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Anaheim Bay and Huntington Harbour Sediment and Water Column Toxicity Study

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Surface Water Ambient Monitoring Program Report: Anaheim Bay and Huntington Harbour Sediment and Water Column Toxicity Study



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I. Introduction

In 1991, Anaheim Bay and Huntington Harbor were listed on the Clean Water Act Section 303 (d) List of Impaired Waters due to metals toxicity and other similar pollutants. The 303 (d) listing was based on limited data; therefore, Santa Ana Regional Board staff determined that additional data was needed to confirm the appropriateness of the 303 (d) Listing for Anaheim Bay and Huntington Harbor and to determine the source or sources of impairment.

In 2000, the California Legislature passed Assembly Bill 982 to create the Surface Water Ambient Monitoring Program (SWAMP) as a statewide monitoring effort aiming to assess the conditions of surface waters throughout the State of California. The California Water Code was amended to include specific SWAMP requirements (Section 13192), and funding was provided to the Regional Boards to carry out the ambient water quality assessments. Fiscal year (FY) 2001-02 marked the first year of the coordinated implementation of the Surface Water Ambient Monitoring Program (SWAMP). Since ambient water quality data for Anaheim Bay/Huntington Harbour was very limited, the Santa Ana Region's SWAMP allocation was targeted for conducting ambient water quality assessment in Anaheim Bay and Huntington Harbor. The purpose of this report is to summarize the results of the Anaheim Bay/Huntington Harbor ambient water quality monitoring study.

II. Setting

As shown in Figure 1, the Anaheim Bay/Huntington Harbor Complex is located on the northern edge of the Orange County Coast, approximately 20 miles southeast of Los Angeles and consists of the outer Anaheim Bay and the inner Huntington Harbour. The Anaheim Bay/Huntington Harbour complex receives a multitude of potentially degrading pollutants, such as heavy metals and organic chemicals from a variety of sources. These sources include boats and boating related activities, storm water/urban runoff, atmospheric deposition, agricultural runoff, and legacy pollutants from historical inputs. Pollutants from these sources could result in impairment of beneficial uses of either or both Anaheim Bay and Huntington Harbour which include contact and non-contact recreation, navigation, biological habitat of special significance, wildlife habitat, rare, threatened or endangered species habitat, fish spawning, and marine habitat.

The U.S. Navy controls access to Anaheim Bay and Huntington Harbour through the outer bay, which serves as the main entrance to the U.S. Naval Weapons Station, Seal Beach. The Navy also operates and manages the National Wildlife Refuge, located on their property. The area surrounding Huntington Harbor is predominantly residential with small boat marina activity. Huntington Harbor receives limited tidal flushing due to the 600 foot wide shipping channel connecting the outer and inner bays and the constriction at the Pacific Coast Highway Bridge. Another hydrologic connection to Huntington Harbour is Bolsa Bay. Bolsa Bay is further divided into Inner and Outer Bolsa Bay. Outer Bolsa Bay is directly connected to Huntington Harbor, which is the only area fully open to tidal influence. Inner Bolsa Bay, on the other hand has a controlled tidal regime (through the use of flood gates to Outer Bolsa Bay) which fluctuates plus or minus two feet around mean sea level.

Two major storm channels enter the Anaheim Bay/Huntington Harbor Complex that collect runoff from portions of urbanized areas in the cities of Anaheim, Stanton, Cypress, Orange, Santa Ana, Garden Grove, Westminster, Fountain Valley, Los Alamitos, Seal Beach, and Huntington Beach. These storm channels are the Bolsa Chica Flood Control Channel which enters lower Huntington Harbor, and the East Garden Grove Wintersburg Flood Control Channel which enters Outer Bolsa Bay. These channels, as well as their tributaries, convey runoff from approximately 90 square miles of watershed that drain the northern portion of the heavily urbanized Orange County into Huntington Harbor. Inputs of storm water and urban nuisance flows via these channels are potentially significant sources of pollutants loadings.

