Region 4

Assessment of Santa Monica Bay Metals

Summary of Proposed Action

Available data were reviewed to determine whether Santa Monica Bay exceeds water quality standards for metals. This analysis was conducted because extensive metals data recently became available. Based on our review of sediment chemistry, sediment toxicity, benthic community structure and fish tissue contamination data we have concluded that the nearshore and offshore areas of Santa Monica Bay are not impaired due to metals and should be not be included on the 303(d) list. This is not intended to make any statements about Palos Verdes shelf which is currently listed for sediment PCBs and DDTs; nor is it intended to make any statements about metals listings in the bays, harbors and estuaries within Santa Monica Bay (*i.e.*, Ballona Lagoon, Ballona Estuary, Marina del Rey, Malibu Lagoon). This document presents a detailed explanation of the rationale for re-assessing metals in Santa Monica Bay, the approach used to evaluate the data, and the results of the re-assessment. Individual fact sheets summarizing the analyses for each of the metals have been prepared and are attached as appendices.

I. Background and Rationale for Reassessment

The 1996 303(d) list identified impairments in Santa Monica Bay associated with six metals (Table 1).

Table 1. Metals listings in Santa Monica Bay from 1996 303(d) list.

Metals	Matrix (basis for listing)
Cadmium	Sediment
Copper	Sediment
Lead	Sediment, Tissue
Mercury	Sediment
Silver	Tissue
Zinc	Sediment

The Regional Board acknowledged that these decisions were based on limited information in the 1996 Water Quality Assessment Documentation, stating that "Due to lack of staff resources at this time, the assessment of nearshore areas, open bays, estuaries, and ocean areas is mostly limited to the review of published reports. Fish consumption advisories and some bioaccumulation data are also used." Santa Monica Bay was not assessed in the 1998 303(d) listing process and the listings for these metals were continued. There was no listing in 2000 and Santa Monica Bay was not assessed by the Regional Board for the 2002 listing. It has been six years since Santa Monica Bay was assessed.

In the case of Santa Monica Bay, the data reviewed in the 1996 Water Quality Assessment was largely limited to the data contained in the Santa Monica Bay Restoration Project Characterization Report (SMBRP, 1993). The data assessed in the Characterization Report generally covers the time period from the late 1970's to the late 1980's. There have been a number of improvements that have occurred since that time that would affect water quality in Santa Monica Bay. There have been significant and substantial reductions in metals loadings to the bay from the two major treatment plants discharging to Santa Monica Bay (Raco-Rands,

1998, 2000). Both plants have also made significant progress to full secondary. The City stopped discharging out the sludge line in 19xx, and both treatment plants have reduced the overall loadings of solids to the system.

Since the time of the last assessment two large regional surveys of the offshore sediment contamination have been performed which provide information that can be used to characterize the sediments in Santa Monica Bay. The first is the Southern California Bight Pilot Project. Data from this project became available for public review in January of 1998. Data from the second regional monitoring project known as Bight '98 project became available in the spring of 2002. Consistent with the federal regulatory requirement at 40 CFR 130.7(b) to consider all existing and readily available data and information, we concluded that it was appropriate to evaluate the data for the 2002 listing decisions.

II. Methodlogy for Re-assessment

All the pertinent and readily available information on Santa Monica Bay were reviewed for ten metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc). The review considered sediment chemistry data and sediment toxicity data from the two regional surveys. We also considered more recent sediment data and fish tissue data collected by the City of Los Angeles as part of the Hyperion Treatment Plant monitoring program. We considered fish tissue data collected in Santa Monica Bay as part of the State's Coastal Sport Fish Contamination Project. Finally we considered the compliance history of the major NPDES discharges into Santa Monica Bay. These data sets are described in Table 2.

Table 2. Summary of Data Reviewed

Data	Data type reviewed	Time span
SCBPP	Sediment chemistry	1994
	Benthic community structure	
	Sediment toxicity	
Bight'98	Sediment chemistry	1998
	Benthic community structure	
	Sediment toxicity	
Hyperion	Sediment chemistry	1999-2000
	Fish tissue	1998-2000
Coastal Fish	Fish tissue	1999-2000
Facility Violation History	Reported Violations	1992-2002
Permit Compliance System	Reported Violations	1997-2002

The applicable water quality standards and objectives for the offshore areas of Santa Monica Bay are from the California Ocean Plan (COP). The COP has been incorporated by reference into the Regional Board Basin Plan. Table B of the COP sets limiting water column concentrations for ten metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc). We know of no data that would indicate that metals concentrations in the water column of Santa Monica Bay are exceeding the water quality standards. Indeed the Regional Board regularly applies ocean background concentrations to Santa Monica Bay when calculating permit limits for wastewater dischargers.

