degree azimuth)
3.0	13.0	266

The extreme wave climate at Marina del Rey can be derived from storm hindcast records. A frequency analysis was performed based on hindcast storm wave data off Southern California Bight and SIO wave transformation database. The wave transformation coefficients for Marina del Rey near the offshore breakwater are shown in Figure A.1.6.1. Results of the frequency analysis for extratropical, tropical and Southern Hemisphere winter storms are shown in Figure A.1.6.2 in terms of wave heights and the associated return periods. Apparently, the wave climate at Marina del Rey is dominated by the influence of extratropical storms, although southern swells are also important during summer times.

Prevailing wave condition landward of the offshore breakwater was evaluated using the wave refraction-diffraction model REFDIF1 (Kirby & Dalrymple, 1983) with the prevailing wave climate as input. Results are shown in Figure A.1.6.3. The breakwater-jetty complex effectively reduces the wave energy by about 90-100%, agreeing excellently with the hydraulic model results of a 95% reduction of the wave energy (USACE, 1965).

A.1.6.2 Nearshore Currents

Nearshore currents consist of tidal and subtidal currents as well as wave-induced longshore currents in the surf zone. Oceanographic data analysis on currents in this region (Moffatt & Nichol, Engineers, 1993) indicate that the typical short-term current speed on Santa Monica Shelf is about 0.66-1.00 fps depending on the time scale of interest, which is consistent with the finding of the short-term current measurements by Dames & Moore (1983). The results of the same study on the mean subtidal current characteristics are presented in Table A.1.5.

Table A.1.5 Subtidal Currents near Marina del Rey (Moffatt & Nichol, Engineers, 1993)

Time Scale	Typical Speed (fps)	Direction /Orientation
Monthly	0.16	Alongshore; Northward in Outer Bay, Southward in Inner Bay
5-10 Days	0.66	Alongshore; Direction Affected by Bay Winds

A drift card study of the seasonal variation of surface currents (Maloney & Chan, 1974) suggested a general onshore surface flow in late winter and a southward flow in spring and summer times near Marina del Rey. The surf zone current characteristics can be inferred from the prevailing wave climate at the site as discussed previously. This suggest a predominantly southward longshore current in the vicinity of Marina del Rey. Seasonal, short-term northward reversals of longshore current, however, may occur when southern swells prevail.

A.1.7 Littoral Transport and Barriers

Marina del Rey is located in the Santa Monica littoral cell which extends from Point Dume to Palos Verdes Point and contains Dume and Redondo Submarine Canyons. Development of this part of coastline with the contruction of a significant number of structures along the shore has essentially stabilized the beach and prevented significant longshore transport. Shoreline erosion has been found non-critical from Santa Monica to Redondo Beach (USACE, 1971).

A.1.7.1 Littoral Barriers

In general, estimates of littoral drift quantities are strongly influenced by coastal construction. Major coastal structures may act as littoral barriers that affect the longshore transport of sediment by impounding sediments and/or rerouting sedimentation, whereby altering the sediment budget along the neighboring shoreline. Hence, littoral drift must be evaluated within the context of the distribution and history of coastal structures in the study area. Table A.1.6 presents a list of major structures up-/downcoast of Marina del Rey.

Table A.1.6 Major Structures near Marina del Rey (Tekmarine, 1985; Shaw, 1980)

Location	Structure	Construction Date	Status
Sunset Blvd to Santa Monica Pier	10-20 Groins	1928 (Earliest)	4 Groins Exist
Santa Monica	Santa Monica Pier	1909 & 1912	Exists
Santa Monica	Santa Monica Breakwater	1934	Exists
Santa Monica Pier to Venice Breakwater	3 Groins	1938 (Earliest)	2 Groins Exist
Ocean Park	Ocean Park Pier	Pre-1935	No Longer Exists
Venice Beach	Venice Pier & Breakwater	1904	Breakwater Only
Venice Beach	1 Groin	Post-1946	Exists
Marina del Rey	Entrance Channel Jetties	1958 (Initial Construction 1946)	Exist
Marina del Rey	Entrance Channel Breakwater	1965	Exists
Ballona Creek	Jetties	1938 (Completed 1946)	Exist
Old Ballona Creek	Jetties	1909	No Longer Exist
Ballona Creek to Redondo Beach	4-8 Groins	Pre-1946 (Earliest)	4 Groins Exist
Redondo Beach	Redondo Beach Breakwater	1939	Exists

A.1.7.2 Longshore Transport

The net longshore transport in the study area has been observed to be southward (USACE, 1985, 1986). This is consistent with the prevailing wave directions as discussed earlier. A number of studies have been performed on the quantities of littoral drift at a few locales along the coast from Santa Monica to Redondo Beach (*e.g.* Handin, 1951; Johnson, 1957; Ingle, 1962, 1966;

DMJM, 1984; Tekmarine, 1985) which may be useful for evaluating net littoral sediment supply to Marina del Rey. These studies span a period during which new structures were added along this stretch of shoreline. Results are shown in Table A.1.7.

Table A.1.7 Longshore Drift Quantities (Santa Monica to El Segundo)

Location	Study	Longshore Transport (cy/yr)
Santa Monica	Handin (1951)	270,000 (Southward, Based on Trapping)
El Segundo	Handin (1951)	162,000 (Southward, Based on Trapping)
Santa Monica	Ingle (1966)	246,000 (Southward, Net Drift, Short-Term)
Santa Monica	DMJM (1984)	Net Drift Leaving Santa Monica Southward: 80,000 (Near Equilibrium, Before Breakwater Damage in 1983) 95,000 (After Breakwater Damage)

For lack of long-term nearshore/beach profiling data and complete dredging records, estimates of longshore drift quantities along this part of coast have been inconclusive. Because of structural alterations and/or the largely qualitative nature of some of the studies, the earlier results are not reliable (USACE, 1986). It is noted, however, that the DMJM data (1985) are derived from a more systematic analysis of beach profiles and shoreline survey data near Santa Monica. These more recent estimates of low longshore drift rates appear to be consistent with the observation of substantially stablized shoreline along this portion of the coast.

A.1.7.3 Cross-Shore Transport

Little information exists on the cross-shore transport near Marina del Rey (USACE, 1986). Its magnitude and effects, however, can be inferred from the beach/shoreline profile records or sediment budgeting.

A.1.8 Ballona Creek Watershed

Ballona Creek Watershed has a drainage area of about 130 square miles and is one of the largest drainage basins in the Santa Monica watershed. The watershed drain through Ballona Creek (including its tributaries Centinela Creek and Sepulveda Channel) and discharges into Santa

Monica Bay. The watershed land use consists primarily of residential, commercial, light industrial, public land and other urban usages. There is, however, a substantial strip of open/undeveloped land along the downstream stretch of Ballona Creek extending to the coast south of Marina del Rey (SMBRP, 1992, 1993).

A.1.8.1 Runoff Discharge

The flow discharge from Ballona Creek has been recorded by Los Angeles County Department of Public Works (LACDPW) at its station near Sawtelle Boulevard. A frequency analysis was performed based on the data supplied by LADPW which span the period from 1928 to 1992. Results on the frequency of occurrence and probability of exceedance are presented in Figures A.1.8.1 and A.1.8.2 . Some characteristic values are summarized in Table A.1.8. The daily discharges are defined as the *daily-mean* flows.

Table A.1.8 Characteristics of Flow Discharge from Ballona Creek (1928-1992)

Median Discharge (cfs)				Most Frequent Discharge (cfs)				Seasonal Occurrence of Peak Flow	
Mean Daily	Min Daily	Max Daily	Ann'l Peak	Mean Daily	Min Daily	Max Daily	Ann'l Peak	Most Freq.	Least Freq.
42	5.5	2,250	12,400	33	3.5	1,110	8,723	Dec-Feb	Jun-Aug

It is noted that the maximum daily mean flow is about 400 times the minimum daily mean flow, which is suggestive of the dominant influence of the stormwater runoff.

Figure A.1.8.3 presents the seasonal frequencies of peak flow occurrence based on the LADPW data. The peak flows in Ballona Creek, which are often associated with the largest amount of sediment discharge, appear to be the most frequent in winter times and rarely occur during summer months. This is consistent with the fact that the runoff discharge is dominated by rainfall runoff in wet months from November to April, and by nuisance water from domestic, agricultural and industrial discharges in dry months from May to October (SMBRP, 1993).

Results of a frequency analysis for the Ballona Creek discharge is shown in Figure A.1.8.4. The 10- and 50-year flows are about 22,000 cfs and 32,000 cfs, respectively.

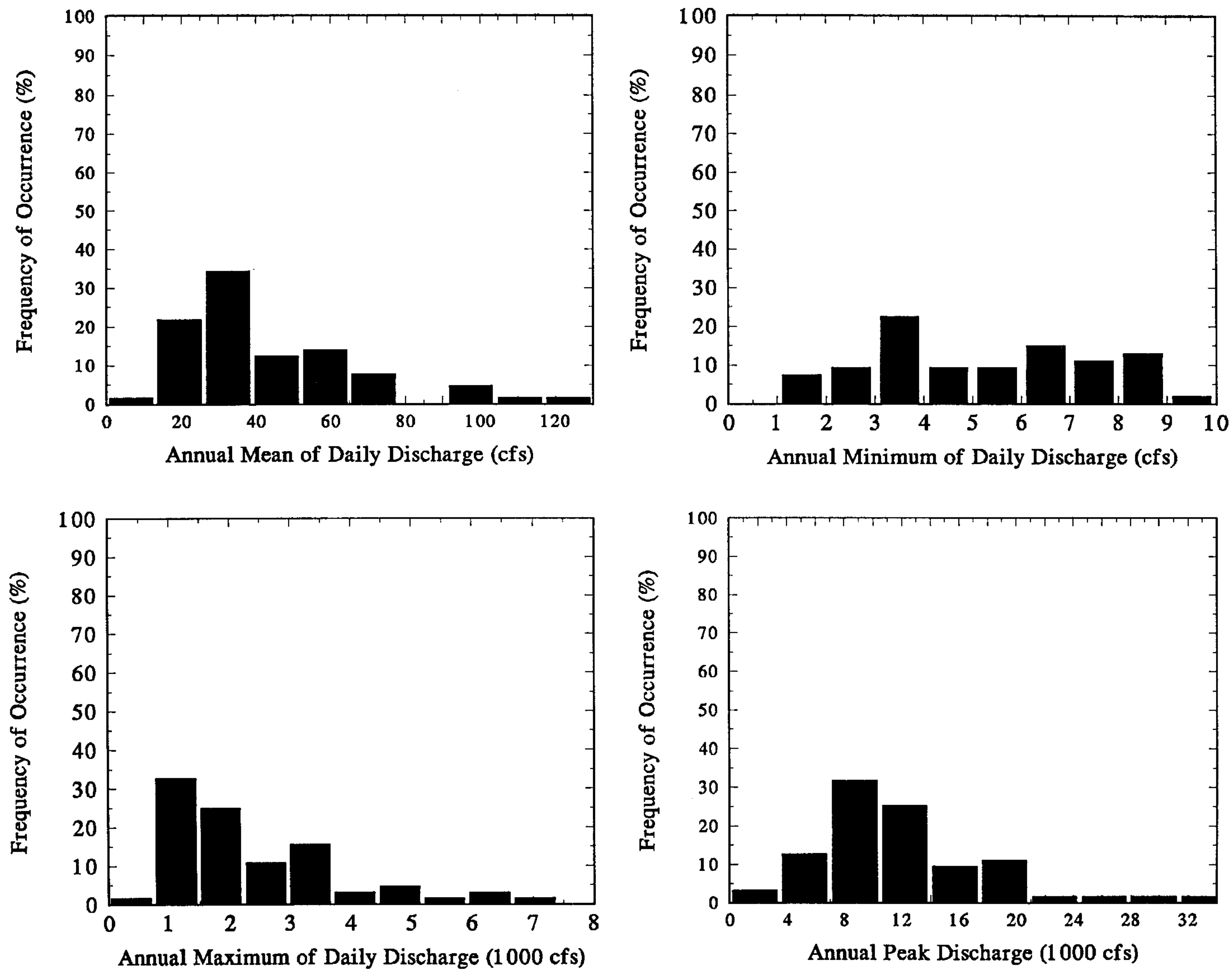

Figure A.1.8.1 Statistics of Ballona Creek Discharge

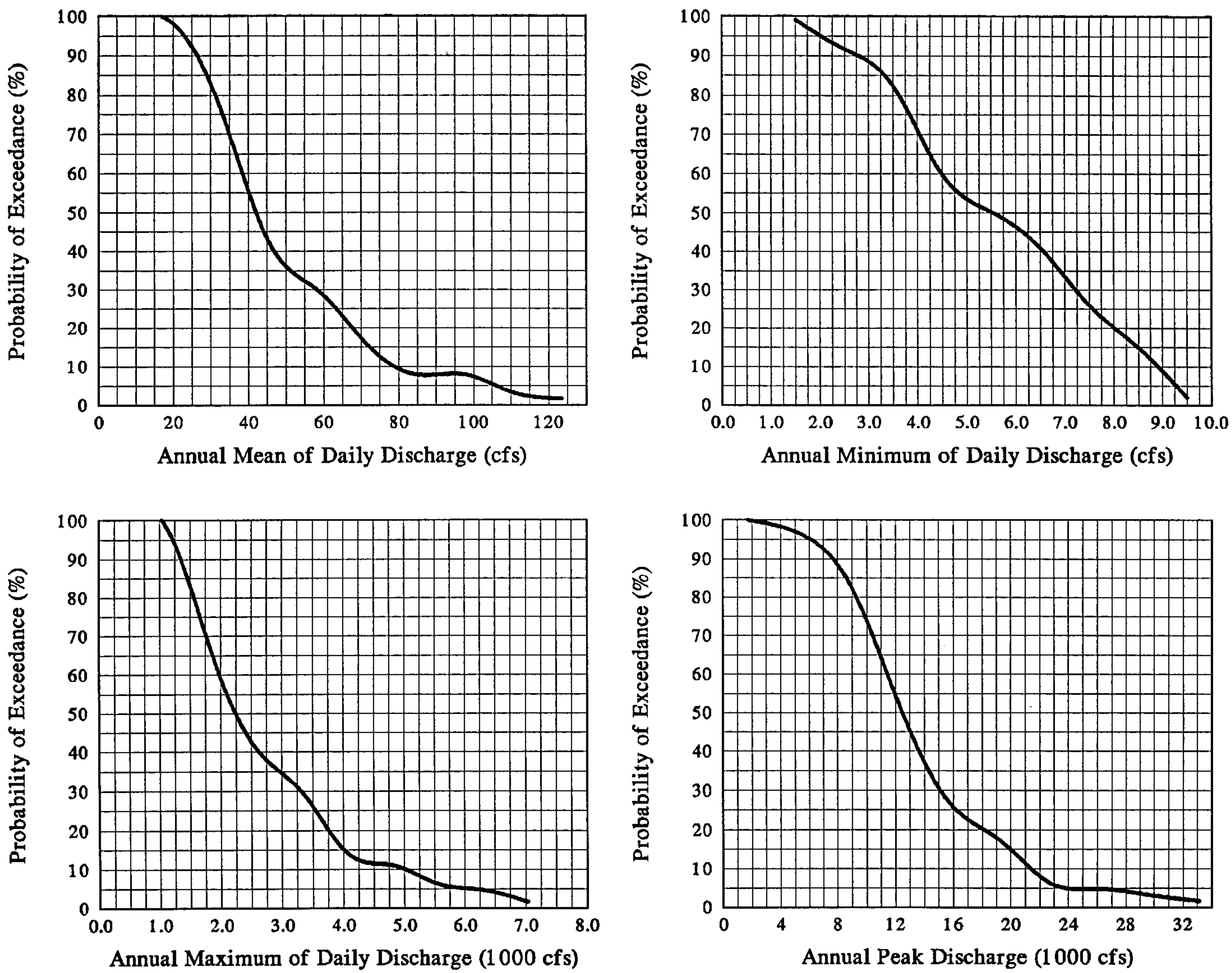

Figure A.1.8.2 Probability of Ballona Creek Discharge

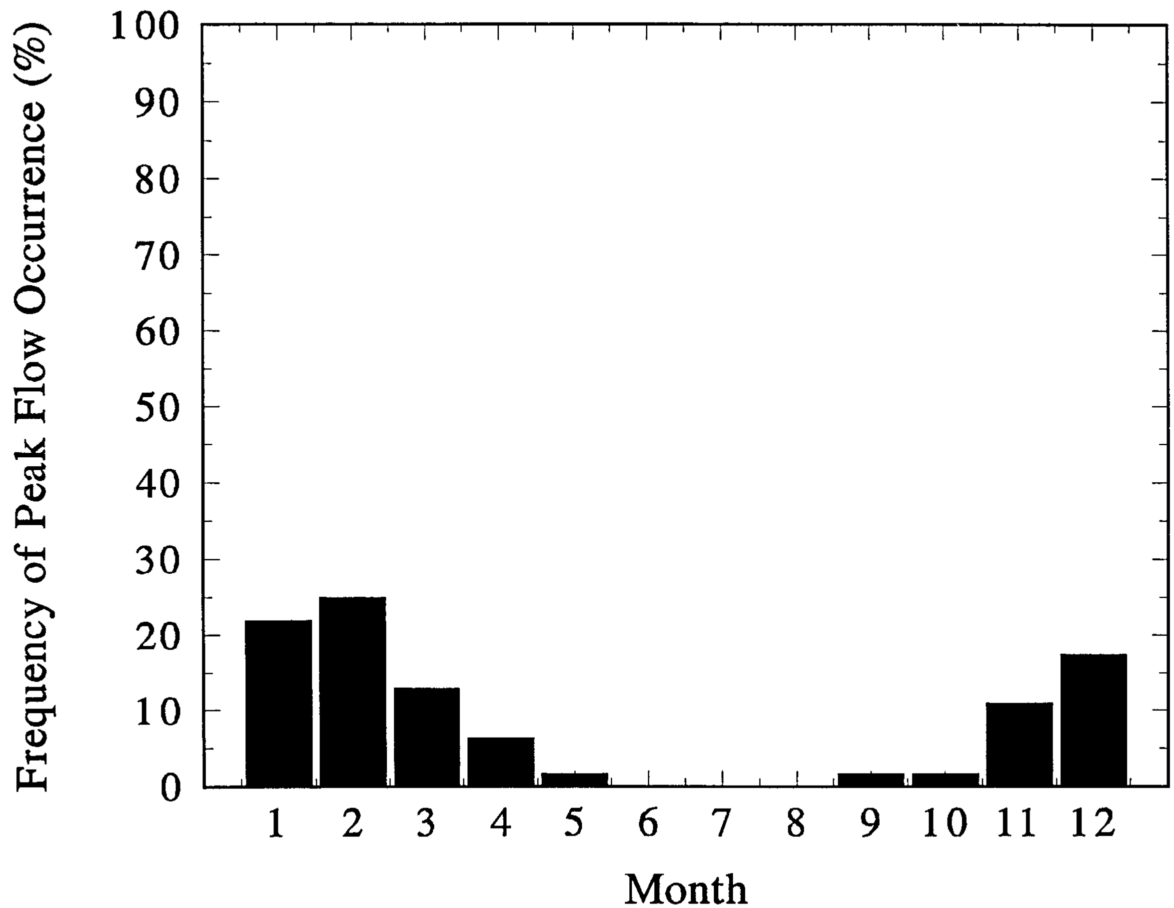

Figure A.1.8.3 Seasonal Occurrence of Annual Peak Flow

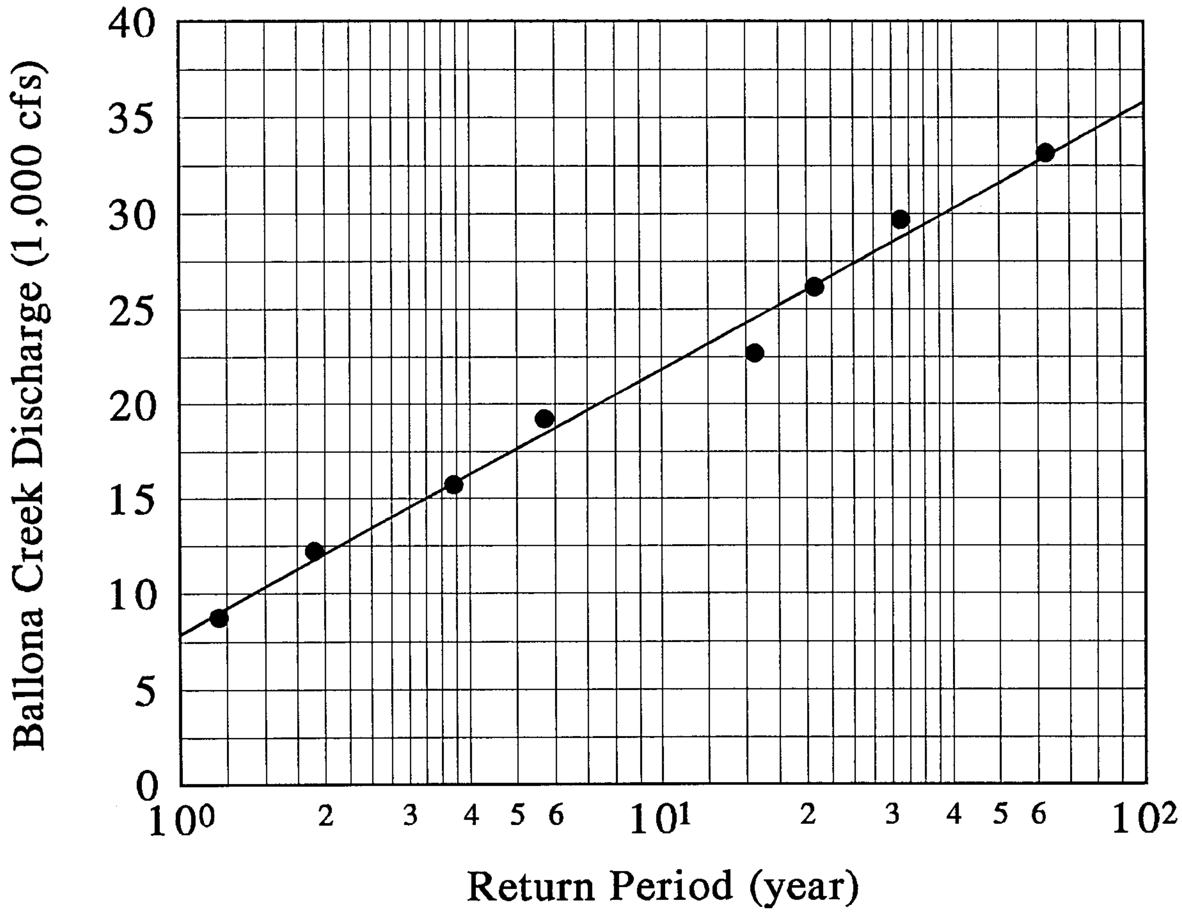

Figure A.1.8.4 Annual Discharge-Return Period Relationship

A.1.8.2 Sediment Production

Estimates of Ballona Creek sediment production have been made in several studies as summarized in Table A.1.9.

Table A.1.9 Ballona Creek Sediment Production

Source	Sediment Production (cy/yr)	Note
State of California (1977)	46,000	Sandy sediments; Same estimate projected for the future (which accounts for potential development within the watershed)
SCCWRP (1973)	5,300	Suspended silt only (<0.063 mm); 1971-1972; 93% Discharged during storms

Noting from the LACDPW data that the storm runoff condition during 1971-72 is close to the 64-year (1928-1992) medians for more severe storm events, and that the vast majority of the fines was discharged during these events, the silt discharge measured by SCCWRP (1973) may be typical of Ballona Creek. Based on the large difference in the annual mean and the annual maximum daily flows and the concentration of large discharge events in the wet months, it appears that the sediment production through Ballona Creek to the coast is predominantly associated with large rainfall runoff events during months from November to April.

A.2 HARBOR SHOALING

A.2.1 Historic Dredging Needs

A history of major maintenance dredging and disposal activities at Marina del Rey after the completion of the offshore breakwater in 1965 is shown in Table A.2.1 based on the data furnished by USACE Los Angeles District (1994).

Table A.2.1 Dredging/Disposal History at Marina del Rey (USACE, 1994)

Year	Dredging Location	Dredging Quantity (cy)	Disposal Location
1969	Ballona Creek mouth	452,000	Del Rey Beach
1973	Shoal along south side of north jetty	11,000	Upcoast of north jetty
1981	Entrance shoal; Ballona Creek mouth	233,000	South of Dockweiler Beach
1987	Jetty tips; Ballona Creek mouth	131,000	
1992	Adjacent area	17,000	Nearshore

The average annual dredging rate is about 31,000 cy/yr after the breakwater contruction. Dredging rates, however, do not necessarily represent shoaling rates since the maintenance dredging operations often differ in area and depth. They directly reflect shoaling rates only if dredging was carried out for the same area and to the same maintenance depth.
It is noted that there has been a frequent need for dredging shoals formed at the Ballona Creek mouth after the breakwater was built. This increased shoaling can probably be attributed to the following:

- The presence of the offshore breakwater creates a protected, low energy environment at the Ballona Creek mouth which facilitates the settling of the sediments discharged from the Creek;

- The presence of the offshore breakwater diminishes the downcoast longshore current which would have moved the discharged Ballona Creek sediments southward;

- The presence of the offshore breakwater causes the waves to bend around its southern end by diffraction-refraction to form a strong northerly energy gradient (Figure A.1.6.3).

This gradient tends to drive a local northward drift which weakens the potential for the discharged Ballona Creek sediments to be transported downcoast.

The accumulation of Ballona Creek sediments at the Creek mouth increases the availability of sediments to be transported into the harbor through tides and sand wave migration.

A.2.2 Harbor Shoaling

Shoaling at Marina del Rey Harbor is the composite result of deposition of sediments primarily from littoral drift and Ballona Creek discharge. It corresponds to the quantity of sediment deposits that need to be removed in order to maintain the federally defined channel. Thus sediment deposition in places away from the maintained areas is by definition excluded in quantifying harbor shoaling. Data available on the shoaling rates in Marina del Rey are shown in Table A.2.2.

Table A.2.2 Existing Data on Harbor Shoaling Rates at Marina del Rey

Source	Shoaling Rate (cy/yr)	Subrates (cy/yr)	Data Source	Note
Tetra Tech (1985)	41,400	3,200 along north jetty 25,600 between jetty mouth and breakwater	USACE survey data (1965-1984)	•For the part of entrance channel 2,000 ft from the jetty tips only •Not including area fronting Ballona Creek and the part of maintenance area near north fillet •1,400-1,800 cy/yr from wind transport; •Sand seepage through jetty negligible

More recent rates of shoaling was obtained in this study based on the USACE condition surveys for the entrance channel and vicinity, which include the post-dredge survey of December, 1992 and the most recent condition survey of June, 1994. Figure A.2.1 shows the areas that shoaled during the intervening period and the magnitudes of shoaling. There is an evident development of sand spits at the tips of the jetties suggesting the around-the-tip sedimentation routing. Significant build-up of shoals in the maintenance area fronting the Ballona Creek mouth is also apparent from the map. Results of analysis on the survey data are summarized in Table A.2.3. Refer to Figure A.2.2.2 for definitions of area A, B and C.

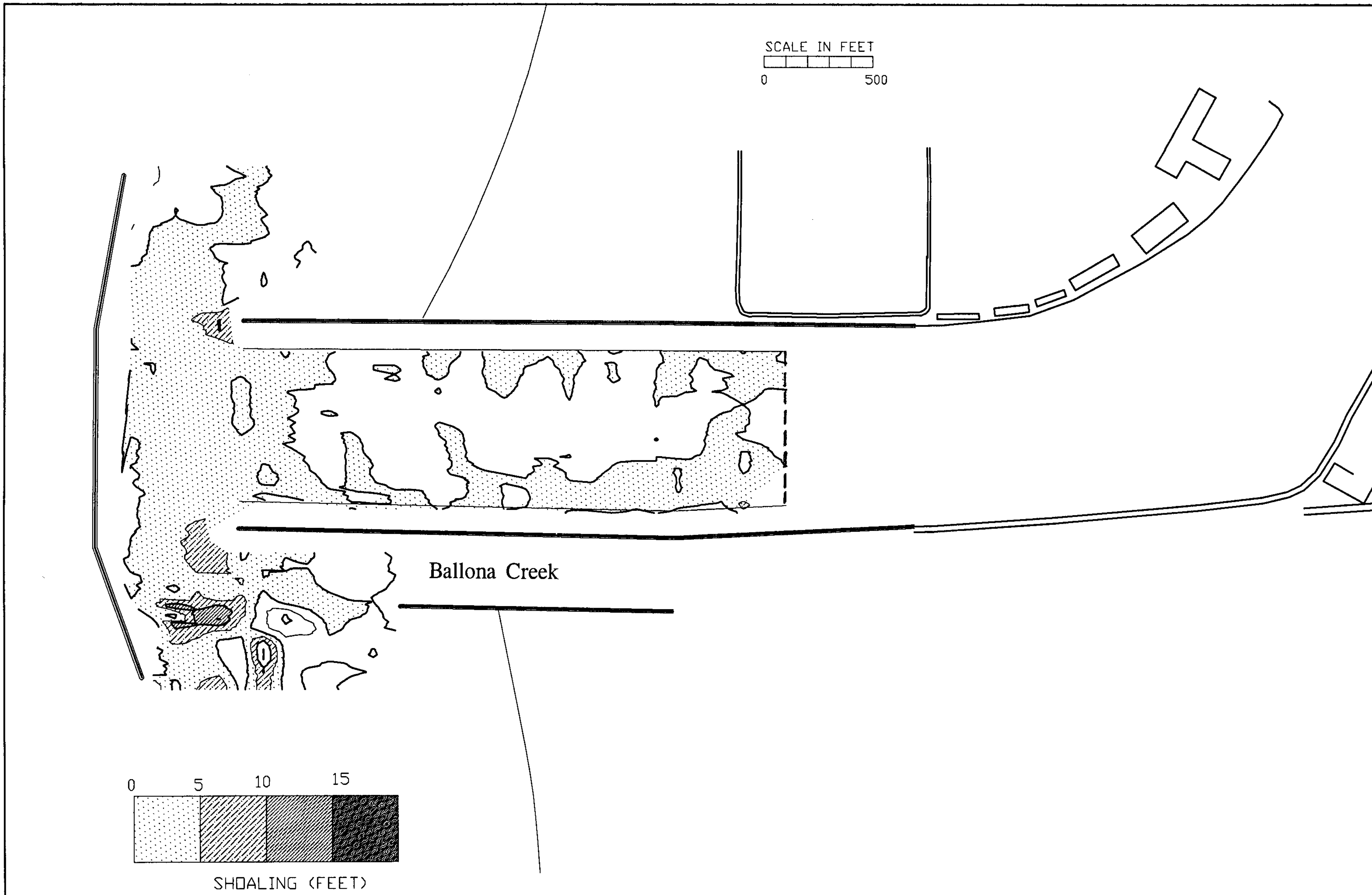

Figure A.2.2.1 Shoaling Pattern

Table A.2.3 Shoaling Rates of Marina del Rey Entrance Channel Maintenance Area

Area	Shoaling Rates (cy/yr)
Entrance Channel Maintenance Area Total	92,000
Maintenance Area with 3,200 ft of Entrance Channel from Jetty Tips	81,600
Area A (West of North Fillet)	6,500
Area C (Fronting Ballona Creek Mouth)	18,000
Area B (Entrance Channel)	57,100

A.2.3 Sediment Budget

Existing sediment budget at Marina del Rey can be characterized based on rates of harbor shoaling and inputs from longshore transport, erosion due to local wave diffraction/refraction, and Ballona Creek sediment yield and other sources of supply such as wind transport. Components in the sediment budget that are unknown from available data can be evaluated by mass balance represented by the sediment budget equations.