III. Historical Data

Anaheim Bay was listed in the 1991 Clean Water Act Section 303(d) of Impaired Waterbodies for toxic metals, and pesticides, while the adjoining Huntington Harbor was listed for bacteria, toxic metals, and sedimentation. The listing of metals and pesticides for these two water bodies was based on the Statewide Mussel Watch data collected prior to 1991. The Mussel Watch data indicated that mussel tissue from mussels placed in Anaheim Bay over a period of time showed levels of lead, cadmium, selenium, DDT, chlorobenzenes, and lindane above elevated data levels (EDL). The Mussel Watch data for Huntington Harbor showed elevated levels of lead, chromium, aldrin, chlordane, DDE, DDT, endrin, and heptachlor with respect to the EDL. It is important to note that EDLs are a comparative measure used by the State Water Resources Control Board (State Board) to rank a given concentration of a particular substance with previous Mussel Watch data. The EDL for a specific pollutant is calculated by ranking all of the pollutant results from highest concentration to non-detect for the various species and exposure conditions (resident or transplant). From this, a cumulative distribution is constructed and percentile rankings are calculated. The EDL is not directly related to potentially adverse human or animal health effects and should not be used in determining impairment of a water body's beneficial use. The EDL is only a way to compare data in a particular area with the larger database that includes the data from the rest of the state. Consequently, the need to conduct a thorough study of Anaheim Bay and Huntington Harbor to determine if the toxics that were identified as exceeding the 95th EDL are, in fact, impacting beneficial uses.

IV. Study Design

In the past, monitoring programs used to prepare the water quality assessments have used sampling and analytical protocols that did not address large-scale questions on the status of the entire water body. Some of these large-scale questions involve defining the number of acres, or percent of acreage of that water body that meets a water quality objective (regulatory threshold). An appropriate monitoring program design to determine the percent area meeting a threshold has been used in offshore and other bay/harbor monitoring programs in Southern California. This monitoring design is a stratified-random sampling design with a spatially systematic component that prevents the clustering of sampling sites. Sample sites are allocated throughout the water body of interest resulting in an unbiased representation of water quality. Stratification within the water body allows for comparisons of one sub-region (sub-population or stratum) to another. In order to evaluate the extent of impairment to Anaheim Bay and Huntington Harbour, the stratified-random study design was chosen for the assessment of ambient water quality. Two strata were identified for the study – Anaheim Bay and Huntington Harbor, and were chosen because it is suspected that the water quality in Anaheim Bay is different than the water quality in Huntington Harbour. For example, the bay is subject to more tidal influences, and better flushing and mixing than the harbor.

This monitoring study consisted of sampling 60 sites in the Anaheim Bay/Huntington Harbor Complex (30 sites per stratum). As stated above, the sampling sites were selected using stratified-random sampling design with a spatially systematic component. Statistician staff at the Southern California Coastal Water Research Project developed the stratified random sampling design that was utilized. Sample analyses at the 60 sites consisted of water column chemistry and toxicity, sediment chemistry and toxicity, and benthic invertebrate community analysis.

The overall goal of the study was to attain a comprehensive and current assessment of the ambient water and sediment quality in Anaheim Bay/Huntington Harbor Complex and to establish baseline conditions. Specific study objectives were as follows:

- Define the extent (percent of area) and magnitude of deviation from water quality criteria and sediment thresholds.
- Describe and depict spatial gradients of contaminants
- Determine seasonal relationships (i.e. dry vs. wet seasons)

- Assess the relationship between biological responses and contaminant exposure
- Compare Anaheim Bay with the bays sampled by the Bight '98 Monitoring Program

Sampling took place in August 2001 in both of these water bodies and in February 2003 in Huntington Harbour and April 2003 in Anaheim Bay. These sampling periods were chosen to represent ambient water quality during both the wet and dry seasons. Further, sampling in February and April allowed for the evaluation of ambient water quality in the wet season after storm events occurred. The sampling dates for February and April were chosen so that it did not coincide with a storm event, or immediately after a storm event so that the data will represent a period of time when the indicators are expected to remain stable (ambient water quality).

V. Methods

Thirty samples from Anaheim Bay and thirty samples from Huntington Harbor were collected during the dry (August 2001) and wet seasons (February/April 2003) respectively. These samples included sediment chemistry, surface water column chemistry, and benthic infauna. The following describes the sample analyses.

Sample collection and analyses were performed in accordance with the Southern California Bight 98 Quality Assurance Project Plan developed by the Southern California Coastal Water Research Project.