Our evaluation of metals data relies on interpretation of narrative objectives in the COP:

> *"The concentration of substances set forth in Chapter IV, Table B, in marine sediments shall not be increased to levels which would degrade indigenous biota".*
>
> *"Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded"*
>
> *"The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful for human health".*

This analysis applied a two-tiered approach to assess the sediment quality data and fish tissue contaminant data to assess whether the Bay is impaired by metals. TIER 1 describes the situation where the we felt the data were sufficient to determine whether there is clear evidence of impairment with probable adverse effects based on a single line of evidence. TIER 2 describes the situation where single lines of evidence are inadequate to make the assessment and multiple lines of evidence are required to make a determination. TIER 2 addresses the "gray area" where exceedances of guidelines or screening thresholds are less frequent or less extreme. Table 3 provides the assessment criteria for determining whether a constituent would be placed in TIER 1 or TIER 2.

Table 3. Two-tiered screening process for assessing metals impairments in Santa Monica Bay.

Indicator of Impairment	Tier 1	Tier 2
Sediment Quality	>25% samples exceed High SQG or > 25% samples with benthic effects or > 25% samples with sediment toxicity	>10% samples above Low SQG and either >10% of samples with benthic effects or >10% with sediment toxicity
Fish Tissue Contamination	posted consumption advisory OR >50% samples above tissue screening values	>25% samples above tissue screening values

We applied this tiered system to sediment and fish tissue data collected in the offshore areas of Santa Monica Bay using sediment quality guidelines and fish tissue screening levels form the literature as thresholds. In out tiered approach, if a chemical exceeded the thresholds in TIER 1 in either category (sediment quality guidelines or fish tissue screening values), we would determine that there was impairment for that chemical in Santa Monica Bay. If a chemical exceeded the screening criteria in TIER 2 in both categories (sediment quality and fish tissue), we would determine that there was impairment for the chemical in Santa Monica Bay. The determination of impairment under TIER 2 would be based on the weight of

available evidence which indicates applicable water quality standards are being exceeded and that designated beneficial uses may not be fully supported.

A. Sediment Quality Guidelines (SQGs).

High concentrations of chemical contaminants may be related to sediment toxicity and degradation of benthic infaunal communities. The state of California has not adopted sediment guidelines as water quality standards. Nor have there any Federal sediment quality criteria been established. Sediment monitoring programs often use a combination of sediment chemistry, sediment toxicity, and benthic community health in a weight-of-evidence approach to evaluate chemical effects in sediments. This is consistent with the techniques used by the State Board's Bay Protection Toxic Clean up Program, EPA's Environmental Monitoring and Assessment Program and NOAA's National Status and Trends Program.

In this review, we reason that evidence of wide-spread sediment toxicity, wide-spread benthic degradation or wide-spread chemical contamination alone should be sufficient to list sediments as being impaired relative to the narrative standards described above. We use a threshold of 25% as a Tier 1 threshold for listing based on a single leg of the triad (*i.e.*, independent applicability of a narrative standard). For effects below this threshold, we would want use a weight-of-evidence approach. We use a Tier 2 threshold of evidence of impairment (greater than 10% of samples) for at least two legs of the triad.

We use the Benthic Response Index (Smith *et al.*, 2001) to evaluate impacts to benthic community structure and interpret the narrative standard related to degradation of marine communities. This has been used assess condition of coastal waters in Southern California (Bergen *et al.*, 1998, Ranasinghe *et al.*, 2002). We use amphipod toxicity test (USEPA, 1994) to evaluate the toxicity of test sediments relative to control sediments. The amphipod toxicity test is used widely in marine monitoring programs throughout the country.

For contaminant concentrations in sediment, we have chosen to use the values from National Oceanic Atmospheric Association (NOAA) Sediment Quality Reference Tables (September 1999). According to NOAA, these numeric values are "intended for preliminary screening purposes only...to initially identify substances which may threaten resources of concern. [These multiple SQGs]... help portray the entire spectrum of [environmental] concentrations which have been associated with various probabilities of adverse biological effects." We recognize these NOAA values have been derived by associating nationwide sediment chemistry data sets with benthic toxicity results and there is no direct cause and effect relationship. Nonetheless, we have concluded that these values provide reasonable evidence of potential adverse aquatic life effects and therefore apply them as sediment quality guidelines (SQGs) to provide comparison for trace. Low SQGs (*e.g.*, threshold effect levels (TELs) and effects range low (ERLs)) are presumed to be non-toxic levels and pose with a high degree of confidence no potential threat. High SQGs (*e.g.*, probable effects levels (PELs) and effects range median (ERMs)) identify pollutants that are more probably elevated to toxic levels. Adverse effect threshold (AET) values were not used, since these values were derived from site-specific studies in Puget Sound

When a judgment of impairment is to based on solely on sediment chemistry (allowable under Tier 1) we would want there to be a fairly high threshold for predicting effects. We use the higher SQGs to indicate probable impairment (TIER1) since adverse effects are (nearly) always expected when PELs or ERMs are exceeded. For metals in marine sediments the ERMs are always the higher than the PELs. Therefore, our threshold for listing based on chemistry alone is 25% of the samples being greater than the ERM.