There has been no reliable data of longshore transport at Marina del Rey. An approximate estimate, however, can be derived from its quantity near Santa Monica, which was about 95,000 cy/yr based on survey data (DMJM, 1984). For essentially similar wave conditions, the difference in magnitudes of transport is primarily determined by that of the angle between wave crests and the shoreline. On this basis and making use of the longshore transport theory, the potential magnitude of southward transport is about 84,000 cy/yr near Venice Beach and about 33,300 cy/yr immediately upcoast of the north fillet at Marina del Rey Harbor.

The gross input from upland along this segment of coast was previously estimated to be 55,000 cy/yr, which includes sediment yield from Ballona Creek (USACE, 1970). This value is comparable to the various estimates of Ballona Creek sediment yield. This implies that the sediment input from Ballona Creek dominates the total input from upland near Marina del Rey, which suggests that inputs from other upland sources need not be considered for the purposes of this study.

Significant localized erosion due to wave refraction/diffraction around the offshore breakwater was observed from the recent USACE condition surveys. Although data for the south fillet are not available from these surveys, those for the north fillet suggest significant erosion. In the period from the post-dredge December, 1992 to June, 1994, the average net erosion rate at north fillet was about 0.9 ft/yr, which translates to a net volume of about 16,000 cy/yr being removed from the north fillet vicinity into the maintained channel. The primary cause of this localized drift is wave diffraction and refraction around the tip of the offshore breakwater which tend to drive a local current southward along the north fillet. This effect is expected to be especially strong during winter storm seasons. Instead of being brought to the deeper water as in the case of an open beach, the eroded beach sediments on and near the north fillet tend to be intercepted by the offshore breakwater as they move seaward and trapped in the channel maintenance area between the north fillet and the breakwater. This erosion, as is clearly suggested by the June, 1994 survey data collected at the start of a summer season when beaches start to recover, is probably made up by the subsequent sediment supply from summer-time accretionary littoral drift. This seasonal erosion-recover cycle seems to be consistent with the seasonal behavior of an open sandy beach; the only difference, however, is that the eroded sediments are trapped in the channel maintenance area instead of moving offshore and, *e.g.*, forming a sand bar.

Sediment delivered from Ballona Creek consists of two parts. One enters the channel maintenance area, the other moves downcoast and eventually deposits on the beachs. The input to the entrance channel from Ballona Creek can be quantified by considering the maintenance area as a control space. The mass balance requires that the difference between the influx and the outflux be equal to the shoaling inside the entrance channel maintenance area. Since the downcoast shoreline was observed to be essentially stable, the net sedimentation to the south of the Harbor is expected to be small, which implies that the potential erosion of the south fillet and vicinity due to wave diffraction/refraction around the south tip of the breakwater is largely compensated by the sediments supplied from Ballona Creek so that a local equilibrium is approximately maintained. On this basis, the input from Ballona Creek into the entrance channel maintenance area was calculated to be about 41,000 cy/yr based on mass balance.

Table A.2.4 presents the magnitudes of the four major inputs to the entrance channel maintenance area. These results are also shown in Figure A.2.2.2. Note that the wind-transport quantity was based on Tetra Tech (1985).

Table A.2.4 Major Inputs to the Entrance Channel Maintenance Area

Origin	Input (cy/yr)
Longshore Transport/North Fillet Erosion	49,000
Ballona Creek	41,000
Wind Transport	1,600

It is clear that sediment supplies from Ballona Creek and from littoral drift are comparable. Since the sediments from Ballona Creek are largely contaminated as will be discussed later, Ballona Creek appears to be the most significant cause for concern in both dredging needs and the environmental conditions in Marina del Rey Harbor. It is also noted that, given the estimate of Ballona Creek input to the harbor entrance channel, the sediment supply to the downcoast beaches from Ballona Creek can be calculated once more accurate estimate of Ballona Creek sediment yield is available.

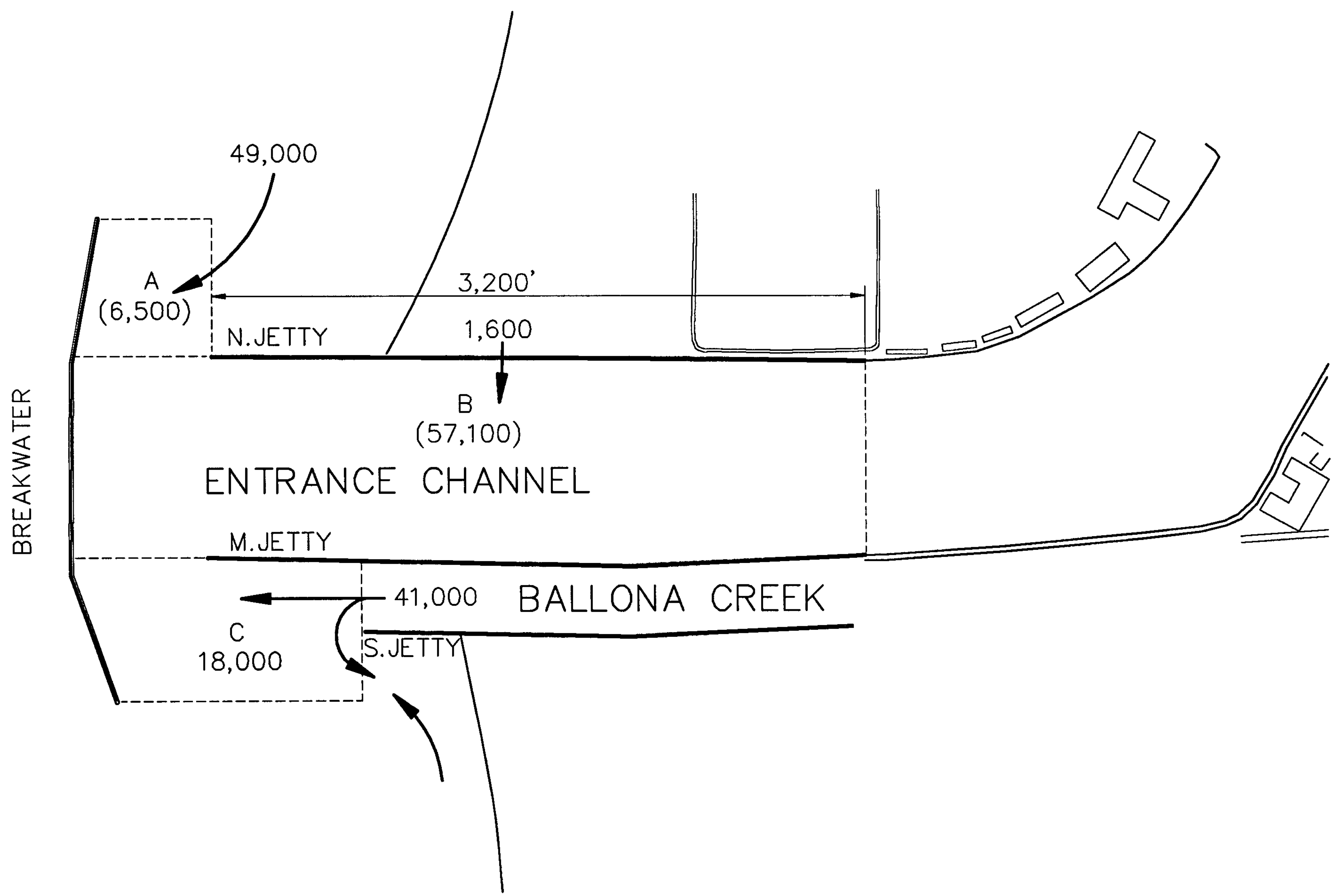

Figure A.2.2.2 Sediment Budget

A.3 MARINE CONTAMINATION

The existing condition of marine contamination at Marina del Rey consists of benthic contamination and water column contamination. While the former pertains to pollution in seabed sediment layers, the latter is primarily associated with pollutants that are dissolved in water or bound on nonsettleable colloids/fines in the water body above the seabed.

A.3.1 Benthic Contamination

The levels of benthic contamination at Marina del Rey can be quantified by the results of three major sediment tests/analyses (Toxscan, 1991; Moffatt & Nichol, 1993; Soule *et al.*, 1993). The Toxscan (1991) and Moffatt & Nichol (1993) studies were conducted in association with the proposed entrance channel dredging/disposal projects following the EPA/USACE (1991) guidelines. Therefore, the levels of benthic contamination as suggested by these results should be viewed as the one that would potentially impact the environment if the sediments are disturbed/reintroduced by dredging/disposal operations. The Soule *et al.* (1993) study, on the other hand, focused on variations in time of contamination levels and impacts on marine animals in Marina del Rey Harbor, especially in the basin areas.

For practical purposes and the nature of data available, the sedimentary condition in Marina del Rey Harbor was analyzed for two relatively distinct parts of the Harbor, namely, the entrance channel areas (including entrance channel, approach channels and the area fronting the Ballona Creek) and the basin areas (including the main channel and the seven berthing basins).

A.3.1.1 Grain Size Distributions

A.3.1.1.1 Entrance Channel Areas

Bulk physical tests on samples from 29 borings in the vicinity of Marina del Rey harbor entrance were conducted by the USACE South Pacific Division Laboratory (Moffatt & Nichol, 1993). The sampling site plan is shown in Figure A.3.1.1 with locations of borings. In order to identify the spatial pattern of grain size distribution in and around the entrance, the data for the top 2 ft of sediments from sieve analysis for each individual boring are compiled and plotted in Figure A.3.1.2; The spatial distribution of the median grain size (50% finer) is also plotted in Figure A.3.1.3. The following can be observed:

- Sediments in the shoals immediate to the inner sides of the jetties along the entrance channel are substantially similar to those in the sand spits near the tips of the middle and north jetties. These sediments are relatively coarse with a typical grain size of about 0.2 mm;

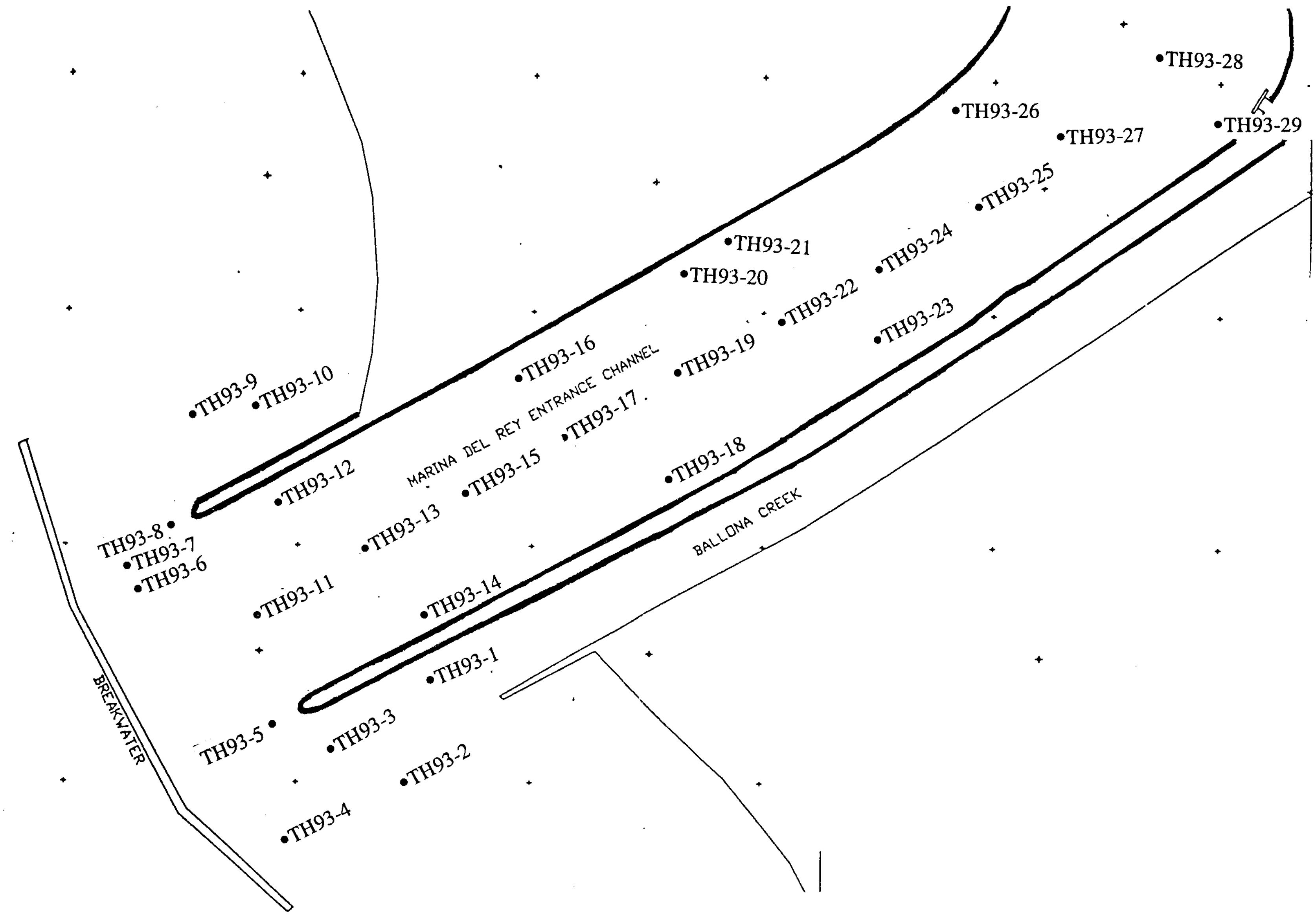

Figure A.3.1.1 Sampling Site Plan

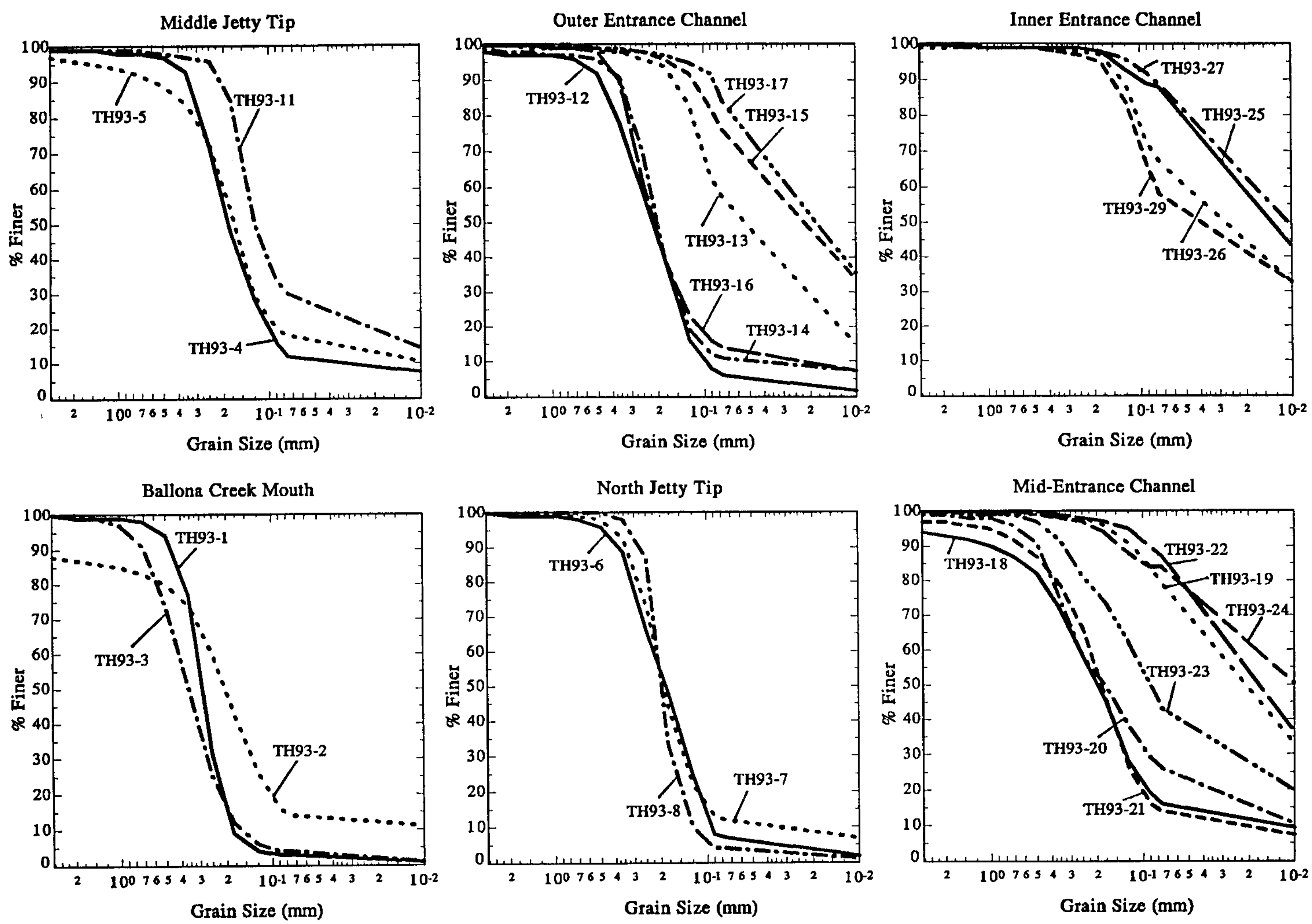

Figure A.3.1.2 Grain Size Distributions

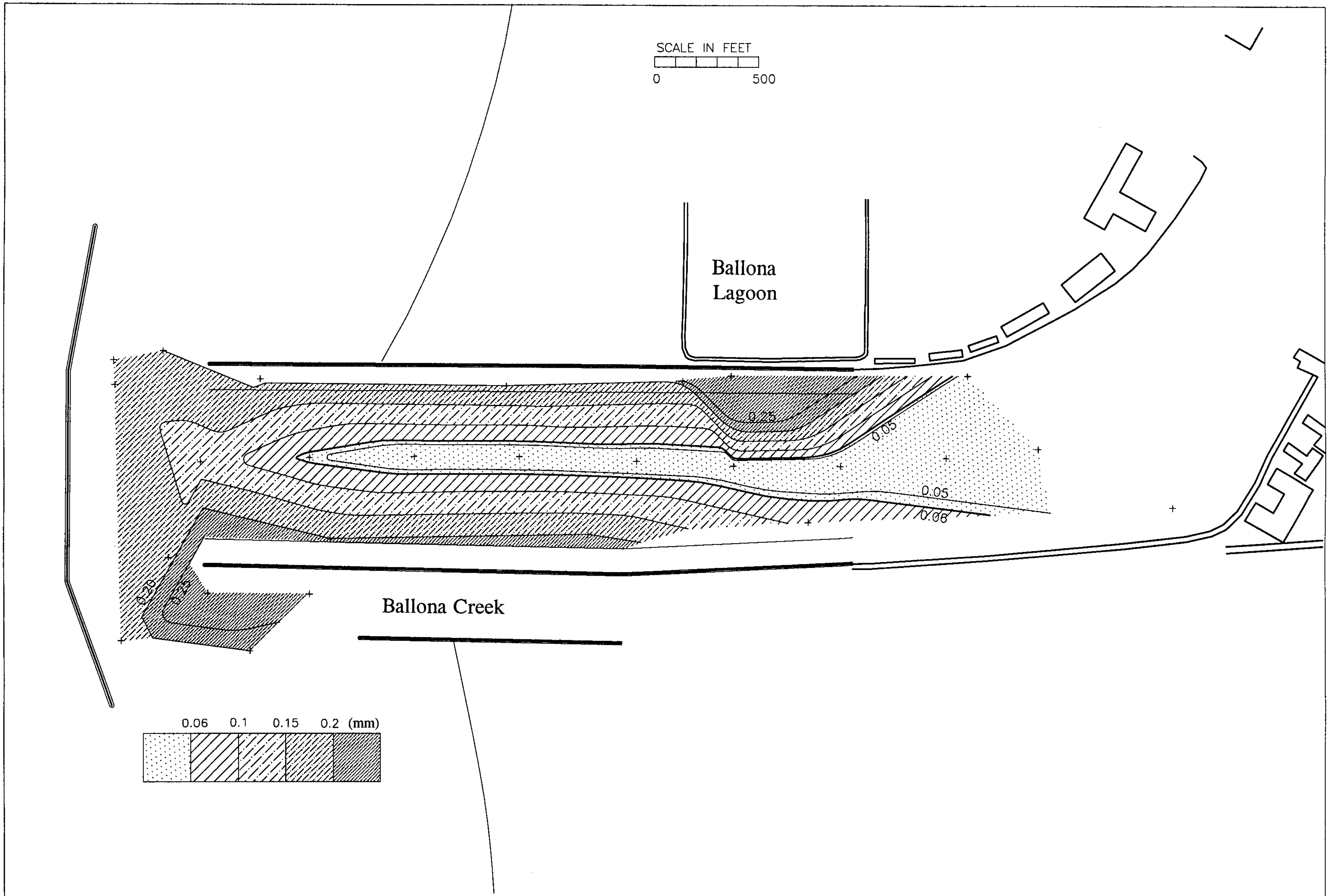

Figure A.3.1.3 Median Grain Size Distribution

• Sediments become predominantly silt/clay near the centerline of the entrance channel with a typical grain size of 0.02 mm;

• Sediments at the Ballona Creek mouth are slightly coarser near the middle jetty with a typical grain size of about 0.3 mm, but are elsewhere similar to those from the middle jetty spit with a median of about 0.2 mm;

• Sediments near the outlet of Ballona Lagoon on the north side of the entrance channel exhibit clear gradation suggesting a sediment-laden discharge from the Lagoon into the entrance channel;

• Sediments near the bend of the navigation channel are predominantly silt/clay.

These distributional characteristics may serve to explain the benthic contamination pattern and provide leads for identifying contamination sources, as will be discussed later.

The accumulation of fine sediments in the middle of the entrance channel appears to be due to the fact that the water near the channel banks is much shallower than in the middle of the channel. The shallow shoals near the channel sides are thus more exposed to the action of wind waves and boat waves. The finer fraction in these shoals thus is subject to constant extraction through resuspension and subsequent redistribution through tides. This results in a relatively coarse composition in these side shoals compared to that in the middle of the channel.

Since the shoals in the area fronting the Ballona Creek mouth have been the most frequently dredged in the past based on the USACE dredging records, and since excessive accumulation in this area necessarily contributes to the shoaling of the entrance channel, it is important to observe the grain size characteristics in the area.

The shoals in this area have long been suspected of being the result of sediment discharge from Ballona Creek rather than from occasional northward reversals of longshore drift. For purposes of verification, the physical testing data of Soule *et al.* (1993) on samples taken from this area in the month of October in 1990, 1991 and 1992 were analyzed against the runoff data for the three water years (October-September). Figure A.3.1.4 shows the percent amount of the coarser sand fraction (>0.063 mm) at the Ballona Creek mouth and the mean daily discharge from Ballona Creek. There is an apparent correlation between sediment composition in the shoals and the strength of flow discharge. During the dry year of 1990, discharge through Ballona Creek was weak and was only able to carry fine sediments through the channel and deposit them at the mouth. This lead to a relatively silty texture in the surface layer with low sand fraction. In the water year of 1991, there were a few more storm events and rainfall runoff was increased slightly. The slightly increased strength of discharge was able to transport more fine sediments but was still too weak to carry significant amount of bedload consisting of coarser sand. This resulted in a decrease in percent sand fraction due to an increase in silt fraction in the shoals at the Ballona Creek mouth. In the wet year of 1992, the strength of discharge nearly doulbed the previous years due to significant rainfall-runoff events. This lead to a drastic increase of the

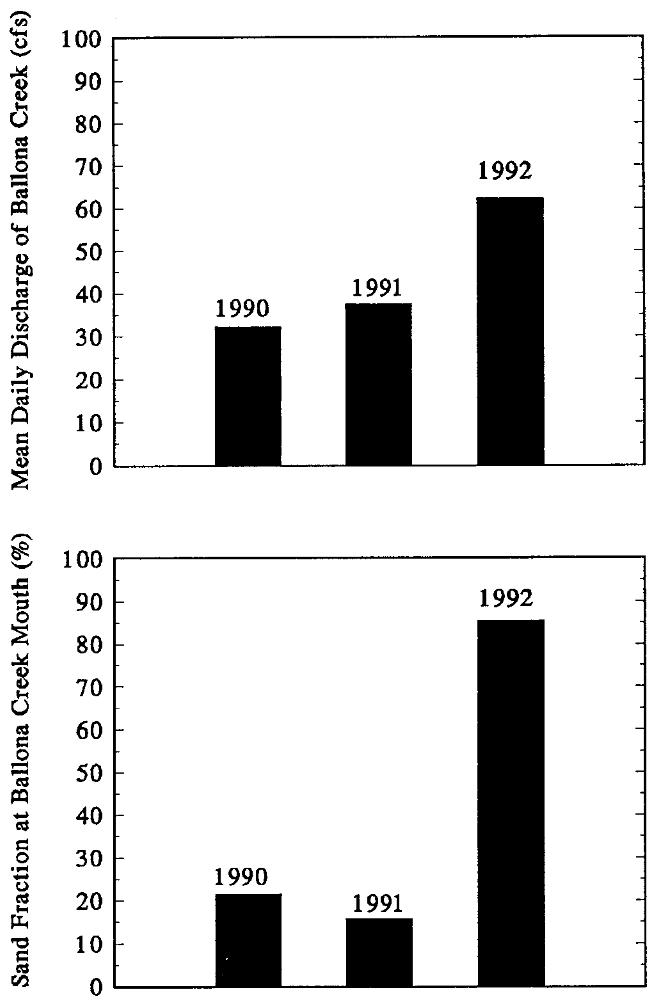

Figure A.3.1.4 Response of Sand Fraction to Runoff Discharge

relatively coarse sediments being transported through the channel and deposited at the mouth. The relative increase of sand fraction in response to that of the channel discharge implies a third-power law between the two quantities and is consistent with the well-known fact that the amount of sand discharge is proportional to the flow velocity raised to at least the third power. These results suggest an apparent correlation between the sediments in the area fronting the Ballona Creek mouth and runoff from the Creek.

The pattern of grain size distribution at the Ballona Creek mouth indicates that there exists a coarse-to-fine gradation of sediments sufficiently away from Ballona Creek mouth. This is consistent with the mechanism of successive deposition of sediments along the flow direction of a developed sediment-laden plume ejected from a channel. The methods of identifying the transport direction from sedimentary signatures can be found in McLaren (1981) and McLaren & Bowles (1985).

These observations on sedimentary compositions and depositional patterns suggest that the the sediments which form the shoals in the area fronting the Ballona Creek mouth have been produced by Ballona Creek through storm-related discharges rather than by upcoast reversals of longshore drift.

The form of depositional gradation of sediments near the outlet of Ballona Lagoon suggests appreciable sediment discharge from the Lagoon. This is consistent with the conclusion in the previous studies of Ballona Lagoon that the banks of the Lagoon experience serious erosion associated with stormwater runoff, and that the net sediment transport is toward Marina del Rey Entrance Channel (BLMP & SCCC, 1992). Part of the sediments may also come from storm drains, which have no sediment traps, during runoff. The weekly flushing of Venice Canals through Grand Canal Washington Street tide gates and Ballona Lagoon is another potential source of sedimentation.

A.3.1.1.2 Basin Areas

Surface sediment characteristics in the basin areas can be analyzed based on testing data presented in Soule *el al.* (1993). Since the sampling results indicated that the sediments are predominantly silty at most stations, their compositions are appropriately characterized by the silt/clay contents. Table A.3.1 shows the silt/clay contents at various locations in the basin areas based on samples taken in October, 1992.

Table A.3.1 Silt/Clay Contents in Sediments in Basin Areas

Location	Silt/Clay Content (%)
Basin F	100.0
Basin E	97.7
End of Main Channel	99.9
Basin D	80.6
Main Channel	98.9
Basin H	97.8
Basin B	59.9
Administration Docks	97.5
Mean of Inner Areas (Basins E, F and End of Main Channel)	99.2
Mean	91.5

Testing results for 1990 and 1991 samples exhibited similar characteristics and pattern (Soule *et al.*, 1993). The trapping of the highly silty sediments in the basin areas especially in the inner basin areas reflects the effects of the harbor geometry on the tidal flow that transport the sediments. The channel bend near the end of the entrance channel tends to damp the kinetic energy of the incoming flow; The narrow basins on the sides of the main channel further restrict the development of turbulent eddies to promote circulation and to keep fine sediments in suspension. This results in a substantially low-energy environment being created, especially in the inner areas, which facilitates deposition of fine sediments in large quantities.