- **Water Column Measurements**

At each sample location, field measurements were taken using a CTD multi-parameter probe to measure pH, dissolved oxygen, temperature, salinity, bottom depth, turbidity, and total suspended solids.

- **Sediment Chemistry**

Sediment samples were collected from the top 2 cm using a 0.1 m² modified Van Veen grab sampler. A list of the constituents analyzed and their detection limits may be found on Appendix 4. In order to determine possible anthropogenic influence of trace metals, the results were normalized to iron and to grain size; the trace organics were normalized to total organic carbon (TOC) and to grain size. Normalizing the organics to TOC assists in the interpretation of sediment quality impacts on biota. The metals were analyzed using EPA Method 6020 (ICP-MS); the chlorinated hydrocarbons and the polyaromatic hydrocarbons were analyzed using EPA method 8270 (GC-MS).

The sediment chemistry data was evaluated by comparing the individual chemicals to the corresponding sediment quality guidelines (SQG), the Effects Range Low (ERL) and Effects Range Median (ERM) concentrations (Long and MacDonald, 1998). Comparison of sediment quality with ERLs and ERMs provide a method to evaluate the possibility that sediment concentrations of the individual constituents could be toxic to amphipods. Concentrations below the ERL are rarely (<11%) associated with adverse effects, concentrations between the ERL and ERM are occasionally (16-18%) associated with adverse effects, and concentrations above the ERM are frequently (48-52%) associated with amphipod toxicity. These guidelines were derived from a large national database of concentrations that have been previously associated with biological effects, and are currently the most widely used and accepted sediment effects-guidelines available. For each sample location, if a chemical concentration exceeded the ERM, it was considered to have the potential for causing toxic effects.

Since chemical mixtures may have synergistic effects on biota, the sediment quality data was also evaluated using a SQG quotient that is calculated by dividing the nine chemical concentrations found in the sediment by its respective SQG and then averaging the resulting nine quotients. The SQG

quotient is a measure that represents chemical mixtures within each unique sediment sample that incorporates both the magnitude and number of SQG exceeded (Fairey et al., 2001) SQG quotients (SQGQ1) were calculated for each station in Anaheim Bay and Huntington Harbor in accordance with Fairey *et al.* (2001). For each sample location, only contaminants exceeding ERMs or quotients exceeding SQGQ1 threshold values were considered as having the potential for toxic effects. The SQGQ1 thresholds published in Fairey *et al.* (2001) are listed on Table 1 and were used to evaluate the data from this study. The SQGQ1 values reflect the mean concentrations of the nine selected chemicals for each station and each value represents the likelihood that toxicity associated with a chemical compound will be present at that station.

SQGQ1 Value	Amphipod Survival (%)	Risk Level*
0.00 – 0.10	100	Low
0.11-0.25	83	Low
0.26 -0.50	76	Low
0.51 -0.75	76	Low
0.76 -1.00	70	Moderate

Modified from Fairey et al. (2001)
 *Risk level not in Fairey et al. (2001). Based on Armstrong (pers. Comm.).

There are other published SQGs in the scientific literature that can be used to compare the results of sediment chemistry data. These include the threshold effects level (TEL), and the probable effects level (PEL). The development of the TEL and the PEL was spearheaded by the State of Florida; these differ from the ERL and the ERM in that data showing no effects were incorporated into the analyses. The State of Florida assembled two databases: a “no effects database” and an “effects database”. The geometric mean of the 50th percentile value in the effects database and the 85th percentile value of the no effects database, was used to calculate the PEL. The geometric mean of the 15th percentile value in the effects database and the 50th percentile value of the no effects database, was used to calculate the TEL. By including the “no effect data” in the analysis, a clearer picture of the chemical concentrations associated with the three ranges of concern: no effects, possible effects, and probable effects can be established. The State Water Resources Control Board, Water Quality Control Policy for Developing California Clean Water Act Section 303 (d) List, Functional Equivalent Document (FED), 2004, states that SQGs that predict toxicity in 50% or more samples should be used in making decisions to place a water body on the Section 303 (d) list. The FED includes a table of various chemicals with the SQG including ERMs, PELs and others that are the most predictive of biological effects. Anaheim Bay and Huntington Harbour sediment data in comparison to the various SQGs as referenced in the FED, are listed on Tables 12 and 13.