We believe a lower threshold is appropriate when there are multiple lines of evidence suggesting impairment. Based upon methods explained by Long, *et al.* (1998), we have opted to use low SQG levels (TELs and ERLs) as protective levels for aquatic life. In that study, the authors determined that if sediment concentrations did not exceed *both* TELs and ERLs then one could reasonably predict non-toxicity in those sediments. We believe it is appropriate to apply these lower threshold values in TIER 2, when evaluating "gray area" data. For metals in marine sediments the ERLs are higher than the TELs. Therefore, our Tier 2 threshold for listing is based on 10% of the samples greater than the ERL where it is supported by either impacts to benthic community structure (defined by BRI) or acute sediment toxicity.

Table 4. Overview of numeric screening values for METALS

	Sediment (ppm)					Tissue (ppm)		
	Salt TEL	Salt ERL	Salt PEL	Salt ERM	Salt AET	EPA (2000)	OEHHA (1999)	MTRL or MIS
As	7.24	8.2	41.6	70	35	1.2	1.0	1.4/1.5
Cd	0.67	1.2	4.2	9.6	3.0	4.0	3.0	0.3/1
Cr	52.3	81	160.4	370	260			1.0
Cu	18.7	34	108	270	390			15
Pb	30.2	46.7	112	218	400			2.0
Hg	0.13	0.15	0.696	0.71	0.41	0.3	0.3	0.37
Ni	15.9	20.9	42.8	51.6	110			220
Ag	0.73	1	1.77	3.7	3.1			
Se					1	20	20	2/0.3
Zn	124	150	271	410	410			45/70

MIS values from Median International Standards from United Nations survey (1983); first value presented for freshwater fish and second for shellfish
MTRL value for Hg from State Mussel Watch (2000)
USFWS value for copper from US Fish & Wildlife (1998)

B. **Fish Tissue Contaminant Concentrations.**

Contaminants in fish tissue have the potential to affect beneficial uses related to the protection of aquatic resources (fish and wildlife) and fish consumption (aquatic life and recreational and commercial fishing).

A waterbody would be listed in Tier 1 if a fish consumption advisory was posted based on analysis of local data or if the median concentration exceeds a screening value. These Tier 1 thresholds are based on EPA's CALM guidance for determining whether water quality standards are being attained. The Tier 2 threshold, of 25% of the samples exceeding a screening value, is based on best professional judgment.

Sport fish and shellfish tissue concentrations were compared to screening values established by EPA or California Office of Environmental Health Hazard Assessment (OEHHA). For chemicals for which neither EPA nor OEHHA have established screening values, we also considered tissue screening values from other sources: maximum tissue residue levels (MTRLs), United Nations Median International Standards (MIS), and wildlife risk values (US Fish and Wildlife, 1998).

Both EPA (2000) and OEHHA (1999) have issued guidance for issuing fish consumption advisories to protect human health via sport fish and shellfish consumption. Tissue screening values were determined for noncarcinogens and some carcinogens using a risk-based approach, assuming a risk level of 1 in 100,000. This risk based approach included assumptions on human body weight, reference dose and daily consumption rates. EPA has evaluated numerous fish consumption surveys and recommended that risk assessments assume consumption values of 17.5 grams per day for the general adult population and recreational fishers and 142.2 grams/day for subsistence fishers (2000). OEHHA assumes recreational fishers consume 21 grams per day. This is the median consumption rate for anglers in Santa Monica Bay (SMBRP, 1994). EPA and OEHHA screening values were available for arsenic, cadmium, mercury and selenium. In general we used the OEHHA screening values as they were at or lower than the EPA screening value. The one exception is for arsenic.

OEHHA developed a screening value for total arsenic of 1.0 ppm based on a human health study for chemical contaminants from two California freshwater lakes (OEHHA, 1999). OEHHA recognizes that the total arsenic screening value is ill-suited for saltwater systems and that inorganic arsenic is the preferred contaminant to evaluate for potential human helath risk (B. Brodberg, pers. comm). The updated EPA guidance (2000b) provides a screening value based on inorganic arsenic. We compare reported total arsenic results to the EPA screening value for inorganic arsenic (1.2 ppm) by assuming that organic arsenic is 10% of the total arsenic in finfish (consistent with FDA estimates). These percentages arise from conclusions in scientific literature (Donohue and Abernathy, 1996; Schoof, *et al.*, 1999).

EPA or OEHHA screening values are unavailable for chromium, copper, lead, selenium and zinc. Median International Standards (MIS) values arise from a survey of international standards and legal limits by Food and Agriculture Organization of United Nations (1983). MIS

standards are available for arsenic, cadmium, chromium, lead, selenium and zinc. MTRLs are calculated by multiplying the applicable water quality objective by a bioconcentration factor specific for each chemical. State Water Board applies MTRLs to fish and shellfish results for Enclosed Bays and Estuaries. An MTRL of 0.37 ppm was calculated for mercury, however it was not used in this review since it was greater than the OEHHA screening value of 0.3 ppm.