It is difficult, however, to determine the origins of the silty deposits due to the fact that the fine particles normally stay in suspension for a relatively long time during which they are transported away from their sources while mixing with particles from other sources. This eventually confounds the physico-chemical signatures they bear of their origins. Qualitatively, the following three sources are potential contributors of the silty deposits in the basin areas:

- Ballona Creek, which discharges about 5,300 cy/yr of silt (93% during storm-rainfall events) based on a 1971-72 measurement (SCCWRP, 1973). The discharged load tends to be flushed into the harbor on flood tides;

- Silt load in longshore drift around (and seepage through) the north jetty;

- Oxford St. Flood Control Basin, which serves as a sump for draining stormwater into Basin E through a tide gate, and Washington Bl. Drain. Fine sediments may be washed into Basin E during large runoff events or high tides (Soule *et al.*, 1993);

• Ballona Lagoon, which exchanges water with the entrance channel through a culvert gate (open when the tide is lower than 1.5 ft). Fine sediments may be carried into the channel during runoff events;

• Other sources including storm drains and wind transport.

Based on sedimentation quantities, Ballona Creek discharges and longshore transport appear to be the potentially dominant sources of supply for silt/clay deposits in Marina del Rey Harbor. Further consideration of contamination levels associated with the silt/clay fraction in the Harbor suggests that the fines deposited in Marina del Rey Harbor originated predominantly from Ballona Creek which discharges 93% of its total production of largely contaminated fines during storm-rainfall events.

A.3.1.2 Contamination Levels

A.3.1.2.1 Entrance Channel Areas

Toxscan (1991) performed bioassay and bioaccumulation tests of sediments from 5 stations in Marina del Rey Harbor. In these experiments, test animal mortality/abnormal development (benthic and elutriate bioassays) and the increase in animal tissue contaminant concentration (bioaccumulation) were determined and compared with reference results obtained by using the samples from the USACE prescribed reference sites. The elutriate bioassay tests indicated significant mortality of test animals. Similar results also found for benthic bioassays for certain sampling locations. The bioaccumulation tests showed that heavy metals, lead, copper and chromium in particular, are the contaminants of potential threat to local eco-system and human health.

Bulk chemistry tests of Marina del Rey sediments were recently conducted by the USACE based on samples taken from 29 borings in the approach channel, entrance channel and the Ballona Creek mouth. Detailed results of bulk concentrations of contaminants by sample are given in Appendix A.1. The results were analyzed by Moffatt & Nichol (1993). The primary pollutants of concern were identified by evaluating their required dilution based on accepted procedures (EPA/USACE, 1991). Table A.3.1 shows the mean concentrations of typical priority contaminants in Marina del Rey sediments and the corresponding values of required dilution determined by using the ADDAMS programs. The water quality criteria used in computing dilution are the instantaneous maximum criteria California Ocean Plan water quality criteria except those for PCBs and fluoranthene for which the EPA daily average marine water quality criteria are used (Federal Register, Vol 45, No. 231, 28 Nov., 1980). Since the Ocean Plan criterion for PCBs is 30-day averages, the one-day averages are relatively acute criteria.

Table A.3.1 Mean Concentrations of Typical Priority Contaminants and Dilution Test Results (Moffatt & Nichol, 1993)

Contaminant	Acute Water Quality Criteria (mg/l)	Mean Concentration in Marina del Rey Sediments (mg/wet kg)	Required Dilution
Arsenic	0.08	5.80	34
Cadmium	0.01	0.94	44
Chromium	0.02	21.74	521
Copper	0.03	24.64	393
Lead	0.02	91.67	2199
Mercury	0.0004	0.12	143
Nickel	0.05	12.45	119
Silver	0.007	0.87	59
Zinc	0.2	104.48	250
PCBs	0.00003	0.115	1839

Results suggested that the most prominent comtaminant in Marina del Rey sediments is lead since it requires the largest dilution due both to the relatively high concentration in the sediments and to the relatively restrictive water quality standard. Chromium, copper and PCBs are also of serious concern compared with other species. These findings are consistent with the Toxscan (1991) bioassay/bioaccumulation test results. It should be noted, however, that the final selection of the *contaminants of concern* for a specific project should be based on multi-agency consultation as well as the testing results.

A.3.1.2.2 Basin Areas

Soule *et al.* (1993) presented chemical testing data for surface sediments sampled in October, 1992 at a number of stations in Marina del Rey Harbor and vicinity, with an emphasis on harbor basin areas. Table A.3.2 shows the mean concentrations of typical contaminants in surface sediments from stations in harbor basin areas. These values are also compared with those in the entrance channel areas based on the USACE data (Moffatt & Nichol, 1993). Concentrations are on dry-weight basis. It is also noted that differences existed in the detection limits applied in the data sets from different laboratories. The potential influence of this on data comparability, however, is expected only for chemicals with negligibly low concentrations (*i.e.* close to detection limits).

Table A.3.2 Mean Contamination Levels in Basin Areas and in Entrance Channel Areas

Contaminants	Mean Concentration in Harbor Basin Areas (mg/kg)	Mean Concentration in Entrance Channel Areas (mg/kg)
Arsenic	8.34	7.13
Cadmium	0.60	0.54
Chromium	53.00	27.39
Copper	154.00	31.05
Mercury	1.65	0.14
Lead	104.64	96.48
Nickel	28.31	15.69
Zinc	267.75	131.64
Oil/Grease	1,050.00	1,705.06
TOC (%)	3.33	2.13
Priority DDTs (P,P'-DDD;P,P'-DDE)	0.104	Not Detected
PCBs	0.028	0.070
TBT	0.846	0.013

It suggests that the harbor basin areas are more contaminated than the entrance channel areas except for oil/grease and PCBs.

A.3.1.2.3 Comparison with Santa Monica Bay

Comparison of the benthic contamination levels in Marina del Rey entrance channel areas with those in Santa Monica Bay can be made based on sediment data collected in the summer of 1991 from 40 stations across the Bay maintained by the marine environmental monitoring program under the City of Los Angeles Hyperion Treatment Plant. Figure A.3.1.5 shows an example of baywide measurements of oil/grease with the locations of sampling stations indicated (CLA, 1993).

Table A.3.3 presents the comparison between the mean contaminant concentrations in Marina del Rey Harbor and the bay-wide means for conventionals (O/G, TOC) and typical priority pollutants. Since the bases for data presentation are different for these two data sets (Delorey, person. comm.), the concentrations in Table A.3.3 have been converted to be based on composite, dry solids; In addition, concentrations that are below detection limits in Marina del Rey samples are taken to be zero so as to be consistent with the the CLA (1993) methodology.

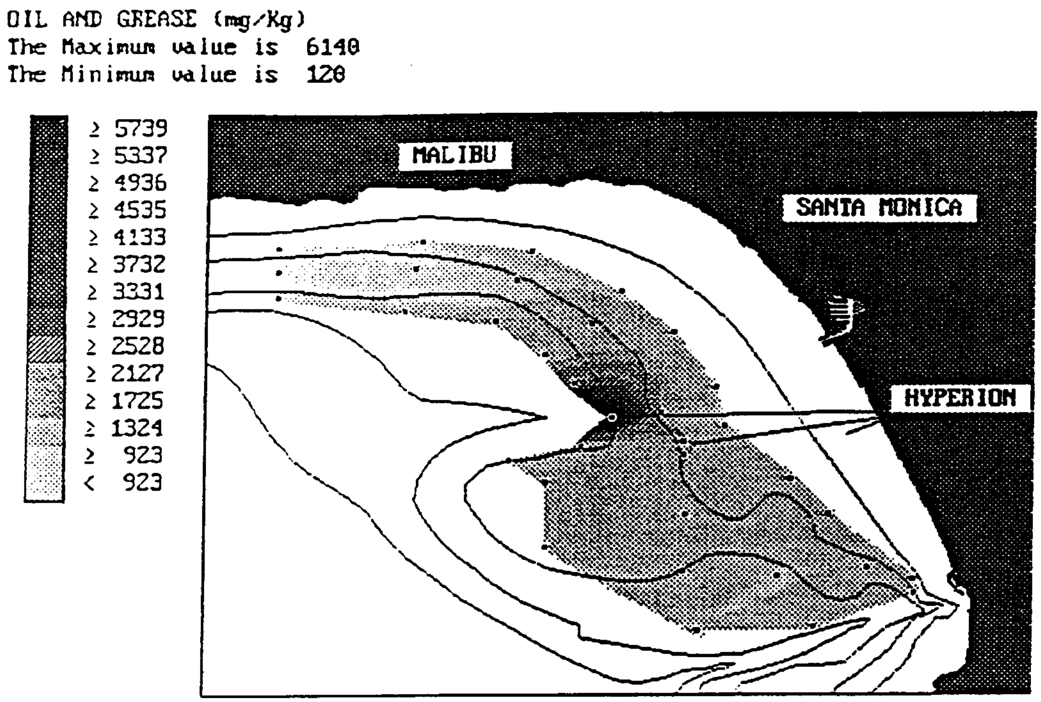

Figure A.3.1.5 Bay-Wide Sampling: Oil/Grease (CLA, 1993)

Table A.3.3 Comparison of Mean Contamination Levels in Marina del Rey Entrance Channel Areas with Those in Santa Monica Bay

Contaminant	Baywide Mean Concentration in Santa Monica Bay (Range[1]) (mg/kg)	Mean Concentration in Marina del Rey Entrance Channel Areas (mg/kg)
Arsenic	6.70 (2.45-30.2)	7.13
Cadmium	1.49 (0.24-18.2)	0.54
Chromium	74.6 (22.2-241)	27.4
Copper	43.3 (9.60-271)	31.1
Mercury	0.24 (0.07-1.09)	0.14
Lead	20.2 (4.80-84.5)	96.5
Nickel	18.8 (8.30-36.0)	15.7
Silver	3.02 (0.34-26.7)	0.45
Zinc	78.1 (35.8-332)	131.6
Oil/Grease	477 (60-3070)	1,705
BNAs (Phthalates)	46.0 (0.00-288)	1.32
Priority DDTs (P,P'-DDD & P,P'-DDE)	0.181 (8.90-807)	Not Detected
PCBs	0.126 (0.00-366)	0.070

It is clear that the mean concentration levels of arsenic, lead, zinc, oil/grease, sulfides and TOC in Marina del Rey exceed the background levels in the Santa Monica Bay. Of particular concern, again, is the lead concentration in Marina del Rey sediments which is about four times the background lead level in the Bay; oil/grease and zinc levels in Marina del Rey are also significantly elevated than the baywide means. PAHs, however, were found to be insignificantly low in the Bay (Shoja-Chaghervand, person. comm.) and detected only at a few spots in Marina del Rey Harbor.

A.3.1.3 Contamination Pattern

Spatial patterns of contamination can be determined from the USACE 29-boring sampling and testing data. Figures A.3.1.6 presents a composite map of the depth-averaged concentrations of four typical contaminants, *i.e.*, oil/grease (O/G), total organic carbon (TOC), total

[1] Product of the measured local concentration and the ratio of the bay-wide mean silt/clay content to the local silt/clay content.

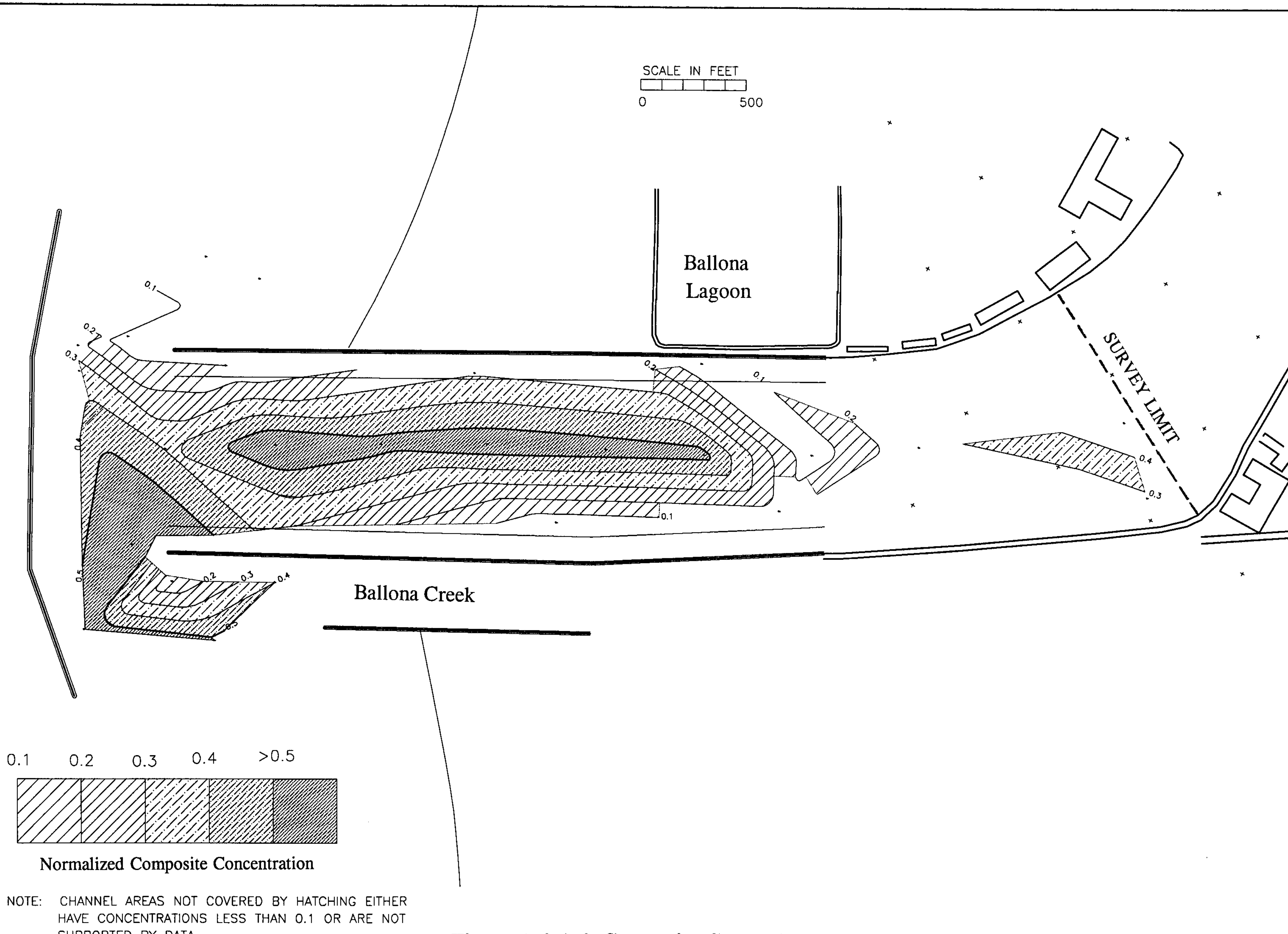

Figure A.3.1.6 Composite Contamination Pattern

polychlorinated biphenyls (PCBs) and lead for the upper 2 ft of sediments from the mud lines. The composite concentration was derived by normalizing the concentrations of each chemical by its maximum value at the site and then taking the average of the normalized concentrations of the four chemicals at each boring location. The distributions of concentrations averaged over the total depths of measurements exhibit similar patterns. The following characteristics are noted:

• Contamination levels are consistently high at the following locations:

- Shoals near the entrance channel centerline;
- Shoals near the foot of breakwater fronting the Ballona Creek mouth;
- Ballona Creek mouth (before discharge plume expands);

• Contamination levels are low along the entrance channel sides near the jetties, consistent with the relatively coarse material present in these places;

• Contamination levels at the north fillet (north of the North Jetty) are significantly lower than those in the channel (typically by an order of magnitude).

• Contamination levels in the entrance channel near the outlet of Ballona Lagoon are low.

The depth-averaged contamination levels reflect the historic accumulative effects of pollution in the harbor and are indicative of the potential impact on the environment due to dredging and disposal operations.

In order to place the pattern shown in perspective, it is first recognized that the most significant sedimentation routes into the Harbor are those around the tips of the north and middle jetties on tidal flows (Tetra Tech, 1985). While the finer fractions (<0.063) are easily suspended and redistributed by flows once inside the harbor, the coarser sand fraction (>0.063 mm) migrates slowly around the jetty tips and along the inner sides of the jetties through the development of sand spits and shoals. As the sandy loads migrates, they mix with local sediments through turbulence. If the new sediments are more contaminated than indigenous ones, the contaminant concentrations become more diluted farther down the channel; otherwise, they become more concentrated. This mechanism is consistent with the pattern shown in Figure A.3.1.6. The contamination level dereases along the initial portion of the middle jetty but increases along the corresponding part of the north jetty. Since the sediments on the north fillet contain much lower contaminant concentrations than those in the harbor, their input to the entrance channel tends to dilute the contamination. On the other hand, the sediments from around the middle jetty tip tend to aggrevate the contamination. This suggests that the contaminated sedimemnts are from the shoals in the area fronting the Ballona Creek mouth which consist largely of sediments discharged from Ballona Creek based on sedimentary pattern, composition and its correlation with runoff through Ballona Creek as discussed previously.

The existence of an isolated low contamination area near the outlet of Ballona Lagoon indicates that the sediment load carried by the discharge plume from Ballona Lagoon is less contaminated than the sediments in the entrance channel. This is consistent with the results of a comprehensive sediment sampling study in Ballona Lagoon by Engineering Science (1987) which showed that the metal concentrations in the sediments are all below the Soluble Threshold Limits of the State of California. Hence Ballona Lagoon does not appear to be a major and persistent source for contaminated sediments.

A.3.2 Water Column Contamination

A.3.2.1 Water Quality

The existing condition of water quality in Marina del Rey can be examined based on data by Soule *et al.* (1993). Figure A.3.2.1 presents the monthly total rainfall in Los Angeles Basin and the mean concentrations of physical water quality parameters, nutrients and bacteria counts during the surveyed period of July 1992-June 1993. In presenting the data, sampling stations outside the Harbor proper (stations 12, 13 and 22; see Soule *et al.*, 1993) were excluded to reflect the condition within the harbor. The following is noted:

- The influence of the terrestrial stormwater runoff on water quality in Marina del Rey is apparent from the relatively robust correlation between the wet season and the elevated concentrations of BOD, nutrients, bacteria counts and the responses of physical water quality parameters;

- The inverse relationship between salinity and nutrient concentrations in the harbor suggests that the nutrients are derived from terrestrial origins (Soule *et al.*, 1993), which further substantiates the observation of stormwater runoff as the primary source of contamination in Marina del Rey Harbor;

- The water quality within Marina del Rey Harbor may deteriorate considerably during the wet season posing potential public health problems as indicated by the appreciable exceedances of the public health standards in bacteria counts during months of significant stormwater runoff.

Since the terrestrial stormwater influx into Marina del Rey Harbor originates predominantly from Ballona Creek, Oxford Street Basin, Washington Street Drain and Ballona Lagoon, they appear to be the most significant potential sources of water column contamination in Marina del Rey.

A.3.2.2 Flushing Ability

The long-term water quality in Marina del Rey Harbor depends not only on the contaminant influx but also on its natural ability to flush itself through tidal exchange. Ocean water enters

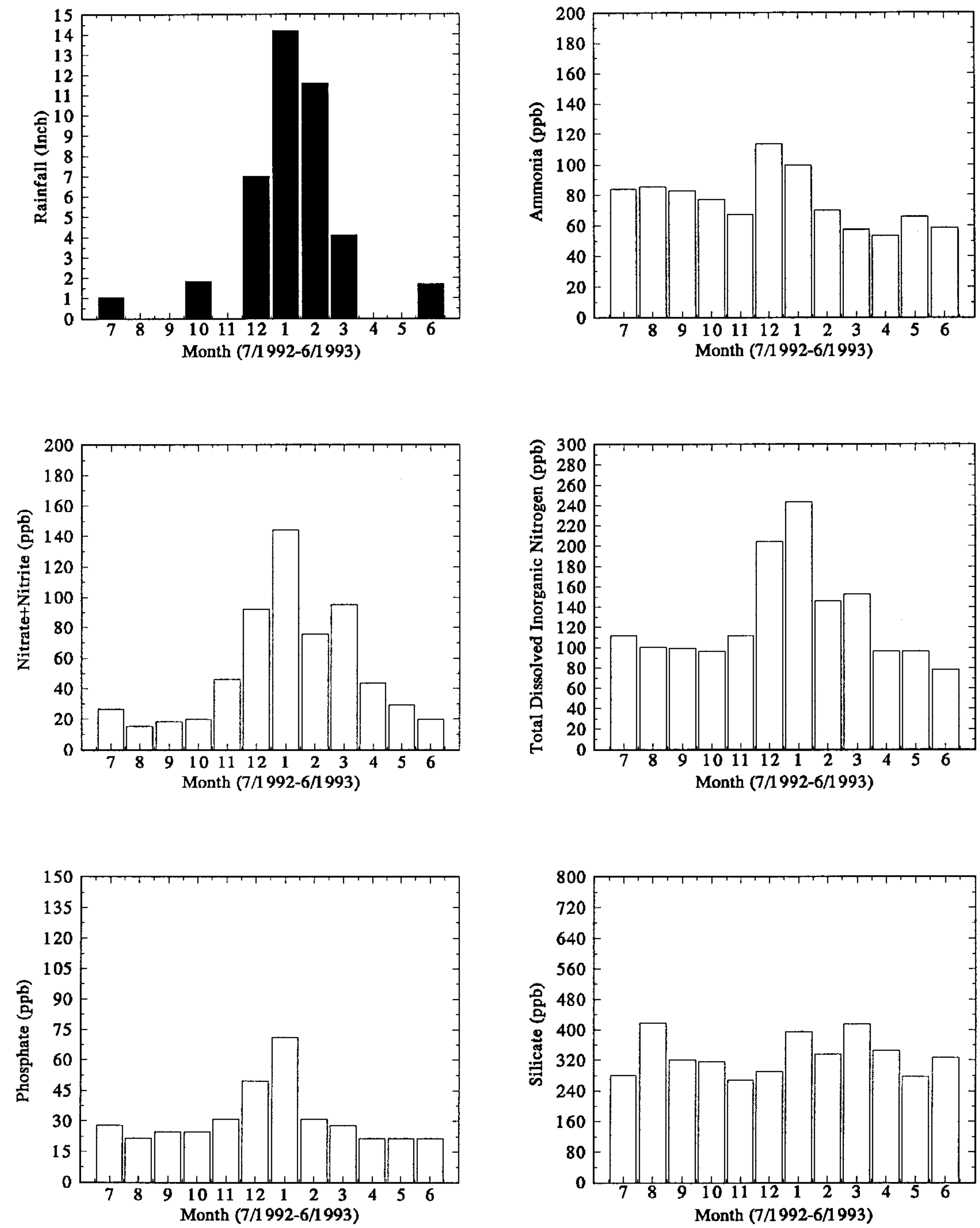

Figure A.3.2.1 Response of Harbor Water Quality to Runoff

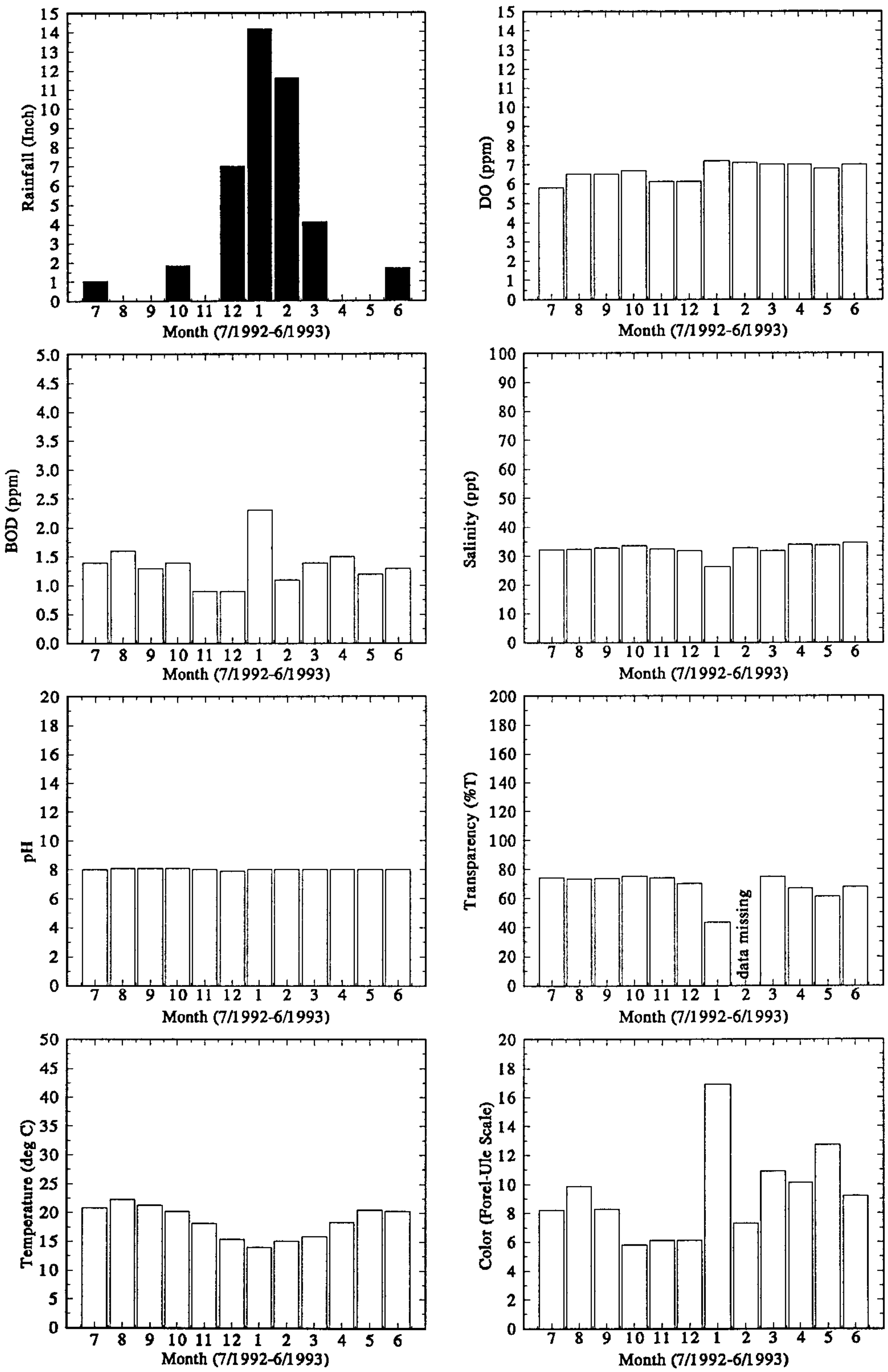

Figure A.3.2.1 Continued

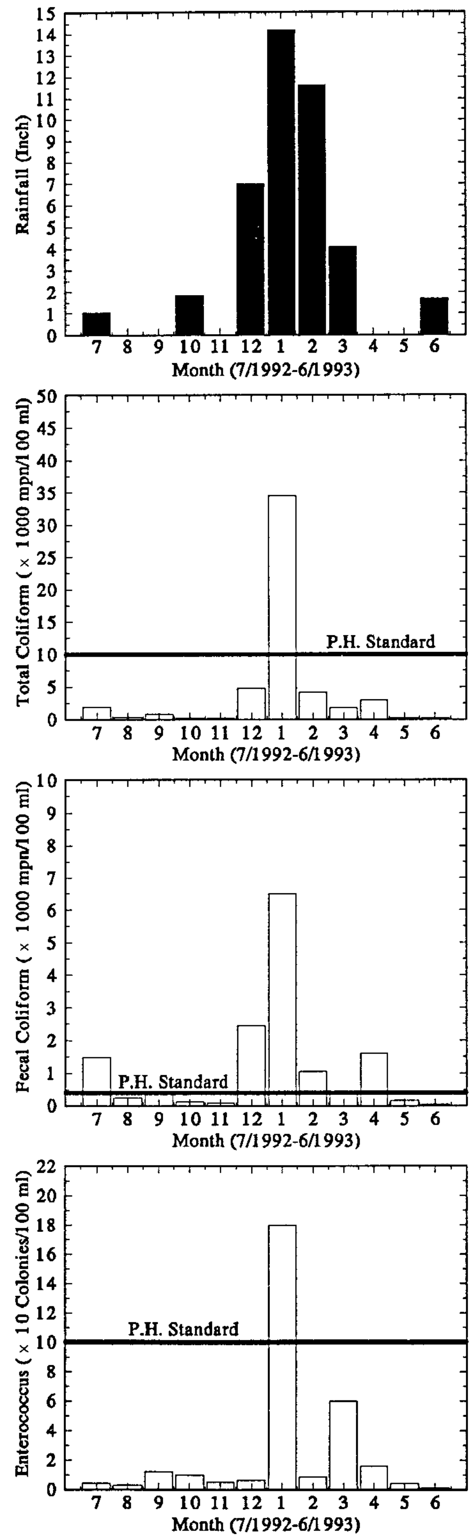

Figure A.3.2.1 Continued

the harbor on the flood tide, mixes with water inside, before exiting the harbor on ebb tides. The existing harbor water then mixes with ambient ocean water near the north fillet and with ocean water and Ballona Creek discharge near the south fillet before being partially sucked into the harbor on the next flood tide.

Since the ocean water near the north fillet is less contaminated, the mixing dilutes the contaminant concentrations in the exiting water so the returning water is cleaner. Similar would be the case near the south fillet if the discharge from Ballona Creek were not or less contaminated. In this case, the harbor water is continually refreshened, or flushed, on successive tides. The effectiveness of the flushing depends primarily on the intensities of the eddies associated with the exiting jets created at the openings between the north and south jetties and the offshore breakwater.

If, however, the Ballona Creek discharge is significantly contaminated, the water returning to the harbor from the south may have elevated contaminant concentrations. The flushing process then becomes slower. In cases where the Ballona Creek discharge is significantly contaminated, as is the case during and after heavy rainfall events in wet seasons, the water being sucked into the harbor may have higher contaminant concentrations than inside the Harbor. This suggests the ceasure of flushing and the start of contamination of Marina del Rey Harbor.

Hence the flushing ability of Marina del Rey Harbor depends on the following:

- Entrance geometry, which determines the mixing characteristics;
- Tidal prism, which determines the strength of tidal exchange;
- Ballona Creek discharge quality, which determines the external contaminant loading.