To address protection of aquatic wildlife and aquatic dependent species as well as human health, we have reviewed available literature and selected the lowest screening value from several sources. For example, National Academy of Sciences *recommended* maximum concentrations of organic chemicals in animals in freshwater systems (NAS Blue Book 1973). These NAS values were designed to protect aquatic organisms themselves as well as wildlife predators. US Fish and Wildlife (1998) have compiled scientific information to provide guidelines for interpreting biological effects of some chemicals in biota, water and sediment. Lacking any other screening value, a US Fish and Wildlife number of 45 ppm designed for the protection of freshwater fish was used for copper.

III. Assessment Summary

A. Sediment Quality.

1. Benthic Community Structure. The condition of the benthic macroinvertebrate assemblage at these sites was evaluated using the Benthic Response Index (BRI; Smith *et al.*2001). Based on the analysis of fifty-five benthic samples collected in Santa Monica Bay in 1994 as part of the SCBPP (Bergen *et al.*, 1998), approximately 87% of the area in Santa Monica Bay was determined to be in reference condition. Ten percent of the Bay was classified as having marginal deviation from reference and 2% was classified as having some loss in diversity. None of the samples in Santa Monica Bay were characterized as representing a loss in community function.

Twenty-four benthic samples were collected in Santa Monica Bay for Bight'98. The results indicated that 18 sites representing 81% of the area were in reference condition. The other four sites, representing 19% of the area were characterized as having marginal deviation from reference condition.

In summary, based on the results of these two regional surveys, the benthic communities in 98 to 100% of Santa Monica Bay show little to no evidence of disturbance.

2. Sediment Toxicity. In 1994 as part of the SCBPP (Bay *et al.*, 1998) sediment toxicity tests were performed on samples from fifty-five locations using the amphipod, *Ampelisca abdita.* No toxicity was observed in these tests. There was some indication of the potential for sublethal toxic effects from pore-water as evidenced by the Sea urchin fertilization bioassay in 5 out of 17 samples from Santa Monica Bay.

In 1998 sediment toxicity tests (Bay *et al.*, 2000) were performed on sediment samples from twenty-three locations in Santa Monica Bay using the amphipod, *Eohaustorius estuaries.* No toxicity was observed in these tests. There was no toxicity demonstrated by the HRGS which

measures response to organic compounds (PAHs, PCBs). As in 1994, there was some indication of toxic response in the area around the Hyperion outfall using the QwikSed test (3 out of 9 samples measured) which measures the response in bioluminescence from a dinoflaggelate exposed to sediment elutriate.

Table 5. Summary of sediment toxicity data from Regional Surveys (Bay *et al.*, 1998, 2000)

Study	Matrix	Test/Species	End-point	Response
SCBPP	Sediment	Amphipod	Acute toxicity	0/55
	Pore-water	Sea urchin	Fertilization	5/17
Bight'98	Sediment	Amphipod	Acute toxicity	0/23
	Pore-water	HRGS/Cell line	Bioluminescence	0/23
	Sediment Elutriate	Dinoflaggelate	Bioluminescence	3/9

Based on the results of the two regional surveys, the sediments from Santa Monica Bay do not exhibit toxicity using the whole-sediment toxicity tests. There were some responses observed in chronic toxicity tests such as the pore-water sea urchin fertilization test in 1994 and the QwikSed bioluminescence tests in 1998. However, there were relatively few samples analyzed and there did not appear to be any relationship between these responses and chemical concentrations in the sediments. We conclude that there is very little evidence to suggest that sediment toxicity in Santa Monica Bay is leading to impairments of beneficial use.

3. Sediment Chemistry. Chemical analyses were performed on sediments from Santa Monica Bay as part of the two regional surveys at the same locations that were analyzed for benthic community structure and sediment toxicity in 1994 (n=55) and 1998 (n=23). These data are summarized in Table 6. The Tier 1 threshold for sediments was 25% greater than ER-M. With the exception of silver the average concentrations for each of the metals analyzed was at or below the ERLs and well below the ERMs. The average silver concentration was above the ERL of 1 ppm. In 1998, 26% of the samples (6 out of 23 samples) were above the ERM of 3.7 ppm.

Table 6. Summary of Sediment Chemistry concentrations (ppm) in Santa Monica Bay from SCBPP and Bight'98 (Schiff and Gosset, 1998, Noblet *et al.*, 2002)

Metal	Mean and area weighted mean (n = 55)	% of samples greater than the ERL	% of samples greater than the ERM	Mean and area weighted mean (n = 23)	% of samples greater than the ERL	% of samples greater than the ERM
As	6 (5.6)	7%	0%	7 (6.9)	35%	0%
Cd	.1 (0.66)	9%	0%	0.77 (0.72)	17%	0%
Cr	97 (85)	45%	0%	47 (45)	4%	0%
Cu	37 (30)	44%	0%	18 (12)	13%	0%
Pb	25 (22)	7%	0%	36 (40)	22%	0%
Hg	0.18 (0.14)	45%	0%	0.17 (0.16)	48%	0%
Ni	22 (24)	40%	2%	18 (20)	30%	0%
Ag	2.24 (1.58)	71%	13%	2.42 (2.06)	65%	26%
Zn	86 (84)	7%	0%	61 (61)	0%	0%

The City of Los Angeles has been using an EMAP-type design to characterize conditions around the outfall and in the greater Santa Monica Bay. These data

provide more recent data for evaluating the extent and magnitude of metal contamination in Santa Monica Bay. We evaluated the data collected during the summers of 1999 and 2000. These data indicate that sediment contamination is relatively low. The exception here is silver, where the detection limit of 2 ppm was greater than the ERL. Silver was detected in 39 out of 101 samples. Only 11% of the samples were greater than the ERM of 3.7 ppm.