Moffatt and Nichol, Engineers (1981) conducted physical model tests for flushing of Marina del Rey Harbor. The effects of Ballona Creek discharge, however, was not investigated. For purposes of the present study where identification of the the role of Ballona Creek in contaminating Marina del Rey Harbor is crucial, the existing flushing condition of Marina del Rey Harbor was examined based on an analytical flushing model adapted from the conceptual formulation of Sanford *et al.* (1993). The empirical coefficient involved in the analytical model was determined by excluding the input from Ballona Creek and then calibrating the prediction with the physical flushing model results. The performance of the model is shown in Figure A.3.2.2.

Figure A.3.2.3 presents the flushing characteristics of Marina del Rey Harbor under the influence of Ballona Creek discharge. When the contaminant mass emission from Ballona Creek is negligible (*e.g.* during dry seasons), a contaminant released in Marina del Rey Harbor take about 5 days to be diluted by 10 times from its initial concentration by tidal flushing. The time required for the same flushing effect, however, increases dramatically as the external loading from Ballona Creek contaminant increases (*e.g.* during wet seasons) which implies that the flushing effeciency becomes much lower. For example, the contaminant concentration in the Harbor is only reduced by half 5 days after the release when the contaminant mass discharged

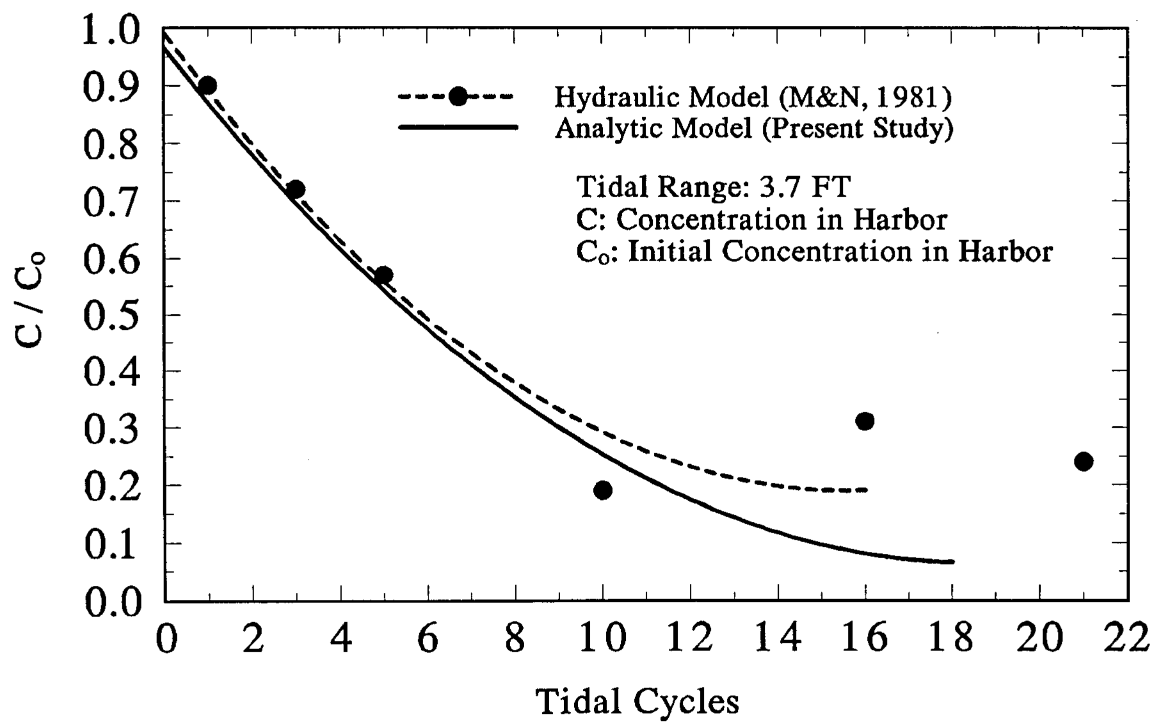

Figure A.3.2.2 Flushing Model Performance

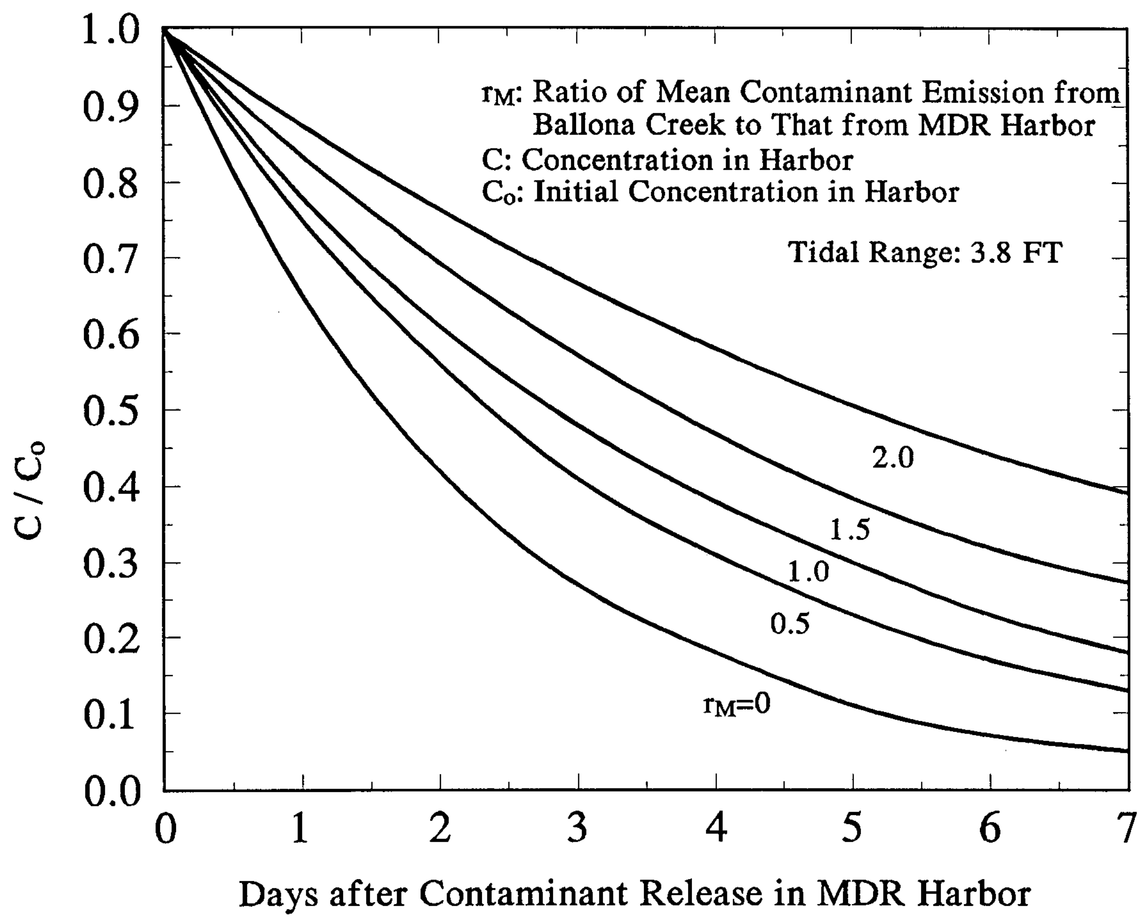

Figure A.3.2.3 Flushing Characteristics

from Ballona Creek is about twice that from Marina del Rey Harbor.

It is therefore evident that the contamination level in Marina del Rey Harbor is highly sensitive to the contaminant discharges from Ballona Creek. This is consistent with the relative robust correlation between water contamination levels and stormwater runoff found in the survey data of Soule *et al.* (1993) as analyzed previously.

A.3.3 Contamination Sources

A.3.3.1 Point Sources

A point source is a discernible, confined and discrete conveyance from which pollutants are or may be discharged (Section 502 (14), Clean Water Act). Typical point sources that affect marine environment include municipal wastewater and industrial effluent discharges. A point source discharge is subject to the permit requirements of the Clean Water Act (CWA). All legally defined point sources that discharge into Santa Monica Bay have been issued National Pollutant Discharge Elimination System (NPDES) permits by the Regional Water Quality Control Board with the concurrence of the USEPA (SMBRP, 1993).

A.3.3.1.1 NPDES Municipal/Industrial Discharges

Major point sources along the coastline near Marina del Rey and their potential effects on contamination in Marina del Rey are listed and analyzed in Table A.3.4.

Table A.3.4 Major Point Sources near Marina del Rey

Source	Operator	Location of Primary Outfall Terminus	Discharge Type	Primary Pollutants in Mass Emission
Hyperion Sewage Treatment Plant	City of Los Angeles	5 miles southwest of Marina del Rey in about 180 ft of water	Treated sewage	Nutrients, conventionals, metals, phenols
Scattergood Generating Station	City of Los Angeles	3 miles downcoast of Marina del Rey in about 15 ft of water	Thermal	Total suspended solids (TSS) and oil/grease (no longer limited by permit), trace amounts of zinc and chromium
El Segundo Refinery	Chevron	3.5 miles downcoast of Marina del Rey in about 20 ft of water	Treated wastewater	TSS, COD, BOD
El Segundo Generating Station	Southern California Edison	4 miles downcoast of Marina del Rey in about 16 ft of water	Thermal	TSS, oil/grease

Since all major point-source discharges are located downcoast of Marina del Rey, their emissions do not have significant potential to influence the contamination levels in Marina del Rey Harbor because of the prevailing southward nearshore and littoral currents. In other words, contaminated discharges can only be swept further away from Marina del Rey under prevailing conditions; Potential reversals of nearshore circulation due to, *e.g.*, local wind forcing or summer time southern swells are not expected to carry elevated pollutant concentration because of miles of dilution before reaching Marina del Rey.

Indeed, the bulk sediment data presented by Toxscan (1991) indicated appreciably lower contamination levels in the sediments north of El Segundo Hyperion Treatment Plant than those in Marina del Rey Harbor. In addition, the seasonal variations of water column contamination in Marina del Rey Harbor was also found to be decoupled from ambient ocean (Soule *et al.*, 1993).

It therefore appears that municipal and industrial discharge facilities near Marina del Rey are not significant sources of pollution for Marina del Rey Harbor.

A.3.3.1.2 NPDES Storm Drains

There are 84 permitted discharges of non-stormwater effluents through storm drains into Ballona Creek system (82) and Marina del Rey Harbor (2) based on data of the Regional Water Quality Control Board. A list of these discharges is given in Appendix A.2. Typical discharges include cooling water and drained groundwater for construction site preparation. The two drains that directly discharge into Marina del Rey include a groundwater discharge (permittee GBW Properties) and a boat washing waste water discharge (permittee Windward Yacht & Repair).

Since the combined discharge of this type of point sources is about 4% of the annual discharges from stormwater runoff (Stenstrom & Strecker, 1993), they do not appear to constitute a significant part of the total contaminant loading on Marina del Rey Harbor.

A.3.3.2 Nonpoint Sources

A nonpoint source is a pollution source that does not meet the legal definition of a point source in Section 502 (14) of the CWA (USEPA, 1993). Typical nonpoint sources that affect marine environment include stormwater runoff and marine activities. A nonpoint source is not subject to Federal permit requirements under the Clean Water Act (USEPA, 1993). In Southern California, stormwater discharges are not regulated.

A.3.3.2.1 Stormwater Runoff

Harbor Drainage Characterization

Stormwater runoff contributes to the contamination of Marina del Rey Harbor primarily through stormwater discharges from

- Oxford St. Flood Control Basin
- Washington Bl. Drain
- Ballona Lagoon
- Marina del Rey Harbor Area
- Ballona Creek

The first four sources constitute the direct drainage into Marina del Rey Harbor. Runoff discharge from Ballona Creek enters Marina del Rey Harbor primarily on flood tides and is thus an indirect drainage. A characterization of the drainage system is shown in Table A.3.5 (LACDPW, 1994; Hailu, LACDPW, person. commun.; BLMP & CSCC, 1992). The definitions of land uses are as follows:

- Residential: single-family units, duplex, etc.;
- Commerical: shopping districts, multi-family complexes, etc.;
- Industrial: industrial fascilities;
- Open: natural open spaces, agricultural lands.

The subbasin IDs are named after the drains of the individual subbasins as defined by LACDPW. The zoning of these subbasin is shown in the attached drainage map (Appendix D). A list of locations, sizes and land uses of these subbasins are provided in Appendix A.3.

Table A.3.5 Characterization of Stormwater Drainage into Marina del Rey Harbor

Drainage Basin	Oxford St Basin	Washington Bl. Basin	Ballona Lagoon	Marina del Rey Harbor	Ballona Creek
Drainage ID	BI5243 BI3872	BI86	GRCNL1	MDREY1	80 basins
Size (sq.mi.) %Watershed	0.07 <0.1%	0.11 <0.1%	0.51 0.4%	0.61 0.5%	127.1 99.0%
Land Use: Residential Commercial Industrial Open	 70% 21% 9% 0%	 55% 36% 9% 0%	 39% 61% 0% 0%	 88% 0% 0% 12%	 53% 40% 4% 2%
%Impervious	54%	56%	60%	74%	49%
RCRA Site	Western Circuits Inc.	No	No	No	5 sites incl. Hughes Helicopter Inc. south of Basin H
Waste Dump	Thatcher Ave Street Maint./ Transfer Yard	No	No	Celery Dump Venice Dump	17 Dumps
Discharge Location	Basin E	Basin E	Entrance Channel	Harbor-wide	Entrance Channel
Drain Type	a 6.8'circular and a 6'x6' box culverts with flap gates, open if water in pond is higher	undergroundsto rm drain	a 7' culvert with a slide gate, open/ close at 1.35'/2.65' MSL on Harbor side	surface drain	on flood tides
Sediment Discharge Potential	fines only due to weak flow in pond during runoff; relatively insignificant in volume	fines/sand; relatively insignificant in volume	fines/sand from bank failure due to runoff	fines/sand	fines on flood tides and sand through accretion

The following may be observed from the above characterization:

- The direct drainage into Marina del Rey Harbor constitutes only about 1% of the total drainage area of Ballona Creek Watershed. The volume of stormwater Marina del Rey Harbor receives therefore originates primarily from Ballona Creek drainage;

• Areas drained by Oxford Basin and Washington Drain are significantly more industrialized than the Ballona Creek average, and thus are potentially significant sources of industrial contaminants such as heavy metals in Basin E of the Harbor;

• Areas drained by Oxford Basin contains a RCRA remediation site (Western Circuits Inc.) and those drained by Ballona Creek have 5 such sites with one (Hughes Helicopter Inc.) near Ballona Creek mouth adjacent to the harbor. The presense of these sites heightens the potential for contaminating stormwater discharged into the harbor by toxicants prevalent at these sites;

• Areas drained by Oxford Basin, the Marina del Rey Harbor area and Ballona Creek contains waste dumps and therefore are potential sources for added level of contamination with the species of contaminants depending on the types of the dumps;

• Areas drained by Oxford Basin, Washington Drain and Ballona Lagoon are highly residential and thus are potentially significant sources of contaminants from human activities such as bacteria (coliforms/enterococcus) especially in Basin E;

• Surface drainage of the Marina del Rey Harbor area has a high percentage of commercial drainage and thus is a potentially significant source for contaminants such as oil/grease in the harbor. Similar but to a lesser degree are the areas drained by Oxford Basin and Ballona Lagoon;

• Areas drained by Oxford Basin, Washington Drain and Ballona Lagoon have negligible open/agricultural land and therefore are not likely to be significant sources of sediments that would contribute to shoaling in the Harbor, although Ballona Lagoon does contribute sediments to entrance channel from lagoon bank failure during runoff events. Nevertheless, sediementation of fines is expected in heavy runoffs;

• Surface drainage of the harbor area is a potential source for sediments in the harbor due to its high percentage of open land. The predominant source of sediments in the harbor, however, appears to be Ballona Creek in view of its appreciable open land acreage and large volume of flow discharge.

The above analysis is summarized in Table A.3.6. Relative importance of various sources has been weighted by their relative acreages.

Table A.3.6 Characterization of Impacts of Direct and Indirect Stormwater Drainages on Contamination of Marina del Rey Harbor

Drainage Basin	Primary Sources of Water Column Impacts	Primary Sources of Benthic Impacts	Primary Locale of Impacts in Harbor	Typical Potential Benthic Contaminants	Significant Effect on Harbor Shoaling
Oxford Basin	•industrial •RCRA site •dump site •residential	•industrial •RCRA site •dump site	Basin E	•heavy metals •site-dependent toxicants	no
Washington Drain	•industrial •residential	•industrial	Basin E	•heavy metals	no
Ballona Lagoon	•commericial •residential	•commercial	Entrance Channel	•oil/grease	moderate (from bank failure)
Marina del Rey Habor Proper	•commercial •open/agric.	•commercial	harbor-wide	•oil/grease	no
Ballona Creek	•industrial •RCRA sites •dump sites •commercial •residential •open/agric.	•industrial •RCRA sites •dump sites •commercial	harbor-wide through Entrance Channel	•heavy metals •site-dependent toxicants •oil/grease	yes

It is noted that the analysis is based on land use characteristics and general principles of urban runoff quality evaluation, and therefore is a conceptual, first-level assessment intended for prioritizing the potential solutions. A definitive and site-specific characterization requires detailed, comprehensive field investigation, sampling and testing program.

Watershed Contamination Source Ranking

Mitigation of contamination from Ballona Creek depends on the identification of the hotspots of contaminant emission into the Creek stream. This can be acheived by investigating the quality of runoff discharges into the Creek.

Ballona Creek Watershed consists 110 subbasins (LACDPW, 1994). A detailed land use characterization of these subbasins is included in Appendix A.3. The zoning of these subbasins is shown in the attached drainage map. These subasins collect rainfall and route it into Ballona Creek through 48 major confluences located along the stream. A runoff quality analysis was performed for the 48 discharges into Ballona Creek. In the analysis, three typical water quality parameters, *i.e.*, metals (lead/copper/zinc), oil/grease and total suspended solids, were taken as the indicators of the runoff quality. The concentrations of these parameters were tied to land uses based on Stenstrom & Strecker (1993). The mean concentrations of these parameters for individual subbasins were calculated by weighted-averaging based on land use compositions for the particular subbasins. Mass loadings from the subbasins were obtained after evaluating the runoff volumns. A ranking for the 48 discharge confluences was then developed based on the mass loadings. It is noted that since the wet-season rainfall (November-April) in the region accounts for about 93% of the total annual rainfall and since the stormwater runoff has been identified as the more significant factor in the contamination in Marina del Rey Harbor, the runoff quality analysis focuses primarily on wet-season conditions with a mean total rainfall of 10.7 inches based on 40 years of rainfall record at Los Angeles Airport. Spatial rainfall correction within the watershed was not considered but can readily be incorporated for a more detailed study.

Table A.3.7 presents the loads and rankings of metals (lead/copper/zinc), oil/grease and total suspended solids (TSS) from 10 most polluted runoff discharges along Ballona Creek. The loads are presented in metric tons per wet season (mt/ws). The composite ranking is the overall ranking of the three parameters analyzed. The complete results of the runoff quality analysis are shown in Table A.3.8. These results have been verified by comparing the watershed total mass loadings of the three analyzed quantities with those of Stenstrom & Strecker (1993) and SCCWRP (1973).

Table A.3.7 Ranking of Runoff Quality along Ballona Creek

Confluence (Approx. Location)	Metals Load (mt/ws)	Metals Rank	Oil/Grease Load (mt/ws)	Oil/Grease Rank	TSS Load (mt/ws)	TSS Rank	Composite Rank
BI84 (Exposition Bl)	5.7	2	78.2	2	1,567	2	1
SEPUL5 (Sepulveda Cyn Channel)	6.3	1	56.9	5	2,005	1	2
BI57-5 (San Vicente Bl)	4.7	3	101.4	1	1,003	5	3
DDI11-4 (La Cienega Bl)	4.6	4	70.1	3	1,230	3	4
BI57-10 (Venice Bl)	3.4	5	68.1	4	757	7	5
BNDCT6 (Benedict Cyn Channel)	3.2	6	41.5	7	1,063	4	6
BI1102-3 (San Vicente Bl)	4.6	4	52.5	6	550	9	7
CNTLA2 (Centinela Crk)	2.6	7	22.3	9	836	6	8
LA1177 (Rodeo Rd/ Higuera St)	2.1	8	22.5	8	625	8	9
BI54 (Fairfax Ave)	1.6	9	22.3	9	456	10	10
Total Load of All 48 Confluences	43.4		604.1		11,486		
% Total Load of the 10 Ranked Confluences	91%		91%		90%		

Figure A.3.3.1 shows the approximate discharge locations of the confluences listed above and their ranks. The 10 discharges account for about 91% of the total heavy metal and oil/grease loads and about 90% of the total suspended solids load in Ballona Creek. Their mitigation is therefore expected to have significant effects on the contamination level in Marine del Rey Harbor. The results can be used in prioritizing potential mitigation actions in planning remedial or control measures.

It is noted that the stretch of Ballona Creek between La Salle Avenue and La Cienega Boulevard maintained by the USACE contains two major confluences that are ranked the 1st and the 9th

Table A.3.8 Ballona Creek Runoff Quality Analysis

	ID	AREA	OPEN	LD S RES	S RES	HD S RE	MULT RE	COMMRC	INDUSTR	IMPERV	TOT RES	COMM/IN	ID-BCD	AREA	OPEN	RES	COMM/IN	%IMP	IMP ARE	LOAD-M	RANK-M	LOAD-OG	RANK-OG	LOAD-SS	RANK-SS	CMP RNK
		(SQ MI)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)		(SQ MI)	(%)	(%)	(%)	(%)	(SQ MI)	(MT/WS)		(MT/WS)		(MT/WS)		
1	BI57-1	1.86	0	46	5	3	26	17	3	44	54	46														
2	BI57-2	1.69	0	17	6	2	59	16	0	60	25	75														
3	BI57-3	0.46	2	0	5	5	59	15	14	71	10	88														
4	BI57-4	3.00	0	18	19	1	44	18	0	57	38	62														
5	BI57-5	3.75	0	0	8	1	48	43	0	76	9	91	1	10.76	0	27	72	62	6.72	4.7	3	101.4	1	1003.2	5	3
6	BI1102-1	2.05	0	0	40	21	25	12	2	55	61	39														
7	BI5213	1.28	0	0	24	25	42	9	0	57	49	51														
8	BI1102-2	0.23	0	0	0	0	91	9	0	70	0	100														
9	BI5212	1	0	0	0	0	76	24	0	74	0	100														
10	BI1102-3	1.33	0	0	10	3	68	19	0	69	13	87	2	5.89	0	35	65	62	3.68	4.6	4	52.5	6	549.9	9	7
11	BI57-3	0.34	0	0	5	5	59	15	14	71	10	88														
12	BI57-6	1.01	0	22	30	23	12	13	0	45	75	25														
13	BI57-7	2.4	0	44	28	0	16	10	2	38	72	28														
14	BI57-8	2.18	0	42	18	1	24	15	0	42	61	39														
15	BI57-9	1.99	0	29	35	13	9	14	0	42	77	23														
16	BI57-10	0.18	0	0	0	17	50	33	0	72	17	83	3	8.10	0	67	33	43	3.49	3.4	5	68.1	4	756.8	7	5
17	BI648A	0.51	0	0	14	0	72	14	0	68	14	86														
18	BLLNA1	0.19	0	0	0	32	63	5	0	61	32	68	4	0.70	0	19	81	66	0.46	0.3		4.6		65.2		
19	BLLNA2	0.13	0	0	8	21	50	21	0	66	29	71	5	0.13	0	29	71	66	0.09	0.1		0.9		12.1		
20	BI494	0.52	0	0	42	14	27	17	0	58	56	44	6	0.52	0	56	44	58	0.30	0.2		2.2		47.2		
21	BLLNA3	0.25	0	0	44	20	20	16	0	55	64	36	7	0.25	0	64	36	55	3.68	0.1		0.9		22.4		
22	PANPC1	3.57	0	52	10	4	17	14	3	38	66	34														
23	BI54	1.43	0	0	43	10	30	16	1	58	53	47	8	5.00	0	62	38	44	2.19	1.6	9	22.3	10	455.8	10	10
24	DDI11-1	4.49	0	25	49	2	11	13	0	43	76	24														
25	DDI11-2	1.42	0	0	27	7	31	35	0	68	34	66														
26	DDI11-3	2.29	0	18	27	8	35	12	0	51	53	47														
27	DDI11-4	5.16	0	0	40	5	34	19	2	61	45	55	9	13.36	0	56	44	54	7.21	4.6	4	70.1	3	1230.6	3	4
28	BLLNA4	0.18	0	0	22	0	56	11	11	67	22	78	10	0.18	0	22	78	67	0.12	0.1		1.4		16.8		
29	BI648C	0.18	0	0	6	0	78	16	0	70	6	94	11	0.18	0	6	94	70	0.13	0.1		1.8		16.8		
30	BLLNA5	0.28	0	0	4	0	71	25	0	73	4	96	12	0.28	0	4	96	73	0.20	0.1		2.8		26.0		
31	DDI3	2.12	0	0	17	10	57	9	7	65	27	73	13	2.12	0	27	73	65	1.38	0.8	10	15.3	11	197.9		
32	BLLNA6	0.16	0	0	0	44	12	0	44	67	44	56	14	0.16	0	44	56	67	0.11	0.1		0.9		14.8		
33	BI488-1	0.47	0	0	54	0	42	4	0	55	54	46														
34	BI488-2	0.24	0	0	43	0	37	20	0	62	43	57														
35	BI488-3	2.86	0	0	56	1	23	15	5	58	57	43														
36	BI71	1.13	0	0	5	2	84	3	6	68	7	93														
37	BI70	1.51	0	0	21	7	63	9	0	63	28	72														
38	BI485	1.37	0	0	19	11	63	7	0	62	30	70														
39	BI487	0.73	0	0	72	0	14	11	3	53	72	28														
40	BI5204-1	1.68	0	0	0	8	35	5	52	79	8	92														
41	BI5204-2	0.69	0	0	0	0	1	38	61	91	0	100														
42	BI5204-3	4.63	0	0	1	9	59	29	2	73	10	90														
43	BI5204-4	1.59	0	0	3	5	77	9	6	69	8	92														
44	BI84	0.27	0	0	52	0	26	7	15	60	52	48	15	17.17	0	25	75	68	11.62	5.7	2	78.2	2	1567.4	2	1
45	BLLNA7	0.03	0	0	0	33	0	0	67	75	33	67	16	0.03	0	33	67	75	0.02	0.0		0.2		2.8		
46	BI70	2.99	0	0	21	7	63	9	0	63	28	72														
47	LA1177	4.04	0	13	52	2	24	8	1	49	67	33	17	7.03	0	50	50	55	3.86	2.1	8	22.5	8	624.6	8	9
48	BLLNA8	0.45	0	76	0	24	0	0	0	18	100	0	18	0.45	0	100	0	18	0.08	0.1		0.4		36.1		
49	BLLNA9	0.12	0	0	0	25	0	0	75	79	25	75	19	0.12	0	25	75	79	0.09	0.0		0.9		11.2		
50	CULVR1	0.62	0	0	37	15	23	6	19	60	52	48	20	0.62	0	52	48	60	0.37	0.2		2.8		56.6		
51	BLLNA10	0.1	0	0	0	70	20	10	0	52	70	30	21	0.10	0	70	30	52	0.05	0.0		0.3		8.8		
52	BLLNA11	0.03	0	0	0	0	0	0	100	91	0	100	22	0.03	0	0	100	91	0.03	0.0		0.3		2.8		
53	BNDCT1	2.77	0	98	2	0	0	0	0	11	100	0														
54	BI411	0.64	0	81	19	0	0	0	0	16	100	0														
55	BNDCT2	0.39	3	28	69	0	0	0	0	32	97	0														
56	FRANK1	1.19	0	100	0	0	0	0	0	10	100	0														
57	COLDW1	1.09	0	72	28	0	0	0	0	19	100	0														
58	BI496	0.76	0	96	4	0	0	0	0	11	100	0														
59	COLDW2	0.65	0	6	94	0	0	0	0	40	100	0														
60	BNDCT3	0.24	4	0	96	0	0	0	0	40	96	0														
61	BNDCT4	0.55	45	51	4	0	0	0	0	7	55	0														
62	BNDCT5	1.08	24	0	26	0	31	19	0	49	26	50														
63	RXFRD1	1.2	0	0	54	0	17	25	4	61	54	46														
64	BNDCT6	1.04	8	0	47	4	24	15	2	53	51	41	23	11.60	5	82	13	27	3.15	3.2	6	41.5	7	1063.3	4	6
65	BI424-1	0.14	0	93	0	0	0	0	7	16	93	7	24	0.14	0	93	7	16	0.02	0.0		0.2		11.5		
66	BI424-2	0.14	0	57	0	0	7	0	36	43	57	43	25	0.14	0	57	43	43	0.06	0.0		0.6		12.7		
67	BLLNA12	0.12	0	0	0	58	8	0	34	61	58	42	26	0.12	0	58	42	61	0.07	0.0		0.5		10.9		
68	BI9404	0.1	0	0	80	0	20	0	0	47	80	20	27	0.10	0	80	20	47	0.05	0.0		0.2		8.6		