Table 7. Summary of Sediment Chemistry concentrations (ppm) in Santa Monica Bay from Hyperion Treatment Plant NPDES monitoring program 1999 and 2000 (n=101)

Metal	Average	%>ER-L	%>ER-M
As	5.9	13	0
Cd	0.6	8	1
Cr	57.8	13	1
Cu	44.5	25	2
Pb	15.8	10	0
Hg	-	46	3
Ni	327	37	2
Ag	-	39*	11
Zn	105.2	3	1

4. Conclusions from sediment data. There is very little evidence of benthic community disturbance in Santa Monica Bay and no evidence of acute toxicity in the sediments from Santa Monica Bay. With the exception of silver all samples were below the ERM values. The regional data is consistent with more recent data targeted around the Hyperion outfall. Only a few measurements were above the ERM. The majority of samples were at or below the ERL value. The only exception was silver which was frequently above the ERL value of 1 ppm and in 1998 the number of samples greater than the ERM was 26% exceeding the Tier 1 threshold for that year. Taking the entire dataset as a whole, the silver values fall below the Tier 1 threshold.

B. Fish Tissue Data.

There are no metals-based fish advisories for the waters off Santa Monica Bay. OEHHA evaluated fish from twenty four locations in Southern California including Santa Monica Pier, Venice Pier, Venice Beach, Marina del Rey and Redondo Beach and determined that no restrictions on consumption due to chemicals was necessary. Due to elevated concentrations of PCBs and DDTs advisories have been issued for several locations in Santa Monica Bay.

To assess potential for metals impacts, we evaluated fish tissue data from two sources (Table 2). The first is the City of Los Angeles NPDES monitoring program for the Hyperion Treatment Plant. The City performs tissue analyses on fish caught from rig and line at various locations within Santa Monica Bay and tissue analyses on muscle and liver tissue from trawl-caught fish. These data which were provided by the City of Los Angeles Environmental Monitoring Division are summarized in Tables 8 and 9 below. The second source of data was from the Coastal Sport Fish Contamination Study. These data were provided by OEHHA and are summarized in Table 10.

The data were compared to the lowest applicable screening values listed in Table 4. Cadmium, mercury, and lead the values were compared to OEHHA screening levels. Arsenic was compared to the EPA screening value. Chromium, lead, and zinc the values were compared to MTRLs. Copper values were compared to the USFWS value. There were no screening values for nickel or silver.

The City's rig-fish data set contains information on metals concentrations from 154 fish representing 16 different species collected between 1988 and 2000 (Table 8). Based on the results from 1998 to 2000, concentrations of in metals in rig-fish were well below applicable screening values.

Table 8. Summary of fish tissue concentrations (ppm ww) from Rig-fish in Santa Monica Bay from Hyperion Treatment Plant NPDES monitoring program between 1998 and 2000 (n=154)

Metal	Number of detects	Average	SD	Median	90th percentile
Ag	10	0.04	0.05	0.03	0.05
As	130	1.74	1.65	1.15	3.50
Cd	30	0.06	0.02	0.06	0.09
Cr	51	0.30	0.41	0.15	0.54
Cu	36	0.72	0.98	0.39	1.00
Hg	147	0.27	0.21	0.20	0.55
Ni	16	0.42	0.39	0.31	0.63
Pb	49	0.64	1.63	0.39	0.67
Se	70	0.45	0.18	0.44	0.68
Zn	153	3.15	0.65	3.10	4.00

We evaluated five years of muscle tissue data for the Hornyhead turbot (Table 9). These fish were chosen because flatfish live in close proximity to the sediment and they provide a good time-series for assessing trends. Average concentrations were well below the applicable screening values.

Table 9. Average fish tissue concentrations (ppm ww) in Hornyhead turbot from Santa Monica Bay (from Hyperion Plant NPDES monitoring program)

	1995-96 Ave	1997-98 Ave	1999 Ave	2000 Ave
Ag	0.009	0.016	0.008	0.009
As	4.07	3.40	4.28	5.98
Cd	0.07	0.05	0.06	nd
Cr	0.06	0.04	0.12	0.103
Cu	0.18	0.15	0.20	0.21
Hg	0.068	0.171	0.053	0.089
Ni	0.06	0.07	0.09	0.10
Pb	0.15	0.29	0.62	0.31
Zn	2.75	3.38	2.81	2.83

The preliminary results from the California Coastal Sport Fish Contamination Survey were provided for this assessment by the SWRCB and OEHHA. The number of fish from Santa Monica Bay is fairly limited. In the first two years of the program we have data for a total of six fish species from three areas. The total number of fish collected was 45 (nine composites of

around 5 fish per composite). These fish were analyzed for a limited set of metals (As, Cd, Hg, and Se) that reflect concern. Concentrations were well below the human health based thresholds.

Table 10. Summary of fish tissue concentration data (ppm ww) from California Coastal Sport Fish Contamination Study

Location	Year	SPECIES NAME	SKIN	#	As	Cd	Hg	Se
Party Boat to Malibu Kelp Beds	1999	Pacific Sanddab	On	4	5.09	0.005	0.12	0.34
Party Boat to Malibu Kelp Beds	1999	Splitnose Rockfish	Off	5	1.54	0.003	0.67	0.48
Santa Monica Pier	1999	California Corbina	Off	5	0.55	0.002	0.03	0.35
Santa Monica Pier	2000	Barred Surfperch	Off	6	0.95	0.002	0.04	0.40
Santa Monica Pier	2000	Queenfish	On	5	0.85	0.009	0.08	0.37
Venice Pier	1999	California Corbina	Off	5	0.58	0.001	0.03	0.30
Venice Pier	2000	Queenfish	On	5	0.39	0.002	0.09	0.27
Venice Pier	2000	Walleye Surfperch	On	5	0.75	0.002	0.03	0.30
Venice Pier	2000	White Croaker	Off	5	0.76	0.002	0.05	0.39

Conclusions from Fish Data. Fish tissue concentrations were generally below the lowest screening thresholds available. Total arsenic measures were in some cases above the threshold for organic arsenic. When adjusted the values were well below concentrations of concern. When compared to MIS or FWS concentrations of the remaining metals Cr, Cu, Pb and Zn were well below the thresholds. There was no threshold for silver or nickel concentrations in fish.

The concentrations of metals in fish from Santa Monica Bay are similar to those found elsewhere in the Southern California Bight (as summarized in NOAA, 1991). Based on these data there is no evidence that fish in Santa Monica Bay are affected by metals. This is consistent with the findings in the Santa Monica Bay Characterization Report which indicated that metals concentrations in fish from Santa Monica Bay were low.

C. Facilities compliance. There have been significant reductions in metals loadings to Santa Monica Bay since the late 1970's (Raco-Rands, 2000) and continue through the present time as a result of improved pretreatment and progress towards secondary treatment at Hyperion and the LACSD Joint Plant. The monitoring programs of the two wastewater discharges have demonstrated that these improvements have resulted in changes in sediment contaminant concentrations around the outfalls and presumably throughout Santa Monica Bay. In this section, we review facilities compliance history of the six major dischargers, provide information on the relative mass emissions from each of the discharges, and describe measures in place to regulate mass emissions to Santa Monica Bay from point source to at or near current levels.

Two databases were reviewed to evaluate facility compliance from the major dischargers. The first was the Regional Board's Facility Violation History data base. This data base was queried for reported violations from 1992-2002 from the six major NPDES discharges to Santa Monica Bay. There where three reported violations in the database that were related to metals. The first was a simply a reporting violation in the AES plant. The two at the El Segundo power plant occurred were related to iron concentrations on a single day (3/20/00). Regional Board

staff later determined that these were not violations and rescinded the notice of violation on 12/10/01. We had data for PCS from three plants Hyperion, LACSD, and El Segundo Refinery. These data confirm that there were no violations for metals for these dischargers related to metals at these three plants.

Table 11. Summary of facilities compliance data

Facility	Reported Metals Violations 1992-2002	Reported Metals Violation (PCS) 1997-2002
Hyperion Wastewater Treatment Plant	0	0
LA County Sanitation District Joint Plant	0	0
Chevron – El Segundo Refinery	0	0
AES Redondo Beach Generating Station	1	-
El Segundo Power Generating Station	2	-
LADPW Scattergood Generating Station	0	-

We also evaluated mass emissions from the six major NPDES dischargers to Santa Monica Bay. Data from two SCCWRP reports (Raco-Rands, 1996, 1998) provided mass emissions data for the six major NPDES discharges to Santa Monica Bay. The two wastewater treatment plants provide the largest loadings to the Bay. Loadings from the El Segundo Refinery were at least one order of magnitude lower for all metals. Data on mass emissions from the three generating stations (Scattergood , El Segundo and Redondo) were too limited to make reasonable estimates of mass emissions. However based on data that were available and comparison with other power generating stations the mass of metals is small. The only exception was for mercury where the combined waste and cooling water were estimated to contribute 125 Kg/yr to Santa Monica Bay.

Table 12. Mass emissions (Kg/yr) from 3 dischargers into Santa Monica Bay for 1995

	Hyperion	LACSD	El Segundo Refinery
As	2,700	1,400	224
Cd	600	100	4.3
Cu	19,000	10,000	21
Cr	1,600	3,800	32
Pb	600	-	15
Hg	12	-	-
Ni	8,000	16,000	134
Se	200	6,900	625
Ag	2,500	2,300	0.4
Zn	27,000	35,000	161

Both LACSD and Hyperion have performance goals for metals to ensure that concentratons are kept at or close to existing levels. The permits for both plants also have mass emission caps for four metals (*i.e.*, copper, lead, silver and zinc) to keep loadings to the Bay at or near the existing loadings.