Table A.3.8 Continued

69	BI52	1.05	0	0	39	2	27	24	8	65	41	59	28	1.05	0	41	59	65	0.68	0.4		5.9		97.1		
70	BI424-3	0.42	0	29	38	0	29	0	4	42	67	33	29	0.42	0	67	33	42	0.18	0.1		1.3		37.3		
71	BI2950	0.04	0	0	75	0	25	0	0	49	75	25	30	0.04	0	75	25	49	0.02	0.0		0.1		3.5		
72	BLLNA13	0.08	0	0	88	0	0	12	0	48	88	12	31	0.08	0	88	12	48	0.04	0.0		0.1		6.7		
73	BI2901	0.4	0	0	65	18	7	10	0	49	83	17	32	0.40	0	83	17	49	0.20	0.1		0.8		34.1		
74	BI425	0.26	0	46	38	4	4	8	0	32	88	12	33	0.26	0	88	12	32	0.08	0.1		0.4		21.8		
75	CCAI4	1.13	0	0	49	3	35	13	0	58	52	48	34	1.13	0	52	48	58	0.66	0.4		5.1		103.2		
76	BLLNA14	0.03	0	0	100	0	0	0	0	42	100	0	35	0.03	0	100	0	42	0.01	0.0		0.0		2.4		
77	BLLNA15	0.21	0	0	67	0	28	5	0	52	67	33	36	0.21	0	67	33	52	0.11	0.1		0.7		18.7		
78	SEPUL1	3.5	23	68	1	0	8	0	0	13	69	8														
79	MORAG1	1.46	1	99	0	0	0	0	0	10	99	0														
80	SEPUL2	1.21	1	45	27	0	2	25	0	40	72	27														
81	BI5237	0.66	0	100	0	0	0	0	0	10	100	0														
82	BI5238	0.39	0	100	0	0	0	0	0	10	100	0														
83	STONE1	2.08	0	94	0	0	6	0	0	13	94	6														
84	STONE2	0.42	0	83	0	0	17	0	0	20	83	17														
85	STONE3	0.42	0	0	12	0	83	5	0	66	12	88														
86	BI498	0.52	0	23	19	0	48	10	0	52	42	58														
87	SEPUL3	1.13	0	0	38	2	38	20	2	63	40	60														
88	BI497-1	1.58	0	95	5	0	0	0	0	12	100	0														
89	BI497-2	3.76	13	2	56	2	13	14	0	46	60	27														
90	SEPUL4	0.57	0	0	51	0	26	11	12	60	51	49														
91	SAWTL1	4.42	1	5	33	5	23	23	10	62	43	56														
92	SEPUL5	0.94	0	0	75	1	20	4	0	49	76	24	37	23.06	6	67	27	36	8.27	6.3	1	56.9	5	2005.2	1	2
93	BI503	0.32	0	0	81	0	19	0	0	47	81	19	38	0.32	0	81	19	47	0.15	0.1		0.7		27.4		
94	BI51	0.82	0	0	57	0	37	6	0	55	57	43	39	0.82	0	57	43	55	0.45	0.3		3.3		74.3		
95	BLLNA16	0.05	0	0	100	0	0	0	0	42	100	0	40	0.05	0	100	0	42	0.02	0.0		0.0		4.0		
96	BI504	0.73	0	0	68	0	30	2	0	51	68	32	41	0.73	0	68	32	51	0.37	0.2		2.3		64.7		
97	BI273	3.4	0	7	41	15	17	12	8	54	63	37														
98	BI81	1.23	0	0	81	11	0	2	6	46	92	8														
99	MT318	2.19	0	21	45	0	22	9	3	47	66	34														
100	MT430	0.27	0	0	0	0	48	52	0	80	0	100														
101	CNTLA1	0.59	0	0	42	0	0	44	14	71	42	58														
102	BI677	0.84	0	50	36	0	0	13	1	33	86	14														
103	BI7	0.64	0	6	57	0	6	20	11	57	63	37														
104	CNTLA2	0.5	0	0	78	0	0	0	22	53	78	22	42	9.66	0	67	33	51	4.97	2.6	7	22.3	9	835.5	6	8
105	BI505	0.33	0	0	91	0	6	0	3	45	91	9	43	0.33	0	91	9	45	0.15	0.1		0.5		27.4		
106	BI547	0.49	20	0	0	0	27	4	49	67	0	80	44	0.49	20	0	80	67	0.33	0.1		3.3		49.4		
107	BLLNA17	0.03	100	0	0	0	0	0	0	0	0	0	45	0.03	100	0	0	0	0.00	0.0		0.0		1.0		
108	BLLNA18	0.14	100	0	0	0	0	0	0	0	0	0	46	0.14	100	0	0	0	0.00	0.0		0.0		4.9		
109	BLLNA19	2.52	29	0	34	0	6	2	29	47	34	37	47	2.52	29	34	37	47	1.18	0.4		6.3		230.5		
110	BLLNA20	0.04	0	0	0	0	100	0	0	68	0	100	48	0.04	0	0	100	68	0.03	0.0		0.4		3.7		
	BC TOT	127.09												127.09					67.12	43.4		604.1		11485.7		
																			%TOT LD		91		91		90	

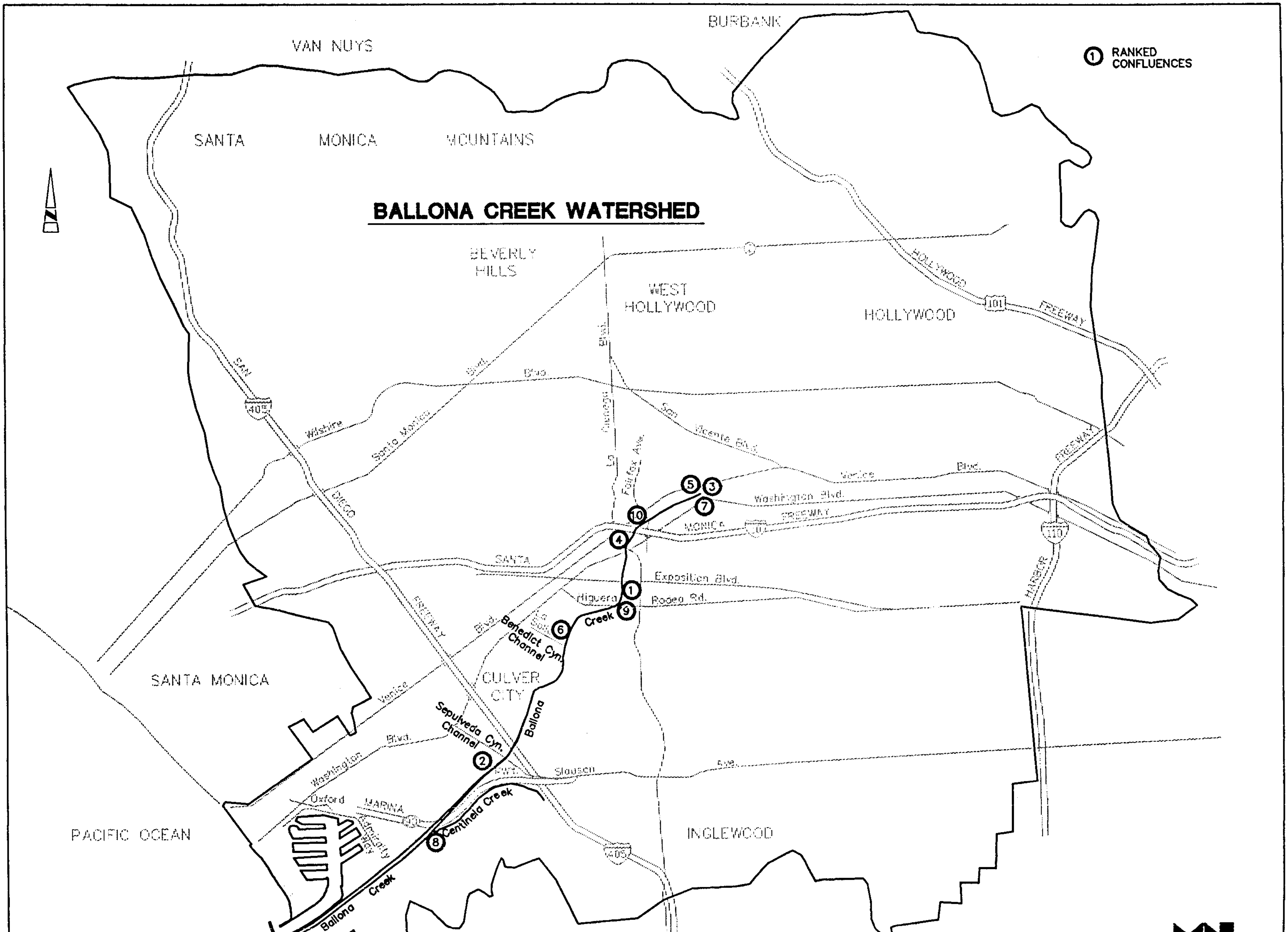

Figure A.3.3.1 Discharge Locations of Ranked Confluences in contaminant mass loads respectively.

Mass Emission from Ballona Creek

Mass emission for selected water quality parameters from Ballona Creek based on land use and runoff characteristics in Ballona Creek Watershed are presented in Table A.3.9 (Stenstrom & Strecker, 1993). These amounts of mass emission from Ballona Creek are generated primarily by wet-season stormwater runoff as analyzed in detail in the previous section. The results are in fair agreement with those presented in SCCWRP (1973).

Table A.3.9 Annual Contaminant Emission from Ballona Creek

Parameter	Load (mt/yr)
TSS	12,200
BOD	750
COD	6,100
Phosphorus	33
Nitrite/Nitrate	70
Copper	4
Lead	17
Zinc	22
Oil/Grease	662

It is noted from the delineation of Ballona Creek Watershed (Figure 2.1) that the stormwater runoff discharges into the sea through Ballona Creek and Marina del Rey Harbor proper. The location and configuration of the offshore breakwater is such that the discharged stormwater from both outlets be reflected and carried into the harbor on flood tides. This implies that Marina del Rey Harbor bears a substantial part of the total contaminant loading of Ballona Creek Watershed on Santa Monica Bay. This is consistent with the relatively robust correlations between water column contamination levels and rainfall events.

Sediment Contamination Sources

In general, in a substantially urbanized basin as Ballona Creek Watershed, wet season storms produce significant surface runoff. As the runoff moves, it entrains contaminants (dissolved/particulate) as well as natural sediments, carries them through confluences into the collecting stream such as Ballona Creek, and discharges/deposits them at the stream mouth. In the process, the contaminants in both the water column and the sediment bed partition between particulate and dissolved phases through adsorption-desorption processes. Natural sediments transported by the runoff flows from the relatively uncontaminated open lands (such as mountains) tend to become contaminated in this process as they are tranported downstream through the urbanized areas and mix with the more contaminated flows and sediment loads before being discharged and deposited at the stream mouth.

For lack of systematic monitoring programs for sediment quality in Ballona Creek, site-specific characterization of sedimentary chemical proceses in Ballona Creek is presently not possible. It has been, however, established based on evidence presented previously and by existing studies that Ballona Creek sediment yield is primarily produced by stormwater runoff during wet seasons. Thus sediment production and contaminant mass emission from Ballona Creek are driven primarily by the same mechanism of stormwater runoff. In this case, the interaction between the sediment loads and the flow is often sufficiently long and extensive to allow sorption and desorption of contaminants to take place. This suggests that the sediments are most likely to bear the signatures of the contaminants in the runoff or vice versa. This phenomenon has been relatively well documented and utilized in stream contaminant transport modeling (*e.g.* Di Toro, 1985; Thomann, 1985; Mills, 1982; Delos *et al.*, 1984).

Since both the volume and the quality of sediments produced by stormwater runoff are of concern for the purposes of this study, the ranking criteria for contaminated sediment production appear to be consistent with those for the runoff quality. Specifically, the ranking of TSS loads reflects the sediment availability and the runoff intensity whereas the rankings of metals and oil/grease loads are indicative of the levels of contamination to be expected as well as the runoff intensity. Therefore, it appears reasonable to consider the composite runoff quality (Table A.3.7) as a first-level indicator of sediment contamination sourcses in Ballona Creek Watershed.

A.3.3.2.2 Marine Activities

Marine activities in Marina del Rey Harbor include primarily recreational boating activities. Major sources for contaminant releases due to boating and related activities include oil spills, antifouling paints, sacrificial zinc anodes and boat wash/waste disposal. Typical contaminants from these sources are listed in Table A.3.10.

Table A.3.10 Typical Contaminants Related to Marine Activities in Marina del Rey

Origin	Primary Contaminant	Distribution Characteristics/Potential Loading from Boating Activities in Marina del Rey Harbor
Oil Spills	Lead, PAHs	Lead: 0.55 mt/yr (SCCWRP,1973; SMBRP, 1993) PAHs: elevated concentration in sediments near North Jetty tip and in a few discrete spots in Entrance Channel (USACE 1993 test data), possibly related to earlier spills Spill occurrence: 9 in harbor basin areas, 10 in Entrance Channel and 5 near entrance during 1973-1987 and in 1991 (U.S. Coast Guard, unpubl. data)
Antifouling Paints	TBT, Copper	TBT in harbor basin areas 65 times higher than the value in Entrance Channel areas (Table A.3.3). Similar is copper but may not be solely attributed to boating activities
Sacrificial Zinc Anodes	Zinc	30-38 mt/yr (SCCWRP, 1973; SMBRP, 1993)
Boat Wash/Waste Disposal	Bacteria	Insignificant compared with loading from stormwater runoff based on correlation between coliform counts and rainfall events (Figure A.3.7)

Compared with contaminant loading in Ballona Creek Watershed, lead releases due to marine activities are essentially negligible but zinc releases are comparable or higher. It is noted, however, the estimates of zinc releases due to boating were based on the assumption that the extent of zinc anode uses has remained essentially the same over the last 20 years since the 1973 study (SCCWRP, 1973).

It therefore appears that the predominantly boating related marine activities as a nonpoint source potentially contribute to the contamination of Marina del Rey by primarily TBT and zinc.

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APPENDIX A.1 Marina del Rey Sediment Test Data

	Detection Limits* Sediments	Units	Method
A. PHYSICAL or CONVENTIONAL			
Total Solids/Dry Weight	0.1	%	Plumb 1981
Total Volatile Solids	0.01	%	EPA 160.4
pH	0.01	pH units	EPA 9045
Ammonia	0.1	mg/kg	EPA 350.2
Total Organic Carbon (TOC)	0.01	%	Dichromate Reduction
Total Sulfides	0.1	mg/kg	Plumb 1981
Oil and Grease	25.0	mg/kg	EPA 413.2
B. METALS and NONMETALS			
Arsenic (As)	0.05	mg/kg	EPA 6010
Cadmium (Cd)	0.01	mg/kg	EPA 6010
Chromium (Cr)	0.1	mg/kg	EPA 6010
Copper (Cu)	0.01	mg/kg	EPA 6010
Lead (Pb)	0.05	mg/kg	EPA 6010
Mercury (Hg)	0.02	mg/kg	EPA 7471
Nickel (Ni)	0.05	mg/kg	EPA 6010
Selenium (Se)	0.1	mg/kg	EPA 6010
Silver (Ag)	0.05	mg/kg	EPA 6010
Zinc (Zn)	0.05	mg/kg	EPA 6010
C. PESTICIDES			
Total Chlorinated Pesticides	0.02	mg/kg	EPA 8080
Aldrin	0.02	mg/kg	EPA 8080
Chlordane and Derivatives	0.02	mg/kg	EPA 8080
Dieldrin	0.02	mg/kg	EPA 8080
DDT and Derivatives	0.02	mg/kg	EPA 8080
Endosulfan and Derivatives	0.02	mg/kg	EPA 8080
Endrin and Derivatives	0.02	mg/kg	EPA 8080
Heptachlor and Derivatives	0.02	mg/kg	EPA 8080
Hexachlorocyclohexane (HCH) and Derivatives	0.02	mg/kg	EPA 8080
Methoxychlor	0.02	mg/kg	EPA 8080
Toxaphene	0.03	mg/kg	EPA 8080
D. ORGANIC COMPOUNDS			
D.1. ORGANOTINS			
Monobutyltin	0.001	mg/kg	Rice et al. 1987 or Uhler and Durrel 1989
Dibutyltin	0.001	mg/kg	
Tributyltin	0.001	mg/kg	
Tetrabutyltin	0.001	mg/kg	
D.2. PETROLEUM HYDROCARBONS			
Total Recoverable Petroleum Hydrocarbons (TRPH)	25.0	mg/kg	EPA 418.1

* Based on dry weight, unless specified otherwise.

		Detection Limits* Sediments	Units	Method
D.3.	**PHENOLS**			
	Total Phenol	0.03	mg/kg	EPA 8270
	Phenol	0.03	mg/kg	EPA 8270
	2,4-Dimethylphenol	0.03	mg/kg	EPA 8270
	2,4,6-Trichlorophenol	0.03	mg/kg	EPA 8270
	Para-chloro-meta-cresol	0.03	mg/kg	EPA 8270
	2-Chlorophenol	0.03	mg/kg	EPA 8270
	2,4-Dichlorophenol	0.03	mg/kg	EPA 8270
	2-Nitrophenol	0.05	mg/kg	EPA 8270
	4-Nitrophenol	0.05	mg/kg	EPA 8270
	2,4-Dinitrophenol	0.05	mg/kg	EPA 8270
	4,6-Dinitro-o-cresol	0.03	mg/kg	EPA 8270
	Pentachlorophenol	0.1	mg/kg	EPA 8270
D.4.	**PHTHALATES**			
	Total phthalates	0.01	mg/kg	EPA 8270
	Bis (2-ethylhexyl) phthalate	0.01	mg/kg	EPA 8270
	Butyl Benzyl phthalate	0.01	mg/kg	EPA 8270
	Di-n-butyl phthalate	0.01	mg/kg	EPA 8270
	Diethyl phthalate	0.01	mg/kg	EPA 8270
	Dimethyl phthalate	0.01	mg/kg	EPA 8270
	Di-n-octyl phthalate	0.01	mg/kg	EPA 8270
D.5.	**POLYCHLORINATED BIPHENYLS (PCB)**			
	Total PCB Congeners	0.02	mg/kg	EPA 8080
	Individual Congeners (Tetra-, Penta-, Hexa-Isomers)	0.02	mg/kg	EPA 8080
D.6.	**POLYNUCLEAR AROMATICS HYDROCARBONS (PAH)**			
	Total PAHs	0.02	mg/kg	EPA 8270
	Acenaphthene	0.02	mg/kg	EPA 8270
	Naphthalene	0.02	mg/kg	EPA 8270
	Acenaphthylene	0.02	mg/kg	EPA 8270
	Anthracene	0.02	mg/kg	EPA 8270
	Phenanthrene	0.02	mg/kg	EPA 8270
	Fluorene	0.02	mg/kg	EPA 8270
	Fluoranthene	0.02	mg/kg	EPA 8270
	Benzo (a) anthracene	0.02	mg/kg	EPA 8270
	Benzo (a) pyrene	0.02	mg/kg	EPA 8270
	Benzo (b) fluoranthene	0.02	mg/kg	EPA 8270
	Benzo (k) fluoranthene	0.02	mg/kg	EPA 8270
	Chrysene	0.02	mg/kg	EPA 8270
	Benzo (g,h,i) perylene	0.02	mg/kg	EPA 8270
	Dibenzo (a,h) anthracene	0.02	mg/kg	EPA 8270
	Indeno (1,2,3-cd) pyrene	0.02	mg/kg	EPA 8270
	Pyrene	0.02	mg/kg	EPA 8270

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* Based on dry weight, unless specified otherwise.

Note:

1. All testing was sediment testing.

15 July 1994

1993 Marina Del Rey Explorations
A. Physical and Conventional Tests

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		m.c. %	% solids %	TVS %	pH	Ammonia mg/kg	TOC %	TS mg/kg	O&G mg/kg
TH93 - 1 -6.5	C-24	-6.5	-8.5	23.9	80.7	2.30	7.16	35	1.20	95	1436
	C-25	-11.0	-13.0	34.6	74.3	12.71	6.76	128	5.32	86	9274
	C-26	-15.5	-17.5	22.9	81.4	2.50	6.88	87	1.26	2.8	2155
	C-27	-20.0	-22.0	25.0	80.0	3.12	7.15	79	2.61	355	2341
TH93 - 2 -10.8	C-21	-10.8	-12.8	26.0	79.4	6.63	6.58	73	4.01	95	4430
	C-22	-15.3	-17.3	31.0	76.3	7.37	6.43	52	2.52	4.9	3752
	C-23	-21.3	-23.3	18.1	84.7	1.59	7.62	58	1.03	1416	456
TH93 - 3 -5.4	C-64	-5.4	-7.4	18.7	84.2	0.71	6.82	31	0.265	3.1	256
	C-65	-9.9	-11.9	20.4	83.1	4.94	6.66	14	0.911	47	2045
	C-66	-14.4	-16.4	19.4	83.8	1.77	6.90	30	0.698	18	1097
	C-67	-18.9	-20.9	22.9	81.4	3.44	6.65	76	2.14	168	2381
TH93 - 4 -17.6	C-14	-17.6	-19.6	28.9	77.6	4.10	6.40	11	2.55	678	3171
TH93 - 5 -13.7	C-18	-13.7	-15.7	54.4	64.8	19.94	6.95	39	8.02	648	8139
	C-19	-15.7	-17.7	45.6	68.7	13.27	7.23	72	5.78	939	5946
	C-20	-20.2	-22.2	35.1	74.0	13.16	6.97	74	7.40	2.7	7937
TH93 - 6 -15.9	C-68	-15.9	-17.9	30.3	76.7	4.15	6.81	30	1.84	499	1826
	C-1	-19.0	-21.0	22.9	81.4	1.13	6.75	35	1.48	23	358
	C-2	-21.0	-23.0	27.6	78.4	3.48	6.32	55	3.72	56	1857
TH93 - 7 -16.0	C-3	-18.5	-20.5	25.9	79.4	3.45	6.61	11	2.27	197	1247

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m.c. moisture content
% solids total percent solids
TVS total volatile solids
TOC total organic carbon
TS total sulfides
O&G Oil and Grease
ND none detected

Marina Del Rey Explorations - Physical and Conventional Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		m.c. %	% solids %	TVS %	pH	Ammonia mg/kg	TOC %	TS mg/kg	O&G mg/kg
TH93 - 8	C-11	-5.8	-7.8	21.1	82.6	0.92	6.57	7.3	0.13	ND	111
-3.3	C-12	-10.8	-13.3	34.0	74.6	8.42	6.75	144	4.18	127	1614
	C-13	-15.8	-17.8	21.3	82.4	0.70	6.31	62.7	0.78	54	188
TH93 - 9	C-4	-10.4	-12.4	20.2	83.2	0.55	6.46	7.7	0.21	11	254
-10.4	C-5	-15.4	-17.4	21.8	82.1	0.84	6.28	8.7	0.33	31	278
	C-6	-17.9	-19.9	20.8	82.8	0.81	6.56	7.2	0.59	2.3	172
TH93 - 10	C-7	-4.7	-6.7	16.6	85.8	0.47	6.76	8.1	0.04	ND	120
-4.7	C-8	-7.2	-9.2	16.3	86.0	0.51	7.10	7.0	0.064	ND	118
	C-9	-12.2	-14.2	16.3	86.0	0.36	6.26	7.1	0.08	21	61
	C-10	-17.2	-19.2	17.6	85.0	1.39	6.44	10	0.22	19	258
TH93 - 11	C-15	-16.6	-18.6	42.8	70.0	4.63	7.47	23	4.58	900	3076
-16.6	C-16	-21.6	-23.6	33.9	74.7	5.44	7.76	89	3.48	567	3845
TH93 - 12	C-59	-7.9	-9.9	25.9	79.4	4.62	6.88	47	1.72	212	504
-7.9	C-60	-12.4	-14.4	19.6	83.6	1.26	6.54	28	0.456	114	202
	C-61	-16.9	-18.9	19.3	83.8	0.48	6.69	28	0.338	69	31
	C-62	-21.4	-23.4	23.0	81.3	3.15	6.94	31	1.38	118	1557
TH93 - 13	C-56	-17.1	-19.1	44.8	69.1	8.32	6.74	49	5.38	620	5587
-17.1	C-57	-21.6	-23.6	22.9	81.4	1.18	6.68	9.7	0.506	0.9	253
TH93 - 14	C-28	-13.6	-15.6	31.2	76.2	2.83	6.93	26	2.96	41	638
-13.6	C-29	-18.1	-20.1	21.5	82.3	1.20	6.86	10	0.20	8.2	389
	C-30	-22.6	-24.6	19.3	83.8	0.81	6.76	16	0.28	ND	45
TH93 - 15	C-53	-17.6	-19.6	52.9	65.4	8.00	6.98	34	4.89	1,160	4382
-17.6	C-54	-22.1	-24.1	15.3	86.7	0.82	6.78	11	0.18	0.2	28

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m.c. moisture content
% solids total percent solids
TVS total volatile solids
TOC total organic carbon
TS total sulfides
O&G Oil and Grease
ND none detected

Marina Del Rey Explorations - Physical and Conventional Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		m.c. %	% solids %	TVS %	pH	Ammonia mg/kg	TOC %	TS mg/kg	O&G mg/kg
TH93 - 16	C-69	-16.8	-18.8	31.5	76.0	4.38	6.99	27	2.71	321	2318
-16.8	C-70	-21.4	-23.4	19.7	83.5	1.25	6.82	26	0.54	13	237
TH93 - 17	C-50	-18.1	-20.1	43.7	69.6	7.90	6.68	90	4.34	343	4248
-18.1	C-51	-22.6	-24.6	21.8	82.1	0.99	6.76	11	0.263	ND	199
TH93 - 18	C-32	-18.3	-20.3	20.1	83.3	1.22	7.28	3.8	0.29	4.5	270
-18.3	C-33	-22.8	-24.8	18.7	84.2	0.71	7.18	7.1	0.20	0.6	ND
TH93 - 19 -20.2	C-47	-20.2	-22.2	37.8	72.6	6.75	6.42	50	3.47	208	3989
TH93 - 20	C-75	-15.6	-17.6	23.1	81.2	3.91	7.32	20	1.51	124	1351
-15.6	C-72	-20.1	-22.1	19.2	83.9	1.10	6.78	20	1.07	5.2	194
TH93 - 21	C-76	-19.7	-21.7	19.3	83.8	0.63	6.88	10	0.306	0.3	63
-15.2	C-77	-28.7	-30.7	19.0	84.0	0.96	6.79	10	0.425	ND	ND
TH93 - 22 -20.8	C-45	-20.8	-22.8	40.5	71.2	6.10	7.16	44	3.55	36	3000
TH93 - 23	C-35	-19.9	-21.9	28.7	77.7	2.21	7.13	19	1.59	24	187
-19.9	C-36	-24.4	-26.4	16.5	85.8	1.05	7.16	9.6	0.27	0.3	26
TH93 - 24 -21.9	C-43	-21.9	-23.9	40.8	71.0	5.36	7.21	29	0.26	21	272
TH93 - 25 -21.4	C-41	-21.4	-23.4	39.2	71.8	5.74	7.18	23	2.44	7.5	2154
TH93 - 26	C-79	-14.0	-16.0	35.9	73.6	4.66	6.83	25	2.30	319	1540
-14.0	C-80	-18.5	-20.5	38.2	72.4	5.60	6.84	33	2.35	226	1540
	C-81	-23.0	-25.0	34.4	74.4	5.18	6.99	42	1.56	13	122

m.c. moisture content
% solids total percent solids
TVS total volatile solids
TOC total organic carbon
TS total sulfides
O&G Oil and Grease
ND none detected

Marina Del Rey Explorations - Physical and Conventional Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		m.c. %	% solids %	TVS %	pH	Ammonia mg/kg	TOC %	TS mg/kg	O&G mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2	42.2	70.3	5.95	7.23	31	2.98	ND	1397
TH93 - 29 -18.5	C-83	-18.5	-20.5	40.2	71.3	4.73	7.31	25	2.67	182	1139
	C-84	-23.0	-25.0	34.4	74.4	3.41	7.35	50	1.52	24	202

m.c. moisture content
% solids total percent solids
TVS total volatile solids
TOC total organic carbon
TS total sulfides
O&G Oil and Grease
ND none detected

1993 Marina Del Rey Explorations
B. Metals

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Pb mg/kg	Hg mg/kg	Ni mg/kg	Se mg/kg	Ag mg/kg	Zn mg/kg
TH93 - 1	C-24	-6.5	-8.5	3.0	ND	14	18	68	0.40	10	ND	ND	92
-6.5	C-25	-11.0	-13.0	7.9	1.1	53	53	280	0.16	18	ND	0.65	380
	C-26	-15.5	-17.5	5.4	0.53	21	20	230	0.09	12	ND	ND	130
	C-27	-20.0	-22.0	4.9	0.69	25	21	270	0.08	12	ND	0.60	140
TH93 - 2	C-21	-10.8	-12.8	4.3	0.81	27	37	150	0.16	16	ND	0.47	220
-10.8	C-22	-15.3	-17.3	3.5	0.69	23	30	110	0.13	13	ND	0.47	170
	C-23	-21.3	-23.3	3.3	ND	11	7.6	52	0.04	6.6	ND	0.53	39
TH93 - 3	C-64	-5.4	-7.4	3.1	ND	10	10	66	0.02	6.8	ND	ND	57
-5.4	C-65	-9.9	-11.9	3.4	0.56	15	21	90	0.07	11	ND	ND	150
	C-66	-14.4	-16.4	5.8	1.2	16	17	100	0.04	10	ND	ND	110
	C-67	-18.9	-20.9	5.6	0.97	28	27	400	0.12	16	ND	0.95	190
TH93 - 4 -17.6	C-14	-17.6	-19.6	6.8	0.99	30	40	270	0.15	16	ND	0.37	200
TH93 - 5	C-18	-13.7	-15.7	5.8	0.90	31	52	120	0.04	21	ND	1.0	230
-13.7	C-19	-15.7	-17.7	5.3	0.93	31	43	140	0.08	17	ND	0.88	220
	C-20	-20.2	-22.2	5.0	1.2	36	53	350	0.14	20	ND	0.82	320
TH93 - 6	C-68	-15.9	-17.9	6.0	0.58	24	27	110	0.09	15	ND	0.48	150
-15.9	C-1	-19.0	-21.0	3.5	0.32	11	7.5	24	0.05	8.7	ND	0.25	46
	C-2	-21.0	-23.0	5.3	0.53	19	24	53	0.18	13	ND	0.31	120
TH93 - 7 -16.0	C-3	-18.5	-20.5	3.5	0.39	18	21	67	0.08	12	ND	0.20	100

As Arsenic; Cd Cadmium; Cr Chromium; Cu Copper; Pb Lead; Hg Mercury; Ni Nickel; Se Selenium; Ag Silver; Zn Zinc; ND none detected