IV. Summary and Recommendations

In 1994, one conclusion of the SCBPP was that concentrations of metals were higher in Santa Monica Bay sediments than the rest of the offshore sediments in the Bight. Our assessment

indicates that concentrations are currently low relative to thresholds for fish and tissue concentration and there is little evidence of contaminant concentrations affecting beneficial uses in Santa Monica Bay. None of the metals exceeded the Tier 1 or Tier 2 thresholds for demonstrating exceedances of water quality objectives. We believe that concentrations of metals to the Bay will continue to improve over time as a result of recent improvements to the wastewater treatment plants and that existing regulatory mechanisms such as performance goals and mass emission caps are sufficient to ensure continued compliance with water quality standards and objectives. Therefore, we conclude that the Santa Monica Bay is not impaired as a result of metals contamination.

V. References

Bay Protection Toxic Cleanup Program (report date May 1997) *Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries* SWRCB, EPA, NOAA, Calif. F&G, UC-Santa Cruz, Moss Landing Labs, Columbia Analytical Services, data from 1994 &1996.

Bay, S.M., D.J. Greenstein, A.W. Jirik, and J.S. Brown. 1998. Southern California Bight 1994 Pilot Project: VI. Sediment Toxicity. Southern California Coastal Water Research Project, Westminster, CA.

Bay, S.M., D. Lapota, J. Anderson, J. Armstron, T. Mikel, A.W. Jirik, and S. Asato. 2000. Southern California Bight 1998 Monitoring Program: IV. Sediment Toxicity. Southern California Coastal Water Research Project, Westminster, CA.

Bergen, M., S.B. Weisberg, D. Cadien, A. Dalkey, D. Montagne, R.W. Smith, J.K. Stull, and R.G. Velarde. 1998. Southern California Bight 1994 Pilot Project: IV. Benthic Infauna. Southern California Coastal Water Research Project, Westminster, CA.

Coastal Sport Fish Contamination Study, unpublished data. (2001) State Water Resources Control Board and OEHHA database. R.K. Brodberg, Office of Environmental Health Hazard Assessment, Calif. EPA, Sacramento, Calif.

Donohue, JM and CO Abernathy. 1996 *Exposure to Inorganic Arsenic (As) from Fish and Shellfish.* Proceedings of International Arsenic conf.

Francesconi, KA and JS Edmonds. 1994. *Biotransformations of Arsenic in the Marine Environment.* in Arsenic in the Environment, Part 1: Cycling and Characterization. J.O. Nriagu, editor. pp. 221-262.

City of Los Angeles, 1996. Santa Monica Bay Biennial Assessment Report 1995-96. Environmental Monitoring Division, City of Los Angeles, Department of Public Works, Bureau of Sanitation

City of Los Angeles, 1999. Marine monitoring in Santa Monica Bay, Annual assessment report for the period of January 1997 – December 1998. Environmental Monitoring Division, City of Los Angeles, Department of Public Works, Bureau of Sanitation

City of Los Angeles, 2001. Marine monitoring in Santa Monica Bay, Biennial Assessment Report for the period January 1999 - December 2000. Environmental Monitoring Division, City of Los Angeles, Department of Public Works, Bureau of Sanitation

Ingersoll, CG and DD MacDonald, N. Wang, JL Crane, LJ Field, PS Haverland, NE Kembe, RA Lindskoog, C Severn, DE Smorong. 2000. *Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines.* USGS Final report for USEPA Great Lakes National Program Office. EPA 905/R-00/007

Long, ER; LJ Field; DD MacDonald. 1998. *Predicting Toxicity in Marine Sediments with Numerical Sediment Quality Guidelines*, Environ. Tox. Chem. Vol. 17, No. 4, pp. 714-727.

NAS. 1973. Water Quality Criteria (Blue Book) prepared by the National Academy of Science for the US Environmental Protection Agency Ecological Research Series EPA-R3-73-033.

Neff, J.M. 1997. Ecotoxicology of arsenic in the marine environment. Environ. Tox. Chem. 17:917-927.

NOAA. 1991. Contaminant trends in the Southern California Bight: Inventory and assessment. NOAA Tech. Mem. NOS ORCA 62. National Oceanographic and Atmospheric Administration, Seattle WA.

NOAA .1999. Screening Quick Reference Tables. National Oceanic and Atmospheric Administration, Coastal Protection and Restoration Division, Washington D.C.

Noblet, J. 2002. Unpublished data from Southern California Bight 1998 Monitoring Program: III. Sediment Chemistry. Southern California Coastal Water Research Project, Westminster, CA.

OEHHA. 1999. *Prevalence of Selected Target Chemical Contaminants in Sport Fish from Two Californa Lakes*: Public Health Designed Screening Study. June 1999, R.K. Brodberg, and G.A. Pollack, Pesticide and Environ. Toxic. Sctn, Office of Environmental Health Hazard Assessment, Calif. EPA, Sacramento, Calif.

Ranasinghe. J. A., D. Montagne, R.W. Smith, T.K. Mikel, S.B. Weisberg, D.B. Cadien, R.G. Velarde and A. Dalkey. 2002. Southern California Bight 1998 Regional Monitoring Program: VII. Benthic Macrofauna. Southern California Coastal Water Research Project. Westminster, CA.

RWQCB4, 1996. Water Quality Assessment and Documentation (1996). California Regional Water Quality Control Board, Los Angeles Region, California Environmental Protection Agency, Los Angeles, CA.

RWQCB4, 1998. Public Notice Biennial listing of impaired surface waters pursuant to the Clean Water Act, Sectin 303(d). Memo dated March 24, 1998. California Regional Water Quality Control Board, Los Angeles Region, California Environmental Protection Agency, Los Angeles, CA.

Schiff, K.C. and R.W. Gossett. 1998. Southern California Bight 1994 Pilot Project: III. Sediment Chemistry. Southern California Coastal Water Research Project. Westminster, CA.

Schoof, RA, and LJ Yost, J Eickhoff, EA Crecilius, DW Cragin, DM Meacher, and DB Menzel. (1999) *A Market Basket Survey of Inorganic Arsenic in Food.* Food and Chem. Toxic. 37: 839-846.

SMBRP. 1993. Santa Monica Bay Characterization Study, 1993. Prepared by MBC Applied Environmental Sciences for the Santa Monica Bay Restoration Project, Monterey Park, CA.

SMBRP. 1995. Santa Monica Bay seafood consumption study. Prepared for the Santa Monica Bay Restoration Project, Monterey Park, CA by Southern California Coastal Water Research Project, Westminster, CA and MBC Applied Environmental Sciences, Costa Mesa CA.

Smith, R.W., M. Bergen, S.B. Weisberg, D. Cadien, A. Dalkey, D. Montagne, J.K. Stull and R.G. Velarde. Benthic response index for assessing infaunal communities on the Southern California shelf. Ecological Applications, 11:1073-1087.

Smith, SL; DD MacDonald; DA Kennleyside; CG Ingersoll and LJ Field. (1996) *A Preliminary Evaluation of Sediment Quality Assessment Values for Freshwater Ecosystems.* J Great Lakes Res. 22(3): 624—638.

SMW. 2000. State Mussel Watch Program 1983-00 Data Base and 1995-97 Data Report. State Water Resources Control Board, California Environmental Protection Agency. Sacramento, CA.

Raco-Rands, V. 1996. Characteristics of large municipal wastewater treatment facilities in 1995. pp. 3-16. In S.B. Weisberg, C. Francisco, and D. Hallock (eds.), Southern California Coastal Water Research Project Annual Report 1996. Westminster, CA.

Raco-Rands, V. 1996. Characteristics of effluents from power generating stations in 1995. pp. 32-43. In S.B. Weisberg, C. Francisco, and D. Hallock (eds.), Southern California Coastal Water Research Project Annual Report 1996. Westminster, CA.

Raco-Rands, V. 1998. Characteristics of effluents from nonpower industrial facilities in 1995. pp. 18-30 In S.B. Weisberg and D. Hallock (eds.), Southern California Coastal Water Research Project Annual Report 1997-1998. Westminster, CA.

Raco-Rands, V. 2000. Characteristics of effluents from large municipal wastewater treatment facilities 1997. pp. 28-44, In S.B. Weisberg and D. Elmore (eds.), Southern California Coastal Water Research Project Annual Report 1999-2000. Westminster, CA.

US Fish & Wildlife Service (1998) Guidelines for Interpretation of the Biological Effect of Selected Constituents in Biota, Water, and Sediment. US Department of Interior report.

USEPA. 1994. Method for assessing toxicity of sediment-associated contaminants with estuarine and marine amphipods. Office of Research and Development, Duluth, MN. EPA-600-R-94-025.

USEPA. 1997. Guidance for Preparation of the Comprehensive State Water Quality Assessment (305(B Reports) and Electronic Updates (Supplement). EPA-841-B-97-002B. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Consumption Advisories, Vol. 1: Fish Sampling and Analysis, 3rd ed. EPA-823-B-00-007. U.S. Environmental Protection Agency, Office of Water, Wash. DC.

USEPA. 2001. DRAFT Equilibrium Partitioning Sediment Guidelines for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver and Zinc) March 2001. U.S. Environmental Protection Agency, Office of Water, Wash. DC.

USEPA. 2002. Consolidated Assessment and Listing Methodology. Toward a Compdendium of Best Practices. First Edition (July 2002). U.S. Environmental Protection Agency, Office of Water, Wash. DC.

USFWS. 1998. Guidelines for interpretation of the biological effect of selected constituents in biota, water, and sediment. US Fish and Wildlife Service, Department of Interior Report.

Appendix A. Individual Fact-Sheets