Marina Del Rey Explorations - Metals Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Pb mg/kg	Hg mg/kg	Ni mg/kg	Se mg/kg	Ag mg/kg	Zn mg/kg
TH93 - 8	C-11	-5.8	-7.8	2.7	ND	7.6	3.1	8.3	0.02	6.4	ND	ND	24
-3.3	C-12	-10.8	-13.3	6.8	0.31	20	17	29	0.10	16	ND	ND	85
	C-13	-15.8	-17.8	2.2	ND	5.9	7.3	7.6	0.03	4.6	ND	ND	18
TH93 - 9	C-4	-10.4	-12.4	1.5	ND	6.6	3.1	6.1	0.05	5.3	ND	ND	18
-10.4	C-5	-15.4	-17.4	2.5	ND	14	5.5	35	0.02	6.4	ND	ND	17
	C-6	-17.9	-19.9	2.2	ND	8.2	4.0	7.8	0.04	5.7	ND	ND	24
TH93 - 10	C-7	-4.7	-6.7	1.7	ND	5.2	1.8	4.6	0.02	3.9	ND	ND	14
-4.7	C-8	-7.2	-9.2	2.3	ND	6.6	2.7	9.0	0.03	5.0	ND	ND	18
	C-9	-12.2	-14.2	1.4	ND	3.6	1.2	4.3	ND	2.3	ND	ND	10
	C-10	-17.2	-19.2	3.0	ND	11	4.8	27	0.04	6.7	ND	ND	32
TH93 - 11	C-15	-16.6	-18.6	3.6	0.86	25	35	96	0.13	16	ND	0.30	180
-16.6	C-16	-21.6	-23.6	7.8	1.4	46	49	300	0.18	20	ND	ND	240
TH93 - 12	C-59	-7.9	-9.9	5.2	ND	16	13	35	0.06	11	ND	ND	72
-7.9	C-60	-12.4	-14.4	2.6	ND	8.7	6.7	12	0.04	5.7	ND	ND	35
	C-61	-16.9	-18.9	ND	ND	5.9	2.8	7.3	0.02	4.1	ND	ND	19
	C-62	-21.4	-23.4	9.8	0.89	36	33	260	0.17	17	ND	1.9	160
TH93 - 13	C-56	-17.1	-19.1	8.6	1.6	41	67	150	0.26	25	ND	2.1	310
-17.1	C-57	-21.6	-23.6	4.5	0.49	21	12	55	0.15	10	ND	0.53	64
TH93 - 14	C-28	-13.6	-15.6	7.1	0.85	29	32	130	0.13	15	ND	0.52	140
-13.6	C-29	-18.1	-20.1	5.3	ND	14	9.1	39	0.03	9.3	ND	ND	43
	C-30	-22.6	-24.6	3.9	ND	10	3.3	ND	0.22	8.2	ND	ND	21
TH93 - 15	C-53	-17.6	-19.6	12.7	1.7	50	77	190	0.34	26	ND	1.7	340
-17.6	C-54	-22.1	-24.1	3.4	ND	8.9	3.5	ND	0.03	6.6	ND	ND	18

As Arsenic, Cd Cadmium, Cr Chromium, Cu Copper, Pb Lead, Hg Mercury, Ni Nickel, Se Selenium, Ag Silver, Zn Zinc, ND none detected

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Pb mg/kg	Hg mg/kg	Ni mg/kg	Se mg/kg	Ag mg/kg	Zn mg/kg
TH93 - 16	C-69	-16.8	-18.8	7.6	0.91	28	47	83	0.36	17	ND	0.85	180
-16.8	C-70	-21.4	-23.4	2.8	ND	10	7.8	27	0.07	6.5	ND	0.55	35
TH93 - 17	C-50	-18.1	-20.1	12.5	1.7	55	77	200	0.33	27	ND	1.6	320
-18.1	C-51	-22.6	-24.6	3.0	ND	8.7	4.1	11	0.05	5.5	ND	ND	24
TH93 - 18	C-32	-18.3	-20.3	3.6	ND	13	9.3	21	0.06	8.2	ND	ND	40
-18.3	C-33	-22.8	-24.8	3.0	ND	8.0	4.1	6.0	0.02	6.1	ND	ND	19
TH93 - 19 -20.2	C-47	-20.2	-22.2	13.3	1.7	51	73	180	0.38	25	ND	1.8	300
TH93 - 20	C-75	-15.6	-17.6	10.1	0.67	30	52	79	0.15	13	ND	1.1	160
-15.6	C-72	-20.1	-22.1	3.6	ND	6.9	6.4	10	0.03	6.0	ND	ND	23
TH93 - 21	C-76	-19.7	-21.7	3.3	ND	6.8	3.6	ND	ND	3.3	ND	ND	15
-15.2	C-77	-28.7	-30.7	4.5	ND	12	5.4	ND	0.05	6.7	ND	ND	24
TH93 - 22 -20.8	C-45	-20.8	-22.8	14.3	1.6	57	72	210	0.37	26	ND	1.6	270
TH93 - 23	C-35	-19.9	-21.9	7.4	0.48	23	21	49	0.13	14	ND	ND	71
-19.9	C-36	-24.4	-26.4	4.2	ND	8.7	4.5	14	0.02	7.4	ND	ND	18
TH93 - 24 -21.9	C-43	-21.9	-23.9	12.3	ND	46	41	18	0.17	31	ND	ND	110
TH93 - 25 -21.4	C-41	-21.4	-23.4	13.5	1.1	54	75	120	0.30	28	ND	0.52	230
TH93 - 26	C-79	-14.0	-16.0	9.8	9.96	39	91	100	0.32	17	ND	1.3	220
-14.0	C-80	-18.5	-20.5	14.9	1.4	63	95	200	0.42	26	ND	1.7	240
	C-81	-23.0	-25.0	13.1	0.57	37	31	4.8	0.12	23	ND	ND	85

As Arsenic
Cd Cadmium
Cr Chromium
Cu Copper
Pb Lead
Hg Mercury
Ni Nickel
Se Selenium
Ag Silver
Zn Zinc
ND none detected

Marina Del Rey Explorations - Metals Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Pb mg/kg	Hg mg/kg	Ni mg/kg	Se mg/kg	Ag mg/kg	Zn mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2	16.6	1.1	62	77	130	0.31	34	ND	0.55	210
TH93 - 29 -18.5	C-83	-18.5	-20.5	12.9	0.96	43	65	110	0.37	17	ND	1.6	170
	C-84	-23.0	-25.0	8.0	ND	25	22	14	0.12	14	ND	ND	140

As Arsenic, Cd Cadmium, Cr Chromium, Cu Copper, Pb Lead, Hg Mercury, Ni Nickel, Se Selenium, Ag Silver, Zn Zinc, ND none detected

1993 Marina Del Rey Explorations
C. Pesticides

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.	
TH93 - 1	C-24	-6.5	-8.5
-6.5	C-25	-11.0	-13.0
	C-26	-15.5	-17.5
	C-27	-20.0	-22.0
TH93 - 2	C-21	-10.8	-12.8
-10.8	C-22	-15.3	-17.3
	C-23	-21.3	-23.3
TH93 - 3	C-64	-5.4	-7.4
-5.4	C-65	-9.9	-11.9
	C-66	-14.4	-16.4
	C-67	-18.9	-20.9
TH93 - 4	C-14	-17.6	-19.6
-17.6			
TH93 - 5	C-18	-13.7	-15.7
-13.7	C-19	-15.7	-17.7
	C-20	-20.2	-22.2
TH93 - 6	C-68	-15.9	-17.9
-15.9	C-1	-19.0	-21.0
	C-2	-21.0	-23.0
TH93 - 7	C-3	-18.5	-20.5
-16.0			

None of the pesticides tested for were detected. Pesticides tested for, detection limits, and testing methods are listed below.

Total Chlorinated Pesticides	0.02 mg/kg	EPA 8080
Aldrin	0.02 mg/kg	EPA 8080
Chlordane and derivatives	0.02 mg/kg	EPA 8080
Dieldrin	0.02 mg/kg	EPA 8080
DDT and derivatives	0.02 mg/kg	EPA 8080
Endosulfan and derivatives	0.02 mg/kg	EPA 8080
Endrin and derivatives	0.02 mg/kg	EPA 8080
Heptachlor and derivatives	0.02 mg/kg	EPA 8080
Hexachlorocyclohexane (HCH) and derivatives	0.02 mg/kg	EPA 8080
Methoxychlor	0.02 mg/kg	EPA 8080
Toxaphene	0.02 mg/kg	EPA 8080

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15 July 1994

1993 Marina Del Rey Explorations
D.1 Organotins and D.2 Total Recoverable Petroleum Hydrocarbons (TRPH)

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Organotins Monobutyltin mg/kg	Dibutyltin mg/kg	Tributyltin mg/kg	Tetrabutyltin mg/kg	TRPH mg/kg
TH93 - 1 -6.5	C-24	-6.5	-8.5	0.002	0.002	0.008	ND	1436
	C-25	-11.0	-13.0	0.002	0.002	0.010	ND	9010
	C-26	-15.5	-17.5	ND	ND	0.006	ND	1984
	C-27	-20.0	-22.0	ND	0.003	0.009	ND	2288
TH93 - 2 -10.8	C-21	-10.8	-12.8	0.004	0.004	0.026	ND	4346
	C-22	-15.3	-17.3	0.007	0.005	0.019	ND	3671
	C-23	-21.3	-23.3	ND	ND	0.012	ND	449
TH93 - 3 -5.4	C-64	-5.4	-7.4	ND	0.002	0.006	ND	238
	C-65	-9.9	-11.9	0.007	0.112	0.537	ND	1998
	C-66	-14.4	-16.4	ND	ND	0.017	ND	915
	C-67	-18.9	-20.9	0.003	0.005	0.017	ND	2037
TH93 - 4 -17.6	C-14	-17.6	-19.6	0.002	0.003	0.017	ND	2444
TH93 - 5 -13.7	C-18	-13.7	-15.7	ND	ND	0.005	ND	8139
	C-19	-15.7	-17.7	ND	ND	0.006	ND	5586
	C-20	-20.2	-22.2	0.006	0.005	0.029	ND	7325
TH93 - 6 -15.9	C-68	-15.9	-17.9	ND	0.004	0.008	ND	1233
	C-1	-19.0	-21.0	0.003	0.004	0.010	ND	324
	C-2	-21.0	-23.0	0.004	0.004	0.016	ND	1682
TH93 - 7 -16.0	C-3	-18.5	-20.5	0.001	0.001	0.004	ND	1000

ND none detected

Marina Del Rey Explorations - Organotins and Total Recoverable Petroleum Hydrocarbons (TRPH) 15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Organotins Monobutyltin mg/kg	Dibutyltin mg/kg	Tributyltin mg/kg	Tetrabutyltin mg/kg	TRPH mg/kg
TH93 - 8 -3.3	C-11	-5.8	-7.8	ND	ND	ND	ND	82
	C-12	-10.8	-13.3	0.007	0.005	0.011	ND	1231
	C-13	-15.8	-17.8	0.005	0.004	0.007	ND	131
TH93 - 9 -10.4	C-4	-10.4	-12.4	ND	ND	ND	ND	253
	C-5	-15.4	-17.4	0.005	0.002	0.004	ND	244
	C-6	-17.9	-19.9	0.004	0.004	0.009	ND	169
TH93 - 10 -4.7	C-7	-4.7	-6.7	ND	ND	ND	ND	111
	C-8	-7.2	-9.2	ND	ND	ND	ND	112
	C-9	-12.2	-14.2	0.010	0.002	ND	ND	70
	C-10	-17.2	-19.2	ND	ND	ND	ND	156
TH93 - 11 -16.6	C-15	-16.6	-18.6	ND	0.001	0.008	ND	2357
	C-16	-21.6	-23.6	ND	0.002	0.010	ND	2864
TH93 - 12 -7.9	C-59	-7.9	-9.9	ND	0.002	0.005	ND	404
	C-60	-12.4	-14.4	0.002	0.003	0.004	ND	180
	C-61	-16.9	-18.9	ND	0.003	0.007	ND	47
	C-62	-21.4	-23.4	ND	0.001	0.006	ND	1292
TH93 - 13 -17.1	C-56	-17.1	-19.1	0.002	0.004	0.019	ND	4194
	C-57	-21.6	-23.6	ND	ND	ND	ND	193
TH93 - 14 -13.6	C-28	-13.6	-15.6	ND	0.006	0.021	ND	565
	C-29	-18.1	-20.1	ND	ND	ND	ND	366
	C-30	-22.6	-24.6	ND	ND	ND	ND	59
TH93 - 15 -17.6	C-53	-17.6	-19.6	ND	0.023	0.026	ND	3576
	C-54	-22.1	-24.1	ND	ND	ND	ND	22

ND none detected

Marina Del Rey Explorations - Organotins and Total Recoverable Petroleum Hydrocarbons (TRPH) 15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Organotins Monobutyltin mg/kg	Dibutyltin mg/kg	Tributyltin mg/kg	Tetrabutyltin mg/kg	TRPH mg/kg
TH93 - 16	C-69	-16.8	-18.8	0.003	0.005	0.011	ND	2024
-16.8	C-70	-21.4	-23.4	0.003	0.004	0.004	ND	204
TH93 - 17	C-50	-18.1	-20.1	0.008	0.028	0.064	ND	4288
-18.1	C-51	-22.6	-24.6	ND	ND	ND	ND	186
TH93 - 18	C-32	-18.3	-20.3	ND	0.003	ND	ND	241
-18.3	C-33	-22.8	-24.8	ND	ND	ND	ND	ND
TH93 - 19 -20.2	C-47	-20.2	-22.2	0.005	0.012	0.012	ND	3914
TH93 - 20	C-75	-15.6	-17.6	0.004	0.014	0.015	ND	1168
-15.6	C-72	-20.1	-22.1	ND	0.007	0.006	ND	128
TH93 - 21	C-76	-19.7	-21.7	ND	ND	ND	ND	50
-15.2	C-77	-28.7	-30.7	ND	ND	ND	ND	ND
TH93 - 22 -20.8	C-45	-20.8	-22.8	ND	0.015	0.028	ND	2809
TH93 - 23	C-35	-19.9	-21.9	0.003	0.010	0.009	ND	208
-19.9	C-36	-24.4	-26.4	ND	ND	ND	ND	48
TH93 - 24 -21.9	C-43	-21.9	-23.9	ND	ND	ND	ND	285
TH93 - 25 -21.4	C-41	-21.4	-23.4	ND	0.005	0.005	ND	1871
TH93 - 26	C-79	-14.0	-16.0	0.004	0.012	0.010	ND	1408
-14.0	C-80	-18.5	-20.5	0.004	0.011	0.007	ND	1310
	C-81	-23.0	-25.0	ND	ND	ND	ND	92

ND none detected

Marina Del Rey Explorations - Organotins and Total Recoverable Petroleum Hydrocarbons (TRPH) 15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Organotins Monobutyltin mg/kg	Dibutyltin mg/kg	Tributyltin mg/kg	Tetrabutyltin mg/kg	TRPH mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2	ND	ND	ND	ND	1200
TH93 - 29 -18.5	C-83	-18.5	-20.5	0.005	0.014	0.016	ND	987
	C-84	-23.0	-25.0	ND	ND	ND	ND	183

ND none detected

15 July 1994

1993 Marina Del Rey Explorations
D.3 Phenols

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.	
TH93 - 1 -6.5	C-24	-6.5	-8.5
	C-25	-11.0	-13.0
	C-26	-15.5	-17.5
	C-27	-20.0	-22.0
TH93 - 2 -10.8	C-21	-10.8	-12.8
	C-22	-15.3	-17.3
	C-23	-21.3	-23.3
TH93 - 3 -5.4	C-64	-5.4	-7.4
	C-65	-9.9	-11.9
	C-66	-14.4	-16.4
	C-67	-18.9	-20.9
TH93 - 4 -17.6	C-14	-17.6	-19.6
TH93 - 5 -13.7	C-18	-13.7	-15.7
	C-19	-15.7	-17.7
	C-20	-20.2	-22.2
TH93 - 6 -15.9	C-68	-15.9	-17.9
	C-1	-19.0	-21.0
	C-2	-21.0	-23.0
TH93 - 7 -16.0	C-3	-18.5	-20.5

The following Phenols with corresponding detection limits were tested using EPA method 8270:

Phenol	0.03 mg/kg
2,4-Dimethylphenol	0.03 mg/kg
2,4,6-Trichlorophenol	0.03 mg/kg
Para-chloro-meta-cresol	0.03 mg/kg
2-Chlorophenol	0.03 mg/kg
2,4-Dichlorophenol	0.03 mg/kg
2-Nitrophenol	0.05 mg/kg
4-Nitrophenol	0.05 mg/kg
2,4-Dinitrophenol	0.05 mg/kg
4,6-Dinitro-o-cresol	0.03 mg/kg
Pentachlorophenol	0.1 mg/kg

ND none detected

15 July 1994

1993 Marina Del Rey Explorations
D.4 Phthalates

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Bis (2-ethylhexyl) phthalate mg/kg	Di-n-butyl phthalate mg/kg	Total phthalates mg/kg
TH93 - 1 -6.5	C-24	-6.5	-8.5	1.635	ND	1.635
	C-25	-11.0	-13.0	8.85	ND	8.85
	C-26	-15.5	-17.5	2.35	ND	2.35
	C-27	-20.0	-22.0	1.80	ND	1.80
TH93 - 2 -10.8	C-21	-10.8	-12.8	7.23	ND	7.23
	C-22	-15.3	-17.3	4.04	ND	4.04
	C-23	-21.3	-23.3	ND	ND	ND
TH93 - 3 -5.4	C-64	-5.4	-7.4	0.553	ND	0.553
	C-65	-9.9	-11.9	0.842	ND	0.842
	C-66	-14.4	-16.4	0.816	ND	0.816
	C-67	-18.9	-20.9	2.52	ND	2.52
TH93 - 4 -17.6	C-14	-17.6	-19.6	5.93	ND	ND
TH93 - 5 -13.7	C-18	-13.7	-15.7	5.14	ND	5.14
	C-19	-15.7	-17.7	3.08	ND	3.08
	C-20	-20.2	-22.2	4.88	ND	4.88
TH93 - 6 -15.9	C-68	-15.9	-17.9	1.634	ND	1.634
	C-1	-19.0	-21.0	3.93	1.92	5.85
	C-2	-21.0	-23.0	4.19	1.49	5.68
TH93 - 7 -16.0	C-3	-18.5	-20.5	1.47	ND	1.47

ND none detected

Marina Del Rey Explorations - Phthalates Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Bis (2-ethylhexyl) phthalate mg/kg	Di-n-butyl phthalate mg/kg	Total phthalates mg/kg
TH93 - 8 -3.3	C-11	-5.8	-7.8	ND	ND	ND
	C-12	-10.8	-13.3	ND	ND	ND
	C-13	-15.8	-17.8	ND	ND	ND
TH93 - 9 -10.4	C-4	-10.4	-12.4	0.518	ND	0.518
	C-5	-15.4	-17.4	0.356	0.636	0.992
	C-6	-17.9	-19.9	ND	ND	ND
TH93 - 10 -4.7	C-7	-4.7	-6.7	ND	ND	ND
	C-8	-7.2	-9.2	ND	ND	ND
	C-9	-12.2	-14.2	ND	ND	ND
	C-10	-17.2	-19.2	ND	ND	ND
TH93 - 11 -16.6	C-15	-16.6	-18.6	6.79	ND	ND
	C-16	-21.6	-23.6	3.92	ND	ND
TH93 - 12 -7.9	C-59	-7.9	-9.9	ND	ND	ND
	C-60	-12.4	-14.4	0.646	ND	0.646
	C-61	-16.9	-18.9	ND	ND	ND
	C-62	-21.4	-23.4	0.990	ND	ND
TH93 - 13 -17.1	C-56	-17.1	-19.1	4.785	ND	4.785
	C-57	-21.6	-23.6	ND	ND	ND
TH93 - 14 -13.6	C-28	-13.6	-15.6	1.79	ND	1.79
	C-29	-18.1	-20.1	ND	ND	ND
	C-30	-22.6	-24.6	ND	ND	ND
TH93 - 15 -17.6	C-53	-17.6	-19.6	5.02	ND	5.02
	C-54	-22.1	-24.1	ND	ND	ND

ND none detected

Marina Del Rey Explorations - Phthalates Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Bis (2-ethylhexyl) phthalate mg/kg	Di-n-butyl phthalate mg/kg	Total phthalates mg/kg
TH93 - 16 -16.8	C-69	-16.8	-18.8	4.05	ND	4.05
	C-70	-21.4	-23.4	ND	ND	ND
TH93 - 17 -18.1	C-50	-18.1	-20.1	4.12	ND	4.12
	C-51	-22.6	-24.6	ND	ND	ND
TH93 - 18 -18.3	C-32	-18.3	-20.3	ND	ND	ND
	C-33	-22.8	-24.8	ND	ND	ND
TH93 - 19 -20.2	C-47	-20.2	-22.2	2.20	ND	2.20
TH93 - 20 -15.6	C-75	-15.6	-17.6	ND	ND	ND
	C-72	-20.1	-22.1	ND	ND	ND
TH93 - 21 -15.2	C-76	-19.7	-21.7	0.422	ND	0.422
	C-77	-28.7	-30.7	ND	ND	ND
TH93 - 22 -20.8	C-45	-20.8	-22.8	2.325	ND	2.325
TH93 - 23 -19.9	C-35	-19.9	-21.9	ND	ND	ND
	C-36	-24.4	-26.4	ND	ND	ND
TH93 - 24 -21.9	C-43	-21.9	-23.9	ND	ND	ND
TH93 - 25 -21.4	C-41	-21.4	-23.4	ND	ND	ND
TH93 - 26 -14.0	C-79	-14.0	-16.0	0.925	ND	0.925
	C-80	-18.5	-20.5	0.965	ND	0.965
	C-81	-23.0	-25.0	ND	ND	ND

ND none detected

Marina Del Rey Explorations - Phthalates Test Results 15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Bis (2-ethylhexyl) phthalate mg/kg	Di-n-butyl phthalate mg/kg	Total phthalates mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2	ND	ND	ND
TH93 - 29 -18.5	C-83	-18.5	-20.5	1.376	ND	1.376
	C-84	-23.0	-25.0	ND	ND	ND

The following phthalates were tested for using the same method and detection limits and were none detected in all samples:

Butyl Benzyl phthalate
Diethyl phthalate
Dimethyl phthalate
Di-n-octyl phthalate

ND none detected

1993 Marina Del Rey Explorations
D.5 Polychlorinated Biphenyls (PCB) Test Results

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Total PCB Congeners (Aroclor 1254) mg/kg	Individual Congeners Tetra Isomers mg/kg	Penta Isomers mg/kg	Hexa Isomers mg/kg
TH93 - 1 -6.5	C-24	-6.5	-8.5	0.214	0.032	0.113	0.056
	C-25	-11.0	-13.0	0.205	0.031	0.109	0.053
	C-26	-15.5	-17.5	0.116	ND	0.061	0.030
	C-27	-20.0	-22.0	0.220	0.033	0.117	0.057
TH93 - 2 -10.8	C-21	-10.8	-12.8	0.098	ND	0.052	0.026
	C-22	-15.3	-17.3	0.092	ND	0.049	0.024
	C-23	-21.3	-23.3	ND	ND	ND	ND
TH93 - 3 -5.4	C-64	-5.4	-7.4	0.027	0.004	0.014	0.007
	C-65	-9.9	-11.9	0.024	0.004	0.013	0.006
	C-66	-14.4	-16.4	0.028	0.004	0.015	0.007
	C-67	-18.9	-20.9	0.110	0.017	0.058	0.029
TH93 - 4 -17.6	C-14	-17.6	-19.6	0.106	ND	0.056	0.028
TH93 - 5 -13.7	C-18	-13.7	-15.7	0.076	ND	0.040	0.020
	C-19	-15.7	-17.7	0.066	ND	0.035	ND
	C-20	-20.2	-22.2	0.187	0.028	0.099	0.049
TH93 - 6 -15.9	C-68	-15.9	-17.9	0.112	0.017	0.059	0.029
	C-1	-19.0	-21.0	0.076	ND	0.040	0.020
	C-2	-21.0	-23.0	0.043	ND	0.023	ND
TH93 - 7 -16.0	C-3	-18.5	-20.5	0.050	ND	0.027	ND

ND none detected

Marina Del Rey Explorations - Polychlorinated Biphenyls (PCB) Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Total PCB Congeners (Aroclor 1254) mg/kg	Individual Congeners Tetra Isomers mg/kg	Individual Congeners Penta Isomers mg/kg	Individual Congeners Hexa Isomers mg/kg
TH93 - 8	C-11	-5.8	-7.8	ND	ND	ND	ND
-3.3	C-12	-10.8	-13.3	0.052	ND	0.028	ND
	C-13	-15.8	-17.8	ND	ND	ND	ND
TH93 - 9	C-4	-10.4	-12.4	ND	ND	ND	ND
-10.4	C-5	-15.4	-17.4	ND	ND	ND	ND
	C-6	-17.9	-19.9	ND	ND	ND	ND
TH93 - 10	C-7	-4.7	-6.7	ND	ND	ND	ND
-4.7	C-8	-7.2	-9.2	ND	ND	ND	ND
	C-9	-12.2	-14.2	ND	ND	ND	ND
	C-10	-17.2	-19.2	ND	ND	ND	ND
TH93 - 11	C-15	-16.6	-18.6	0.065	ND	0.034	ND
-16.6	C-16	-21.6	-23.6	0.177	0.027	0.094	0.046
TH93 - 12	C-59	-7.9	-9.9	ND	ND	ND	ND
-7.9	C-60	-12.4	-14.4	ND	ND	ND	ND
	C-61	-16.9	-18.9	ND	ND	ND	ND
	C-62	-21.4	-23.4	0.151	0.023	0.080	0.039
TH93 - 13	C-56	-17.1	-19.1	0.106	0.016	0.056	0.028
-17.1	C-57	-21.6	-23.6	0.074	0.011	0.039	0.019
TH93 - 14	C-28	-13.6	-15.6	0.060	ND	0.032	ND
-13.6	C-29	-18.1	-20.1	0.029	ND	ND	ND
	C-30	-22.6	-24.6	ND	ND	ND	ND
TH93 - 15	C-53	-17.6	-19.6	0.069	0.010	0.037	0.018
-17.6	C-54	-22.1	-24.1	ND	ND	ND	ND

ND none detected

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Total PCB Congeners (Aroclor 1254) mg/kg	Individual Congeners Tetra Isomers mg/kg	Individual Congeners Penta Isomers mg/kg	Individual Congeners Hexa Isomers mg/kg
TH93 - 16	C-69	-16.8	-18.8	0.047	0.007	0.025	0.012
-16.8	C-70	-21.4	-23.4	ND	ND	ND	ND
TH93 - 17	C-50	-18.1	-20.1	0.104	0.016	0.055	0.027
-18.1	C-51	-22.6	-24.6	ND	ND	ND	ND
TH93 - 18	C-32	-18.3	-20.3	ND	ND	ND	ND
-18.3	C-33	-22.8	-24.8	ND	ND	ND	ND
TH93 - 19	C-47	-20.2	-22.2	0.132	0.020	0.070	0.034
-20.2							
TH93 - 20	C-75	-15.6	-17.6	0.040	0.006	0.021	0.010
-15.6	C-72	-20.1	-22.1	ND	ND	ND	ND
TH93 - 21	C-76	-19.7	-21.7	ND	ND	ND	ND
-15.2	C-77	-28.7	-30.7	ND	ND	ND	ND
TH93 - 22	C-45	-20.8	-22.8	0.110	ND	0.058	0.029
-20.8							
TH93 - 23	C-35	-19.9	-21.9	0.060	ND	ND	ND
-19.9	C-36	-24.4	-26.4	ND	ND	ND	ND
TH93 - 24	C-43	-21.9	-23.9	ND	ND	ND	ND
-21.9							
TH93 - 25	C-41	-21.4	-23.4	0.028	ND	ND	ND
-21.4							
TH93 - 26	C-79	-14.0	-16.0	ND	ND	ND	ND
-14.0	C-80	-18.5	-20.5	0.065	0.010	0.034	0.017
	C-81	-23.0	-25.0	0.076	0.011	0.040	0.020

ND none detected

15 July 1994

Marina Del Rey Explorations - Polychlorinated Biphenyls (PCB) Test Results

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		Total PCB Congeners (Aroclor 1254) mg/kg	Individual Congeners		
					Tetra Isomers mg/kg	Penta Isomers mg/kg	Hexa Isomers mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2	0.053	ND	0.028	ND
TH93 - 29 -18.5	C-83	-18.5	-20.5	0.051	0.008	0.027	0.013
	C-84	-23.0	-25.0	ND	ND	ND	ND

ND none detected

1993 Marina Del Rey Explorations
D.6 Polynuclear Aromatic Hydrocarbons (PAH)

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		(1) mg/kg	(2) mg/kg	(3) mg/kg	(4) mg/kg	(5) mg/kg	(6) mg/kg	(7) mg/kg	(8) mg/kg	(9) mg/kg
TH93 - 1	C-24	-6.5	-8.5			0.278	0.108	0.102	0.140	0.140	0.229	0.997
-6.5	C-25	-11.0	-13.0		1.325	1.910			1.270	1.050	1.84	7.395
	C-26	-15.5	-17.5									
	C-27	-20.0	-22.0									
TH93 - 2	C-21	-10.8	-12.8									
-10.8	C-22	-15.3	-17.3		1.180	2.220	1.140	1.020	1.600	1.210	2.220	10.59
	C-23	-21.3	-23.3			0.051					0.052	0.103
TH93 - 3	C-64	-5.4	-7.4									
-5.4	C-65	-9.9	-11.9	0.225	0.580	1.100	0.407	0.392	0.570	0.462	1.01	4.746
	C-66	-14.4	-16.4									
	C-67	-18.9	-20.9	0.220	0.365	0.793	0.385	0.388	0.495	0.320	0.745	3.711
TH93 - 4	C-14	-17.6	-19.6									
-17.6												
TH93 - 5	C-18	-13.7	-15.7									
-13.7	C-19	-15.7	-17.7									
	C-20	-20.2	-22.2		1.10	1.54					1.08	3.72
TH93 - 6	C-68	-15.9	-17.9	0.195	0.434	0.553	0.262	0.255	0.380	0.307	0.450	2.838
-15.9	C-1	-19.0	-21.0									
	C-2	-21.0	-23.0									
TH93 - 7	C-3	-18.5	-20.5		0.978	1.59			0.284	0.370	1.11	4.332
-16.0												

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a blank entry represents no detection for that sample

(1) Anthracene
(2) Phenanthrene
(3) Flouranthene
(4) Benzo(a)anthracene
(5) Benzo(a)pyrene
(6) Benzo(b)fluoranthene
(7) Chrysene
(8) Pyrene
(9) Total PAH

Marina Del Rey Explorations - Polynuclear Aromatic Hydrocarbons Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		(1) mg/kg	(2) mg/kg	(3) mg/kg	(4) mg/kg	(5) mg/kg	(6) mg/kg	(7) mg/kg	(8) mg/kg	(9) mg/kg
TH93 - 8	C-11	-5.8	-7.8									
-3.3	C-12	-10.8	-13.3									
	C-13	-15.8	-17.8									
TH93 - 9	C-4	-10.4	-12.4									
-10.4	C-5	-15.4	-17.4									
	C-6	-17.9	-19.9									
TH93 - 10	C-7	-4.7	-6.7									
-4.7	C-8	-7.2	-9.2									
	C-9	-12.2	-14.2									
	C-10	-17.2	-19.2									
TH93 - 11	C-15	-16.6	-18.6									
-16.6	C-16	-21.6	-23.6									
TH93 - 12	C-59	-7.9	-9.9									
-7.9	C-60	-12.4	-14.4								0.880	4.398
	C-61	-16.9	-18.9	0.790	0.460	1.14	0.355	0.178	0.247	0.348	0.129	1.251
	C-62	-21.4	-23.4			0.132						
TH93 - 13	C-56	-17.1	-19.1									
-17.1	C-57	-21.6	-23.6									
TH93 - 14	C-28	-13.6	-15.6		0.143	0.207	0.069	0.072	0.107	0.105	0.153	0.856
-13.6	C-29	-18.1	-20.1									
	C-30	-22.6	-24.6									
TH93 - 15	C-53	-17.6	-19.6									
-17.6	C-54	-22.1	-24.1									

a blank entry represents no detection for that sample

(1) Anthracene
(2) Phenanthrene
(3) Flouranthene
(4) Benzo(a)anthracene
(5) Benzo(a)pyrene
(6) Benzo(b)fluoranthene
(7) Chrysene
(8) Pyrene
(9) Total PAH

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		(1) mg/kg	(2) mg/kg	(3) mg/kg	(4) mg/kg	(5) mg/kg	(6) mg/kg	(7) mg/kg	(8) mg/kg	(9) mg/kg
TH93 - 16 -16.8	C-69 C-70	-16.8 -21.4	-18.8 -23.4			0.187	0.136			0.140	0.200	0.663
TH93 - 17 -18.1	C-50 C-51	-18.1 -22.6	-20.1 -24.6									
TH93 - 18 -18.3	C-32 C-33	-18.3 -22.8	-20.3 -24.8									
TH93 - 19 -20.2	C-47	-20.2	-22.2			0.228					0.210	0.438
TH93 - 20 -15.6	C-75 C-72	-15.6 -20.1	-17.6 -22.1									
TH93 - 21 -15.2	C-76 C-77	-19.7 -28.7	-21.7 -30.7									
TH93 - 22 -20.8	C-45	-20.8	-22.8									
TH93 - 23 -19.9	C-35 C-36	-19.9 -24.4	-21.9 -26.4									
TH93 - 24 -21.9	C-43	-21.9	-23.9									
TH93 - 25 -21.4	C-41	-21.4	-23.4									
TH93 - 26 -14.0	C-79 C-80 C-81	-14.0 -18.5 -23.0	-16.0 -20.5 -25.0									

a blank entry represents no detection for that sample

(1) Anthracene
(2) Phenanthrene
(3) Flouranthene
(4) Benzo(a)anthracene
(5) Benzo(a)pyrene
(6) Benzo(b)fluoranthene
(7) Chrysene
(8) Pyrene
(9) Total PAH

Marina Del Rey Explorations - Polynuclear Aromatic Hydrocarbons Test Results

15 July 1994

Hole Mudline Elev. ft.	Field ID	Elev. Interval ft.		(1) mg/kg	(2) mg/kg	(3) mg/kg	(4) mg/kg	(5) mg/kg	(6) mg/kg	(7) mg/kg	(8) mg/kg	(9) mg/kg
TH93 - 27 -21.2	C-39	-21.2	-23.2									
TH93 - 29 -18.5	C-83	-18.5	-20.5									
	C-84	-23.0	-25.0									

The following PAHs were tested for using the same method and detection limits, but were not detected in any samples:

Acenaphthene
Naphthalene
Acenaphthylene
Flourene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Dibenzo(a,h)anthracene
Indeno(1,2,3-cd)pyrene

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a blank entry represents no detection for that sample
(1) Anthracene
(2) Phenanthrene
(3) Flouranthene
(4) Benzo(a)anthracene
(5) Benzo(a)pyrene
(6) Benzo(b)fluoranthene
(7) Chrysene
(8) Pyrene
(9) Total PAH

APPENDIX A.2 Ballona Creek Watershed NPDES Storm Drains

Permit Number	Permitee Name	Reporting Period	Average Flow Rate (gpd)	Average TSS Mass (lb/day)	Average BOD Mass (lb/day)	Average O&G Mass (lb/day)	Average Temp. (o F)	Discharge Type	Receiving Water	City
58297	Wilshire Blvd. Office Bldg.	1/90 - 12/90	2,000	0	0	0		G.water seepage, cooling-tower bleed.	Ballona Creek	Los Angeles
58602	City of Inglewood	1/90 - 12/90		NO DISCHARGE				Swimming pool drainage	Ballona Creek	Inglewood
59382	Realty Center Management	1/90 - 12/90	50,000	0	0	0		Groundwater seepage	Ballona Creek	Los Angeles
59404	Carolco Pictures	1/90 - 12/90	50,000	0	0	0	73	Cooling tower and groundwater	Ballona Creek	Los Angeles
59421	City of Beverly Hills	4/90 - 12/90	40,697	0	0	0	61	Groundwater seepage	Ballona Creek	Beverly Hills
59722	L.A. County Museum of Nat. History	1/90 - 3/90		NO DISCHARGE				Groundwater seepage, ponded rainfall	Ballona Creek	Los Angeles
59765	CoastFed Properties	2ndQ & 3rdQ 90	309	0	0	0		Groundwater seepage	Ballona Creek	Beverly Hills
59781	Museum Terrace Apartments	1/90 - 12/90	1,500	0.16	0.06	0.08	70	Subsoil drainage	Ballona Creek	Los Angeles
59803	Cal-Four Capital Thayer Associates	1/90 - 12/90	900	0.02	0.05	0.03	72	Groundwater waste	Ballona Creek	Los Angeles
59889	The Casden Company	1/90 - 12/90	65,000				64	Groundwater seepage	Ballona Creek	Los Angeles
60062	Masselin Manor Apartments	1/90 - 9/90	9,000	0.7	0.33	0.15	70	Groundwater seepage	Ballona Creek	Los Angeles
60062	Masseline Man.	1/90 - 12/90	9,000	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
60143	Wilshire Westwood Associates	1/90 - 6/90	100	0.12			68	Subsoil drainage	Ballona Creek	Los Angeles
60143	Wilshire Westwood Asso.	1/90 - 12/90	100	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
60186	Center for Early Education	1/90 - 12/90	75,000					Groundwater dewatering	Ballona Creek	Los Angeles
60259	Bracton Corporation	7/90 - 9/90					70	Groundwater waste	Ballona Creek	Los Angeles
60259	Hara Corp.	1/90 - 9/90	5,000	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
60381	Lake View Mansion Partnership	1/90 - 12/90	100				74	Groundwater waste	Ballona Creek	Los Angeles
60411	Third and Fairfax Plaza Associates	10/90 - 12/90	15,053			0.01	73	Groundwater waste	Ballona Creek	Los Angeles
60542	Parkmile Asso.			NO DISCHARGE (PERMIT INACTIVE)				Treated groundwater during construction	Ballona Creek	Los Angeles
60623	Two Rodeo Asso.	12/90	36,000	0	0	0		Groundwater dewatering	Ballona Creek	Beverly Hills
60640	Huntley Drive Asso. (Sheldon M. Gordon)	1/90 - 12/90	5,000	0	ND	ND		Groundwater dewatering	Ballona Creek	Los Angeles
60658	Los Angeles Free Clinic	1/90 - 12/90	1stQ - 150	Not Reported		1stQ - <0.006	60	Groundwater dewatering	Ballona Creek	Los Angeles
60763	Tracinda Corporation	1/90 - 12/90						Groundwater seepage	Ballona Creek	Beverly Hills
60763	MGM/UA Comm.	1/90 - 12/90	22,000	0.6411809	0.3975322	0.421347464		Groundwater seepage	Ballona Creek	Beverly Hills
60810	Dorchester	5/90 - 12/90	100,000	0	0	Not Reported		Groundwater - no additives	Ballona Creek	Los Angeles
60879	Westwood Gateway	1/90 - 11/90	23,110	Not Reported		<0.96		Treated groundwater from chlorinated org. solvent	Ballona Creek	Los Angeles
61115	Howard Hughes	1/90 - 11/90	7,200	Not Reported		0.24		Treated groundwater	Ballona Creek	Los Angeles
61123	Jan Development			NO DISCHARGE REPORTED					Ballona Creek	Los Angeles
61140	Jack Slomovic - 01	1/90 - 12/90	17,460	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
61158	Jack Slomovic - 02	1/90 - 12/90	17,460	0	0	0		Groundwater - no additives	Ballona Creek	Los Angeles
61221	Abraham Moradzudeh Samshaou		6,952	NO DISCHARGE				-	Ballona Creek	Los Angeles

Permit Number	Permitee Name	Reporting Period	Average Flow Rate (gpd)	Average TSS Mass (lb/day)	Average BOD Mass (lb/day)	Average O&G Mass (lb/day)	Average Temp. (o F)	Discharge Type	Receiving Water	City
1786	Cochran (342)			NO REPORTS FILED				Groundwater dewatering	Ballona Creek	Los Angeles
52710	Fedral Employees Distributing Company	1/90 - 12/90	1,800	0.15	0.02	0.02	80	Cooling tower bleed off	Ballona Creek	Los Angeles
52809	Pacific Management Company	1/90 - 12/90	4,000				72	Cooling tower bleed off	Ballona Creek	Hollywood
53074	Rreef USA Fund II	1/90 - 12/90	1,000	0	0	0	70	Groundwater seepage	Ballona Creek	Los Angeles
53091	Mark Wishire Associates	1/90 - 12/90	2,350	0.82	0.31	0.03	70	Cooling tower bleed off	Ballona Creek	Los Angeles
53139	Culver City Unified School District	4Q 90	4,000	2.23	0	Not Reported	80	Backwash waste	Ballona Creek	Culver City
53163	Delta Towers Joint Venture	1/90 - 6/90	1,400		0.01	0.07	79	Subsoil drainage	Ballona Creek	Los Angeles
53163	Delta Towers Join Venture	1/90 - 12/90	1,400	0	0	0		Groundwater seepage	Ballona Creek	Los Angeles
53228	Cedars-Sinai Med.	1/90 - 11/90	50,000	0	0	0		Subsoil drainage	Ballona Creek	Los Angeles
53261	R & B Enterprises	1/90 - 12/90	900	0.21	0.66	0.64		Subsoil drainage	Ballona Creek	Los Angeles
53279	Wilshire Highland Bldg.	1/90	2,000	0.07	<0.033	<0.02	66	Subsoil drainage	Ballona Creek	Los Angeles
53287	Pine Realty - Gateway West	1/90 - 12/90	10,000	0	0	0		Groundwater seepage & refect	Ballona Creek	Los Angeles
53490	Holiday Inns, Inc.	1/90 - 12/90	800	0.22	0.03		70	Swimming pool drainage	Ballona Creek	Los Angeles
53503	Coldwell Banker Real Estate Services	1/90 - 12/90	2,000	0.08	0.02	0.03	70	Subsoil drainage	Ballona Creek	Los Angeles
53503	Topa	1/90 - 12/90	2,000	0	0	0		Groundwater seepage	Ballona Creek	Los Angeles
53511	Howard David Ltd & Fatesh Bldng Mngmt Corp	1/90 - 12/90	900	0.11	0.15	0.03	75	Cooling tower bleed off	Ballona Creek	Los Angeles
53538	Nationwide Theatres	1/90 - 12/90	100	0	0	0		Cooling tower bleed & Subsoil drainage	Ballona Creek	Los Angeles
53996	City of Los Angeles	1/90 - 12/90	36,200	0	0	0		Cooling tower bleed off	Ballona Creek	Los Angeles
54101	City of Santa Monica	1/90 - 12/90	573,080	422.6			71	Plant backwash waste	Ballona Creek	Los Angeles
54127	Century Towers	1/90 - 12/90	-	NO DISCHARGE				Swimming pool drainage	Ballona Creek	Los Angeles
54305	Holiday Inns, Inc	1/90 - 12/90	500	0.02	0.01		75	Groundwater seepage, pool backwash	Ballona Creek	Hollywood
54453	University of Southern California	1/90 - 12/90	5,000				84	Backwash waste	Ballona Creek	Los Angeles
54861	Harbor Ins.	1/90 - 12/90	1,400					Cooling tower bleed & Subsoil drainage	Ballona Creek	Los Angeles
54887	Scottish Rite Cathedral Asso.	1/90 - 12/90	760	0	0	0		Cooling tower bleedoff	Ballona Creek	Los Angeles
54909	City of Inglewood	1/90 - 12/90		NO DISCHARGE				Vehicle wash water, service area rainfall	Ballona Creek	Inglewood
55361	Universal Properties, Inc.	4/90 - 6/90	1,800				76	Cooling tower bleed off	Ballona Creek	Beverly Hills
55409	The Salvation Army	7/90 - 12/90	20,000	0	0	Not Reported	80	Backwash waste	Ballona Creek	Los Angeles
55638	Westin Hotels, Inc	1/90 - 12/90	1,572	17.53	0.06		80	Backwash waste	Ballona Creek	Los Angeles
55786	Litton Industries	1/90 - 12/90	1,000	0.19	0.03	0.05	67	Groundwater, cooling water, fountain	Ballona Creek	Beverly Hills
56707	Great Western Savings & Loan	1/90 - 12/90	3,891	0	0	0		Grndwtr seepage, no additive	Ballona Creek	Beverly Hills

Permit Number	Permitee Name	Reporting Period	Average Flow Rate (gpd)	Average TSS Mass (lb/day)	Average BOD Mass (lb/day)	Average O&G Mass (lb/day)	Average Temp. (o F)	Discharge Type	Receiving Water	City
61239	Miracle Mile HR-Capital	6/90 - 12/90	2,200	0	0	0		Groundwater dewatering (treated)	Ballona Creek	Los Angeles
61247	Beverly Mercedes Place		6,978	NO DISCHARGE				-	Ballona Creek	Los Angeles
61263	Alvarado Grand Plaza		6,950	NO REPORTS				-	Ballona Creek	Los Angeles
61271	Project West Corp.	7/90 - 12/90	25,000	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
61506	Ogden Ave. Asso.	1/90 - 9/90		NO DISCHARGE				Groundwater dewatering	Ballona Creek	Los Angeles
61531	WBM Partners Develop Corp.	7/90 - 9/90		NO DISCHARGE REPORTED				Groundwater	Ballona Creek	Los Angeles
61557	Hayworth Asso.	7/90 -10/90		NO DISCHARGE REPORTED					Ballona Creek	Los Angeles
61603	Wilshire West Inc.	3rd &4thQ 90	16,500	0	0	ND		Groundwater dewatering	Ballona Creek	Los Angeles
61662	Glenfed Develop.	8/90 - 12/90		NO DISCHARGE				Wastewater - underground drainage	Ballona Creek	Los Angeles
61735	CWD Detroit Asso.			NO RECORD OF DISCHARE				Groundwater dewatering	Ballona Creek	Los Angeles
61743	CWD Cloudedale Asso.			NO RECORD OF DISCHARE				Groundwater dewatering	Ballona Creek	Los Angeles
61751	Peter Giorganni	1/90 - 9/90		NO DISCHARGE				Groundwater dewatering	Ballona Creek	Los Angeles
61808	Panglossian Asso.			NO REPORTS FILED				Groundwater dewatering	Ballona Creek	Los Angeles
61832	House Ear Institute	8/90 - 12/90	1,890					Groundwater waste	Ballona Creek	Los Angeles
61875	Westlake Kingston	4thQ 90	17,280	0	0	ND		Groundwater dewatering	Ballona Creek	Beverly Hills
61883	McGregor Co.	1/90 - 12/90		NO DISCHARGE				Groundwater dewatering	Ballona Creek	Los Angeles
61891	Clinton Partnership	7/90 - 12/90	33,120	0	0	0		Groundwater dewatering	Ballona Creek	Los Angeles
61948	S. Doheny HR-Capital	9/90 - 11/90	7,280	0	0	ND		Groundwater dewatering (Treated)	Ballona Creek	Los Angeles
62154	Clark Swall Ltd.		7,003	NO REPORTS FILED				Groundwater dewatering	Ballona Creek	Los Angeles
			1,412,995	445.87118	2.1375322	1.801347464				

60372	GBW Properties	1/90 - 12/90	2,462	Not Reported		0.04		Groundwater dewatering	Marina del rey	Marina del rey
54089	Windward Yacht & Repair			NO DATA SUBMITTED				Boat washing waste water	Marina d.r. Hbr	Marina del rey

APPENDIX A.3 Ballona Creek Watershed Land Uses

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
BI57-1	HOLLYWOOD	1.86	1.86	0	46	5	3	26	17	3	44	0	46	5	3	26	17	3	44	YES
BI57-2	HOLLYWOOD	1.69	1.69	0	17	6	2	59	16	0	60	0	17	6	2	59	16	0	60	NO
BI57-3	HOLLYWOOD	0.80	0.80	2	0	5	5	59	15	14	71	2	0	5	5	59	15	14	71	NO
Split 57%			0.46									2	0	5	5	59	15	14	71	
BI57-4	HOLLYWOOD	3.00	3.46	0	18	19	1	44	18	0	57	0	16	17	2	46	18	2	59	NO
BI57-5	HOLLYWOOD	3.75	10.76	0	0	8	1	48	43	0	76	0	16	10	2	45	26	1	62	NO
BI1102-1	HOLLYWOOD	2.05	2.05	0	0	40	21	25	12	2	55	0	0	40	21	25	12	2	55	NO
BI5213	HOLLYWOOD	1.28	1.28	0	0	24	25	42	9	0	57	0	0	24	25	42	9	0	57	NO
Confl			3.33									0	0	34	23	32	11	1	56	
BI1102-2	HOLLYWOOD	0.23	3.56	0	0	0	0	91	9	0	70	0	0	32	21	35	11	1	57	NO
BI5212	HOLLYWOOD	1.00	1.00	0	0	0	0	76	24	0	74	0	0	0	0	76	24	0	74	NO
Confl			4.56									0	0	25	16	44	14	1	61	
BI1102-3	HOLLYWOOD	1.33	5.89	0	0	10	3	68	19	0	69	0	0	21	13	50	15	1	63	NO
Confl			16.65									0	10	14	6	47	22	1	62	
BI57-3	HOLLYWOOD		0.80									2	0	5	5	59	15	14	71	
Split 43%			0.34									2	0	5	5	59	15	14	71	
BI57-6	HOLLYWOOD	1.01	1.35	0	22	30	23	12	13	0	45	1	16	24	18	24	14	4	51	NO
BI57-7	HOLLYWOOD	2.40	2.40	0	44	28	0	16	10	2	38	0	44	28	0	16	10	2	38	NO
BI57-8	HOLLYWOOD	2.18	4.58	0	42	18	1	24	15	0	42	0	43	23	0	20	12	1	40	NO
BI57-9	HOLLYWOOD	1.99	6.57	0	29	35	13	9	14	0	42	0	39	27	4	17	13	1	41	NO
BI57-10	HOLLYWOOD	0.18	24.75	0	0	0	17	50	33	0	72	0	18	18	6	38	19	1	56	NO
BI648A	HOLLYWOOD	0.51	0.51	0	0	14	0	72	14	0	68	0	0	14	0	72	14	0	68	NO
BLLNA1	HOLLYWOOD	0.19	0.19	0	0	0	32	63	5	0	61	0	0	0	32	63	5	0	61	YES
Confl			25.45									0	18	18	6	38	19	1	56	
BLLNA2	HOLLYWOOD	0.13	0.13	0	0	8	21	50	21	0	66	0	0	8	21	50	21	0	66	NO
Confl			25.58									0	17	18	6	38	19	1	56	
BI494	HOLLYWOOD	0.52	0.52	0	0	42	14	27	17	0	58	0	0	42	14	27	17	0	58	NO
Confl			26.10									0	17	18	6	38	19	1	56	
BLLNA3	HOLLYWOOD	0.25	0.25	0	0	44	20	20	16	0	55	0	0	44	20	20	16	0	55	NO
Confl			26.35									0	17	18	7	38	19	1	56	
PANPC1	HOLLYWOOD	7.43	7.43	0	52	10	4	17	14	3	38	0	52	10	4	17	14	3	38	NO
Split 48%			3.57									0	52	10	4	17	14	3	38	
BI54	HOLLYWOOD	1.43	5.00	0	0	43	10	30	16	1	58	0	37	19	6	21	15	2	44	NO

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
Confl			31.35									0	20	19	6	35	18	1	54	
DDI11-1	BEVERLY HILLS	3.52	3.52	0	25	49	2	11	13	0	43	0	25	49	2	11	13	0	43	YES
DDI11-2	HOLLYWOOD	0.45	0.45	0	0	27	7	31	35	0	68	0	0	27	7	31	35	0	68	NO
Confl			3.97									0	22	47	3	13	15	0	46	
DDI11-3	HOLLYWOOD	1.32	5.29	0	18	27	8	35	12	0	51	0	21	42	4	19	15	0	47	NO
Split 52%			3.86									0	52	10	4	17	14	3	38	
DDI11-4	HOLLYWOOD	4.19	13.34	0	0	40	5	34	19	2	61	0	23	32	4	23	16	1	49	NO
Confl			44.69									0	21	23	6	32	18	1	53	
BLLNA4	HOLLYWOOD	0.18	44.87	0	0	22	0	56	11	11	67	0	21	23	6	32	18	1	53	NO
BI648C	HOLLYWOOD	0.18	0.18	0	0	6	0	78	16	0	70	0	0	6	0	78	16	0	70	NO
Confl			45.05									0	21	22	6	32	18	1	53	
BLLNA5	BEVERLY HILLS	0.28	0.28	0	0	4	0	71	25	0	73	0	0	4	0	71	25	0	73	NO
Confl			45.33									0	21	22	6	32	18	1	53	
DDI3	HOLLYWOOD	2.12	2.12	0	0	17	10	57	9	7	65	0	0	17	10	57	9	7	65	NO
Confl			47.45									0	20	22	6	33	17	2	54	
BLLNA6	BEVERLY HILLS	0.16	0.16	0	0	0	44	12	0	44	67	0	0	0	44	12	0	44	67	NO
Confl			47.61									0	20	22	6	33	17	2	54	
BI488-1	INGLEWOOD	0.70	0.70	0	0	54	0	42	4	0	55	0	0	54	0	42	4	0	55	NO
BI488-2	INGLEWOOD	0.35	0.35	0	0	43	0	37	20	0	62	0	0	43	0	37	20	0	62	NO
Confl			1.05									0	0	50	0	40	9	0	57	
BI488-3	INGLEWOOD	4.24	5.29	0	0	56	1	23	15	5	58	0	0	55	1	26	14	4	58	NO
BI71	INGLEWOOD	1.68	1.68	0	0	5	2	84	3	6	68	0	0	5	2	84	3	6	68	NO
Confl			6.97									0	0	43	1	40	11	4	60	
BI70	HOLLYWOOD	2.24	9.21	0	0	21	7	63	9	0	63	0	0	38	3	46	11	3	61	NO
Split 67.5%			6.22									0	0	38	3	46	11	3	61	
BI485	HOLLYWOOD	1.37	7.59	0	0	19	11	63	7	0	62	0	0	34	4	49	10	3	61	NO
BI487	HOLLYWOOD	0.73	8.32	0	0	72	0	14	11	3	53	0	0	38	4	46	10	3	60	YES
BI5204-1	HOLLYWOOD	1.68	1.68	0	0	0	8	35	5	52	79	0	0	0	8	35	5	52	79	NO
BI5204-2	HOLLYWOOD	0.69	0.69	0	0	0	0	1	38	61	91	0	0	0	0	1	38	61	91	NO
Confl			2.37									0	0	0	6	25	15	55	83	
BI5204-3	HOLLYWOOD	4.63	7.00	0	0	1	9	59	29	2	73	0	0	1	8	48	24	20	76	NO
BI5204-4	HOLLYWOOD	1.59	8.59	0	0	3	5	77	9	6	69	0	0	1	7	53	21	17	75	YES
Confl			16.91									0	0	19	6	49	16	10	68	

Ballona Creek

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
BI84	HOLLYWOOD	0.27	17.18	0	0	52	0	26	7	15	60	0	0	20	5	49	16	10	68	NO
Confl			64.79									0	15	21	6	37	17	4	57	
BLLNA7	BEVERLY HILLS	0.03	0.03	0	0	0	33	0	0	67	75	0	0	0	33	0	0	67	75	NO
Confl			64.82									0	15	21	6	37	17	4	57	
BI70	HOLLYWOOD		9.21									0	0	38	3	46	11	3	61	
Split 32.5%			2.99									0	0	38	3	46	11	3	61	
LA1177	HOLLYWOOD	4.04	7.03	0	13	52	2	24	8	1	49	0	7	46	2	33	9	2	54	NO
Confl			71.85									0	14	24	6	37	16	4	57	
BLLNA8	BEVERLY HILLS	0.45	0.45	0	76	0	24	0	0	0	18	0	76	0	24	0	0	0	18	YES
Confl			72.30									0	14	24	6	37	16	4	57	
BLLNA9	BEVERLY HILLS	0.12	0.12	0	0	0	25	0	0	75	79	0	0	0	25	0	0	75	79	NO
Confl			72.42									0	14	24	6	37	16	4	57	
CULVR1	BEVERLY HILLS	0.62	0.62	0	0	37	15	23	6	19	60	0	0	37	15	23	6	19	60	NO
Confl			73.04									0	14	24	6	37	16	4	57	
BLLNA10	BEVERLY HILLS	0.10	0.10	0	0	0	70	20	10	0	52	0	0	0	70	20	10	0	52	NO
Confl			73.14									0	14	24	6	37	16	4	57	
BLLNA11	BEVERLY HILLS	0.03	0.03	0	0	0	0	0	0	100	91	0	0	0	0	0	0	100	91	NO
Confl			73.17									0	14	24	6	37	16	4	57	
BNDCT1	BEVERLY HILLS	2.77	2.77	0	98	2	0	0	0	0	11	0	98	2	0	0	0	0	11	NO
BI411	BEVERLY HILLS	0.64	0.64	0	81	19	0	0	0	0	16	0	81	19	0	0	0	0	16	NO
Confl			3.41									0	95	5	0	0	0	0	12	
BNDCT2	BEVERLY HILLS	0.39	3.80	3	28	69	0	0	0	0	32	0	88	12	0	0	0	0	14	NO
FRANK1	BEVERLY HILLS	1.19	1.19	0	100	0	0	0	0	0	10	0	100	0	0	0	0	0	10	NO
COLDW1	BEVERLY HILLS	1.09	2.28	0	72	28	0	0	0	0	19	0	87	13	0	0	0	0	14	NO
BI496	BEVERLY HILLS	0.76	0.76	0	96	4	0	0	0	0	11	0	96	4	0	0	0	0	11	NO
Confl			3.04									0	89	11	0	0	0	0	14	
COLDW2	BEVERLY HILLS	0.65	3.69	0	6	94	0	0	0	0	40	0	74	26	0	0	0	0	18	NO
Confl			7.49									0	81	19	0	0	0	0	16	
BNDCT3	BEVERLY HILLS	0.24	7.73	4	0	96	0	0	0	0	40	0	79	21	0	0	0	0	17	NO
BNDCT4	BEVERLY HILLS	0.55	0.55	45	51	4	0	0	0	0	7	45	51	4	0	0	0	0	7	NO
Confl			8.28									3	77	20	0	0	0	0	16	
BNDCT5	BEVERLY HILLS	1.08	9.36	24	0	26	0	31	19	0	49	6	68	21	0	4	2	0	20	YES
RXFRD1	BEVERLY HILLS	1.20	1.20	0	0	54	0	17	25	4	61	0	0	54	0	17	25	4	61	YES
Confl			10.56									5	60	24	0	5	5	0	25	

Ballona Creek

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
BNDCT6	BEVERLY HILLS	1.04	11.60	8	0	47	4	24	15	2	53	5	55	26	0	7	6	1	27	NO
Confl			84.77									1	20	24	5	32	14	4	53	
BI424-1	BEVERLY HILLS	0.14	0.14	0	93	0	0	0	0	7	16	0	93	0	0	0	0	7	16	YES
Confl			84.91									1	20	24	5	32	14	4	53	
BI424-2	BEVERLY HILLS	0.14	0.14	0	57	0	0	7	0	36	43	0	57	0	0	7	0	36	43	NO
Confl			85.05									1	20	24	5	32	14	4	53	
BLLNA12	BEVERLY HILLS	0.12	0.12	0	0	0	58	8	0	34	61	0	0	0	58	8	0	34	61	YES
Confl			85.17									1	20	24	5	32	14	4	53	
BI9404	BEVERLY HILLS	0.10	0.10	0	0	80	0	20	0	0	47	0	0	80	0	20	0	0	47	NO
Confl			85.27									1	20	24	5	32	14	4	53	
BI52	BEVERLY HILLS	1.05	1.05	0	0	39	2	27	24	8	65	0	0	39	2	27	24	8	65	NO
Confl			86.32									1	20	24	5	32	14	4	53	
BI424-3	BEVERLY HILLS	0.42	0.42	0	29	38	0	29	0	4	42	0	29	38	0	29	0	4	42	NO
Confl			86.74									1	20	24	5	32	14	4	53	
BI2950	BEVERLY HILLS	0.04	0.04	0	0	75	0	25	0	0	49	0	0	75	0	25	0	0	49	NO
Confl			86.78									1	20	24	5	32	14	4	53	
BLLNA13	BEVERLY HILLS	0.08	0.08	0	0	88	0	0	12	0	48	0	0	88	0	0	12	0	48	NO
Confl			86.86									1	20	24	5	32	14	4	53	
BI2901	BEVERLY HILLS	0.40	0.40	0	0	65	18	7	10	0	49	0	0	65	18	7	10	0	49	YES
Confl			87.26									1	19	24	5	32	14	4	53	
BI425	BEVERLY HILLS	0.26	0.26	0	46	38	4	4	8	0	32	0	46	38	4	4	8	0	32	NO
Confl			87.52									1	20	25	5	32	14	4	53	
CCAI4	BEVERLY HILLS	1.13	1.13	0	0	49	3	35	13	0	58	0	0	49	3	35	13	0	58	NO
Confl			88.65									1	19	25	5	32	14	4	53	
BLLNA14	BEVERLY HILLS	0.03	0.03	0	0	100	0	0	0	0	42	0	0	100	0	0	0	0	42	NO
Confl			88.68									1	19	25	5	32	14	4	53	
BLLNA15	VENICE	0.21	0.21	0	0	67	0	28	5	0	52	0	0	67	0	28	5	0	52	NO
Confl			88.89									1	19	25	5	32	14	4	53	
SEPUL1	BEVERLY HILLS	3.50	3.50	23	68	1	0	8	0	0	13	23	68	1	0	8	0	0	13	YES
MORAG1	BEVERLY HILLS	1.46	1.46	1	99	0	0	0	0	0	10	1	99	0	0	0	0	0	10	NO
Confl			4.96									17	77	1	0	6	0	0	12	
SEPUL2	BEVERLY HILLS	1.21	6.17	1	45	27	0	2	25	0	40	13	71	6	0	5	5	0	17	NO
BI5237	BEVERLY HILLS	0.66	0.66	0	100	0	0	0	0	0	10	0	100	0	0	0	0	0	10	NO
BI5238	BEVERLY HILLS	0.39	0.39	0	100	0	0	0	0	0	10	0	100	0	0	0	0	0	10	NO
Confl			1.05									0	100	0	0	0	0	0	10	

Ballona Creek

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
STONE1	BEVERLY HILLS	2.08	2.08	0	94	0	0	6	0	0	13	0	94	0	0	6	0	0	13	YES
STONE2	BEVERLY HILLS	0.42	0.42	0	83	0	0	17	0	0	20	0	83	0	0	17	0	0	20	NO
Confl			2.50									0	92	0	0	8	0	0	15	
STONE3	BEVERLY HILLS	0.42	2.92	0	0	12	0	83	5	0	66	0	79	2	0	19	1	0	22	NO
BI498	BEVERLY HILLS	0.52	4.49	0	23	19	0	48	10	0	52	0	77	3	0	18	2	0	23	NO
Confl			10.66									8	74	5	0	10	4	0	20	
SEPUL3	BEVERLY HILLS	1.13	11.79	0	0	38	2	38	20	2	63	7	67	8	0	13	5	0	24	NO
BI497-1	BEVERLY HILLS	1.58	1.58	0	95	5	0	0	0	0	12	0	95	5	0	0	0	0	12	NO
BI497-2	BEVERLY HILLS	3.76	5.34	13	2	56	2	13	14	0	46	9	30	41	1	9	10	0	36	NO
Confl			17.13									8	55	18	1	12	7	0	28	
SEPUL4	BEVERLY HILLS	0.57	17.70	0	0	51	0	26	11	12	60	7	53	19	1	12	7	1	29	NO
SAWTL1	BEVERLY HILLS	4.42	22.12	1	5	33	5	23	23	10	62	6	44	22	1	14	10	2	35	YES
SEPUL5	BEVERLY HILLS	0.94	23.06	0	0	75	1	20	4	0	49	6	42	24	1	15	10	2	36	NO
Confl			111.95									2	24	25	4	28	13	3	49	
BI503	VENICE	0.32	0.32	0	0	81	0	19	0	0	47	0	0	81	0	19	0	0	47	NO
Confl			112.27									2	24	25	4	28	13	3	49	
BI51	VENICE	0.82	0.82	0	0	57	0	37	6	0	55	0	0	57	0	37	6	0	55	NO
Confl			113.09									2	24	25	4	28	13	3	49	
BLLNA16	VENICE	0.05	0.05	0	0	100	0	0	0	0	42	0	0	100	0	0	0	0	42	NO
Confl			113.14									2	24	25	4	28	13	3	49	
BI504	VENICE	0.73	0.73	0	0	68	0	30	2	0	51	0	0	68	0	30	2	0	51	NO
Confl			113.87									2	24	26	4	28	13	3	49	
BI273	INGLEWOOD	3.40	3.40	0	7	41	15	17	12	8	54	0	7	41	15	17	12	8	54	NO
BI81	VENICE	1.23	1.23	0	0	81	11	0	2	6	46	0	0	81	11	0	2	6	46	NO
MT318	VENICE	2.19	6.82	0	21	45	0	22	9	3	47	0	10	49	9	16	9	6	50	YES
MT430	VENICE	0.27	0.27	0	0	0	0	48	52	0	80	0	0	0	0	48	52	0	80	NO
Confl			7.09									0	10	48	9	17	11	6	51	
CNTLA1	VENICE	0.59	7.68	0	0	42	0	0	44	14	71	0	9	47	8	15	13	6	53	NO
BI677	VENICE	0.84	0.84	0	50	36	0	0	13	1	33	0	50	36	0	0	13	1	33	YES
BI7	VENICE	0.64	1.48	0	6	57	0	6	20	11	57	0	31	45	0	3	16	5	43	NO
Confl			9.16									0	13	47	7	13	14	6	51	
CNTLA2	VENICE	0.50	9.66	0	0	78	0	0	0	22	53	0	12	48	7	13	13	7	51	NO
Confl			123.53									2	23	27	4	27	13	4	50	
BI505	VENICE	0.33	0.33	0	0	91	0	6	0	3	45	0	0	91	0	6	0	3	45	NO
Confl			123.86									2	23	27	4	27	13	4	50	

SUBAREA NAME	QUAD	Area (sq.mi.)	Total (sq.mi.)	Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Total Percent of Development Type 1	2	3	4	5	6	7	Overall IMP (%)	Waste Disposal Site
BI547	VENICE	0.49	0.49	20	0	0	0	27	4	49	67	20	0	0	0	27	4	49	67	NO
Confl			124.35									2	22	27	4	27	13	4	50	
BLLNA17	VENICE	0.03	0.03	100	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	NO
Confl			124.38									2	22	27	4	27	13	4	50	
BLLNA18	VENICE	0.14	0.14	100	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	NO
Confl			124.52									2	22	27	4	27	13	4	50	
BLLNA19	VENICE	2.52	2.52	29	0	34	0	6	2	29	47	29	0	34	0	6	2	29	47	YES
Confl			127.04									2	22	27	4	27	13	4	49	
BLLNA20	VENICE	0.04	0.04	0	0	0	0	100	0	0	68	0	0	0	0	100	0	0	68	NO
Confl			127.08									2	22	27	4	27	13	4	49	

Note :

1 Low flow percentage split of BI57-3 into BI57-4 and BI57-6: 57% goes south in Norton Ave. and 43% goes west in Beverly Blvd.

2 Low flow percentage split of BI70 into LA1177 and BI485: 32.5% goes west into LA1177 and 67.5% goes north into BI485.

3 Low flow percentage split of PANPC1 into DDI11-4 and BI54: 52% goes west into DDI11-4 and 48% goes south into BI54.

APPENDIX B ENVIRONMENTAL RESOURCES

CONTENTS

B.1 BIOLOGICAL ENVIRONMENT

B.1.1 Benthic Fauna

The benthic fauna in Marina del Rey is typical of areas with shallow warm waters, a fine grained, unstable silty bottom, and with limited circulation. Soule and Oguri (1988) reported that the most common benthic species in the harbor were roundworms (unidentified nematodes), making up some 30% of the total benthic population and found primarily in the channel entrance. The second most common species was the polychaete Tharyx spp., which are common in the poorly circulated inner marina. The third most common species was the polychaete Mediomastus ambiseta (family: Cpitellidae), which is more common in the main channel.

B.1.2 Fish Fauna

Soule and Oguri (1988) report that the fish habitat in the harbor is constrained by its physical characteristics. Those characteristics which cause conditions less favorable to a diverse fishery resource are: the harbor's shallow depths allow rapid warming and cooling of the entire water column; the straight side walls, as opposed to irregular dikes, provide limited fish habitat; and the breakwater and dikes which are designed to protect boasts decreases the flushing of marina waters which in turn exposes fish to longer periods of pollutants that enter the marina.

The total number of fish caught in otter trawls, gill nets, and beach seines during May and October surveys over the past ten years has fluctuated (ranging from 260-870 individuals) partially due to the 1982-1983 El Nino. The number of species taken over the past several years, however, has been fairly consistent at 36-40 species. It was also reported that the species composition also changes seasonally, as well as over longer periods of cooler water seasons (or years) and warmer water seasons (or years). A list of the more common fish found in the marina appears in Table B.1.

The California grunion, an important sportfish, occasionally uses nearlby Dockweiler Beach for spawning in mid-March through mid-September. Spawning activity initiates with the grunion depositing their eggs in the san during high tides. The eggs are incubated in the sand and hatched during the ascending series of hight tide conditions before the next full moon. The newly hatched fish are carried out to the ocean with ebbing tide.

B.1.3 Seabirds and Mammals

Certain seabirds are seasonally common in the Marina (Table B.1). The species found here are those that occur in sheltered waters of shallow depths (grebes and scooters for example), or those generalists species that exploit a wide variety of marine and coastal habitats (e.g. gulls). The only marine mammals epxected to occur in the project area are the California sea lion and the harbor seal.

Table B.1. Common Flora and Fauna Found in Marina del Rey

FISH SPECIES COMMONLY FOUND IN MARINA DEL REY

Species	Common Name
Leuresthes tenuis	California grunion
Atherinops affinis	Topsmelt
Embiotoca jacksoni	Black surf perch
Girella nigricans	Opaleye
Cheilotrema saturnum	Black croaker
Anisotremus davidsoni	Sargo
Chromis punctipinnis	Blacksmith
Clevelandia ios	Arrow goby
Fundulus parvipinnis	California Killfish
Genyonemus lineatus	White croaker
Halochoeres semicinctus	Rock wrasse
Heterostichus rostratus	Giant kelpfish
Hypopsetta guttulata	Diamond turbot
Hypsipops rubicundus	Garibaldi

MACROFAUNA COMMONLY FOUND IN MARINA DEL REY

Species	Common Name
Apoprionospio pygmaeus	Spionid
Nephtys californiensis	Nephtyid
Paraphoxus epistomus	Amphipod
Dendraster excentricus	Sand dollar
Mandibulophoxus unicirostratus	Amphipod
Mysella golischi	Veneroid clam
Donax gouldii	Bean clam
Nemertea spp.	Ribbon worm
Typosyllis armillais	Syllid
Goniada littorea	Goniadid
Lumbrineridae minima	Lumberinerid
Haploscolopolos elongatus	Orbiniid
Spiophanes bornbyx	Spionid
Magelona californica	Magelonid
Mediomagtus californiensis	Capitellid
Euchone limnicola	Feather duster worm
Diastylopis tenuis	Cumacean
Euhaustorius washingtonanus	Amphipod
Phoxocephalidae epistomun	Amphipod
Eptosynapta albicans	Sea cucumber

AVIFAUNA COMMONLY FOUND IN MARINA DEL REY

Species	Common Name
Aechmophorus occidentallis	Western grebe
Podiceps auritus	Horned grebe
Oiduceos caspious	Eared grebe
Phalacrocorax penicillatus	Brants cormorant
Phalacrocorax auritus	Double-crested cormorant
Bucephala clangula	Bufflehead
Oidemia nigra	Common scooter
Melanitta degland	White-winged scooter
Melanitta persicillata	Surf scooter
Larus occidentalis	Western gull
Larus argentatus	Herring gull
Larus canus	Mew gull
Larus heermanni	Heermanns gulls
Larus philadelphia	Bonapartes gull
Larus californicus	California gull
Larus delewarerisis	Ring-rilled gull
Hydroprogne caspia	Caspian tern
Sterna antillarum browni	California least tern
Pelecanus occidentalis Californicus	California brown pelican

B.2 THREATENED AND ENDANGERED SPECIES

A list of threatened, endangered, and candidate species that may occur in the project area provided by the USFWS is given in Table B.2.

B.2.1 California Least Tern

The California least tern migrates from Mexico and Central and South America to coastal south-central California to breed. During their stay in California, the birds forage for fish in the nearshore coastal waters and embayments. Birds typically nest in small colonies. A colony is known to occur at Venice Beach, immediately north of the entrance to the Marina. The nest usually occurs in the open expanse of lightly colored sand or dirt or dried mud next to lagoons or estuaries or on open sandy beaches. The nest generally consists of merely a small depression or scrape in the soil or sand lined with pebbles or sea shell fragments. Nesting usually concludes by mid-August, with post-breeding groups still present into September (USFWS, 1980).

The foraging colony of least terns in the study area has been reported by Atwood and Minsky (1983).

B.2.2 California Brown Pelican

The California brown pelican is a frequent visitor of many coastal harbors and has been observed throughout the year, but is most conspicuous in the fall and winter following the breeding season on Anacapa and Santa Barbara Islands from January to March.

Pelicans use the breakwaters in Southern California extensively as a day-time roost; the breakwater off the Marina does not fit the criterion for night (communal) roost. Day-time roost requirements appear to be areas where birds can see far enough to detect predators and where birds have shelter from wind, waves, and the elements. Night or communal roost are generally surrounded by water, provide protection from the elements, and have the capacity to support hundreds of birds (Jaques & Anderson, 1987).

This species is extremely tolerant of human activity at day-time roost an dis often seen roosting and loafing on breakwaters, piers, buoys, harbors, and wharves. Birds are far less tolerant of any types of disturbances on night roost, however, and are known to quickly fluch from roost at the slightest disturbances.

B.2.3 Western Snowy Plover

The snowy plover is a small shorebird which has twelve subspecies worldwide. The pacific coast population of the western snowy plover (which is listed as threatened) is defined as those individuals that nest adjacent to or near tidal waters, and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays, and estuaries. (The pacific coast population is considered distinct from western snowy plovers that breed in the interior). This subspecies breeds primarily on the coastal beaches from southern Baja California to southern Washington. Sand spits, dune-backed beaches, unvegetated beach strands, open areas around estuaries, and beaches at river mouths are the preferred coastal habitats. Nest sites typically occur in flat, open area with sandy or saline substrates; vegetation and driftwood are usually present.

Snowy plovers forage on invertebrates in wet sand and among surf cast kelp within the intertidal zone, in dry, sandy areas above the high tide, on salt pans, and along the edges of salt marshes and salt ponds.

Snowy plovers occur year-round in coastal California. A population shift probably occurs where migrant, wintering birds augmenting or even replaces resident (breeding and non-breeding) birds in late August.

REFERENCES

Atwood, J.L. and D.E. Minsky, 1983, "Least Tern Foraging Ecology at Three Major California Breeding Colonies," West Birds, 14, 57-72.

Jaques, D.L. and D.W. Anderson, 1987, "Conservation Implications of Habitat use and Behavior of Wintering Brown Pelicans," Unpublished Final Dissemination Program, U.C. Davis, CA.

Soule, Dorothy F. and M. Oguri, 1988, "The Marine Environment of Marina del Rey," Prepared for Dept. of Beaches and Harbors, County of Los Angeles.

USFWS, 1980, "California Least Tern Recovery Plan," U.S. Fish and Wildlife Service, 57pp.

Table B.2 Federally-Listed Threatened, Endangered and Candidate Species Potentially Occurring at the Project Site

Mammals		
Pacific little pocket mouse	Perognathus longimembris pacificus	(E)
Birds		
Bald eagle	Haliaeetus leucocephalus	(E)
Brown pelican	Pelecanus occidentalis	(E)
California least tern	Sterna antillarum browni	(E)
American peregrine falcon	Falco peregrinus anatum	(E)
Artic peregrine falcon	Falco peregrinus tundrius	(T)
Peregrine falcon	Falco peregrinus	(E)
Western snowy plover	Charadrius alexandrinus nivosus	(T)
Coastal California gnatcatcher	Polioptila californica californica	(T)
Fish		
Tidewater goby	Eucyclogobius newberryi	(E)
Unarmored threespine stickleback	Gasterosteus aculeatus williamsoni	(E)
Invertebrates		
El Segundo blue butterfly	Euphilotes battiodes allyni	(E)
Plants		
Salt marsh bird's beak	Cordylanthus maritimus ssp. maritimus	(E)
Swamp sandwort	Arenaria paludicola*	(E)
Gambel's watercress	Rorippa gambellii*	(E)
Proposed Species		
Plants		
Lyon's pentachaeta	Pentachaeta lyonii	(PE)
Candidate Species		
Mammals		
San Diego black-tailed jackrabbit	Lepus californicus bennettii	(2)
Stephens' California vole	Microtus californicus stephensi	(2)
San Diego desert woodrat	Neotoma lepida intermedia	(2)
Southern grasshopper mouse	Onychomys torridus ramona	(2)
San Diego pocket mouse	Perognathus fallax fallax	(2)
Southern marsh harvest mouse	Reithrodontomys megalotis limicola	(2)
Ornate salt marsh shrew	Sorex ornatus saliconicus	(2)
Brush rabbit	Sylvilagus bachmani	(R)
Birds		
Tricolored blackbird	Agelaius tricolor	(2)
San Diego cactus wren	Campylorhynchus bruneicappilus couesi	(2)
California horned lark	Eromophila alpestris actia	(2)
Western least bittern	Ixobrychus exilis hesperis	(2)

Loggerhead shrike	Lanius ludovicianus	(2)
California black rail	Laterallus jamaicensis coterniculus	(2)
Belding's savannah sparrow	Passerculus sandwichensis belding	(2)
White-faced ibis	Plegadis chihi	(2)
Elegant tern	Sterna elegans	(2)

Reptiles

Southwestern pond turtle	Clemmys marmorata pallida	(1)
Coastal western whiptail	Cnemidophorus tigris multiscutatus	(2)
San Bernardino ringneck snake	Diadophis punctatus modestus	(2)
Coastal rosy boa	Lichanura trivirgata rosafusca	(2)
San Diego horned lizard	Phrynosoma coronatum blainvillei	(2)
Coast patch-nosed snake	Salvadora hexalepis virgultea	(2)
Two-striped garter snake	Thamnophis hammondii	(2)

Amphibians

Western spadefoot	Scaphiopus hammondii	(2R)

Fish

Santa Ana sucker	Catastomus santaanae	(2)
Arroyo chub	Gila orcuttii	(2)

Invertebrates

Ca. brackish water snail	Tyronia imitator	(2)
Santa Monica shieldback katydid	Neduba longipennis	(2)
Oblivious tiger beetle	Cicindela latesignata obliviosa	(2)
Bauir Beach tiger beetle	Cicindela hirticollis gravida	(2)
Globose dune beetle	Coelus globosus	(2)
Dohrn's elegant eucnemid beetle	Paleoxenus dohrni	(2)
Lange's El Segundo dune weevil	Onychobaris langei	(2)
Dorothy's El Segundo dune weevil	Trigonscuta dorothea dorothea	(2)
Harbison's dun skipper	Euphyes vestris harbisoni	(2)
Wandering (Salt marsh) skipper	Panoquina errans	(2)
Henne's eucosman moth	Eucosma hennei	(2)
Clouded Tail Copper	Tharsalea arota rubila	(2)
El Segundo flower-loving fly	Rhaphiomidas terminatus terminatus*	(2)
California diplectronan caddisfly	Diplectrona californica	(2)

Plants

Aphanisma	Aphanisma blitoides	(2)
Marsh locoweed	Astragalus pycnostachys var. lanosissimus	(1)
Coastal dunes milk-vetch	Astragalus tener var. titi	(2)
Scalloped moonwort	Botrychium crenulatum	(2)
Palmer's mariposa lily	Calochortus palmeri var. palmeri	(2)
Plummer's mariposa lily	Calochortus plummerae	(2)
Peirson's morning-glory	Calystegia peirsonii	(2)
San Fernando Valley spineflower	Chorizanthe parryi var. fernandina	(1)
Parry's spineflower	Chorizanthe parryi var. parryi	(2)
Blochmann's dudleya	Dudleya blochmannae ssp. blochmannae	(2)
Many-stemmed dudleya	Dudleya multicaulis	(2)
Bright green dudleya	Dudleya virens	(2)
Beach spectaclepod	Dithyrea maritima	(2)

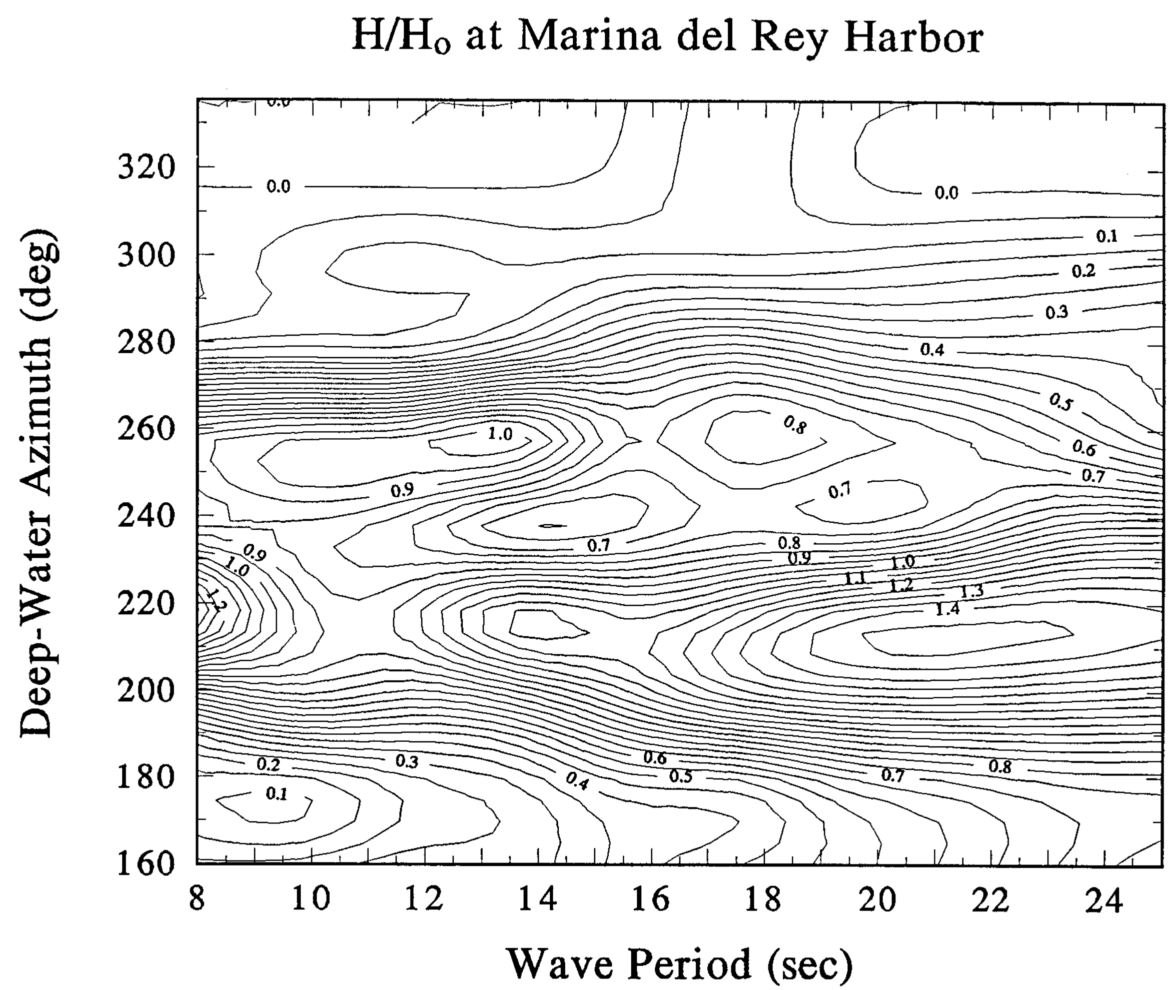

Figure A.1.6.1 Wave Transformation Coefficient at Marina del Rey

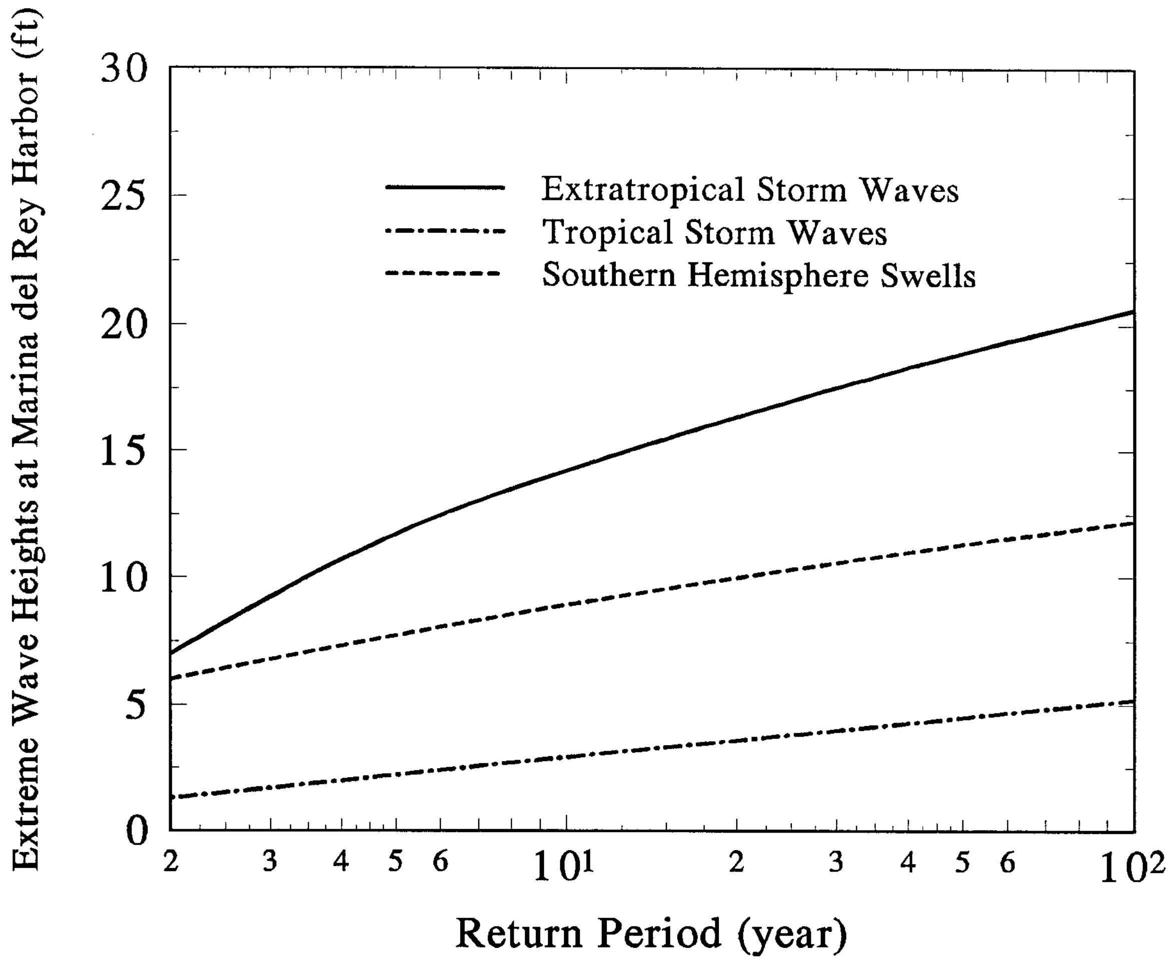

Figure A.1.6.2 Extreme Wave Condition at Marina del Rey

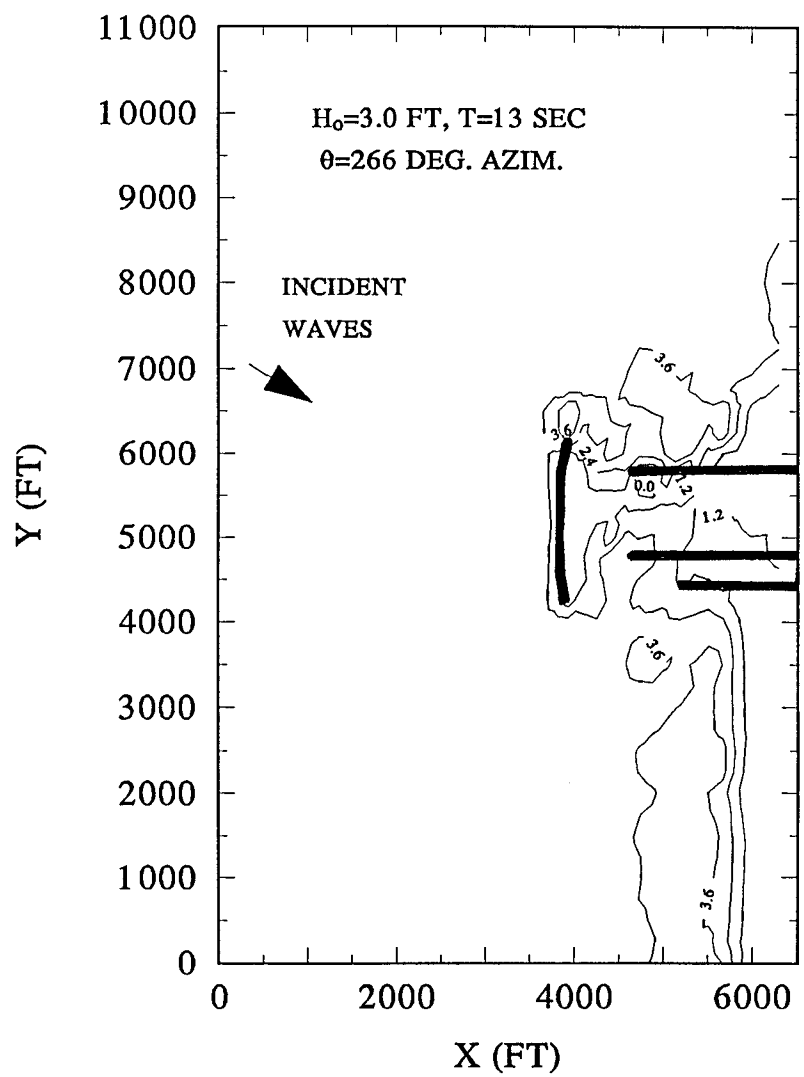

Figure A.1.6.3 Prevailing Wave Condition at Marina del Rey