- **Water Column Chronic Toxicity**

At each station, water column samples taken near the surface were collected and kelp (*Macrocystis pyrifera*) germination and growth, red abalone (*Haliotis rufescens*) larval development, and purple sea urchin (*Strongylocentrotus purpuratus*) fertilization bioassays were performed on the undiluted samples.

Table 2 lists the toxicity test endpoints that were used to assess choired toxicity. The chronic toxicity testing protocols included all required reference toxicant testing on the three species (EPA 1995).

Species Tested	Test End Point
Kelp	Germination and Growth after 48 hour exposure
Abalone Larva	Larval development after 48 hour exposure
Purple Sea Urchin	Fertilization after 2 hour exposure.

- **Sediment Toxicity**

Sediment for the toxicity tests was collected using a 0.1m² modified Van Veen grab sampler. Samples were collected from the top 2 cm of the sediment grab, and were kept on wet ice for transport to the laboratory where they were kept refrigerated at 4°C ±2°C prior to testing.

Toxicity was evaluated using the 10-day amphipod whole sediment test with *Eohaustorius estuarius* as the test organism (EPA 1994). The end-point of the test was percent survivorship after 10 days. The toxicity data (replicates) for each sample were compared to their control samples. Toxicity was determined by adjusting the average percent survival for each sample to the average percent survival for their respective control. A sediment sample was considered toxic if there was a significant difference ($p < 0.05$) between the laboratory control and sample replicates using a t-test (one sided and assuming unequal variance). *E. estuarius* was chosen to allow comparison to toxicity data collected during the Bight'03 regional monitoring survey, which included bay and harbors throughout southern California. The State Board's 303 (d) Listing Policy does not include a threshold for sediment toxicity bioassay tests; therefore, 80 % survival was used as the threshold for the sediment toxicity tests in this study to be consistent with other studies of similar nature, such as the Bight'98 regional study.

- **Benthic Infauna**

Benthic infauna (invertebrates that live in the sediment) are an important part of the marine food web. They generally reside in one location for most of their life, exhibit limited mobility, and are continually exposed to sediment contaminants. Consequently, infauna are excellent indicators of sediment quality. Samples for infaunal analyses were taken using a 0.1m² modified Van Veen grab sampler. The sediment was sieved through a 1 mm mesh screen and the organisms retained on the screen were preserved in a 70% formalin solution. The preserved organisms were later transferred to 70% ethanol solution in the laboratory for storage. Infaunal analyses consisted of sorting and identifying organisms to the lowest possible taxon, usually to the species level.

The measures used to assess infaunal community health and function included the calculation of the number of species, total number of individuals, Shannon-Weiner Diversity Index (H'), Species Evenness Index (J'), and the Benthic Response Index (BRI) for each station. Shannon-Weiner Diversity Index (H') and the Species Evenness Index (J') are based on number theory and are sensitive to the distribution of the number of individuals per species within a sample. The BRI measures the pollution tolerance of species on an abundance-weighted average basis. The BRI is scaled such that values below 25 represent the reference condition, values between 25-34 indicate a marginal deviation from reference, values between 35-44 represent a loss of biodiversity, values between 45-72 represent a loss of community function, and values between 73-100 represent the defaunation or exclusion of most species.

- **Statistical Analysis**

Seasonal differences in biological and chemical parameters were tested using a two-sample student's t-test. Significance was set at $p \leq 0.05$. Analysis of PAH, PCB and DDT was conducted on totals of similar compounds, not individual metabolites or congeners. The relationship of infaunal indices to

BRI, toxicity, percent TOC and grain size were analyzed using Pearson Product Moment Correlation Analysis with significance set at $p \leq 0.05$. The relationships of chemical and physical parameters to infaunal indices were analyzed using backwards stepwise multiple linear regression analysis with significance at 0.1. This analysis was conducted for each stratum for dry season, wet season, and both seasons combined. All analyses were performed using the Minitab statistical package. Prior to analysis, the data was tested for normality. Where necessary the data was \log_{10} or rank transformed and the analyses were performed on the transformed data.

- **Weight-of-Evidence Analysis**

The different types of data were assessed using a weight-of-evidence analyses following the sediment quality triad (TRIAD) model (Chapman 1990). The possible outcomes of the analysis and their conclusions are presented in Table 3. Evaluation of the sediment chemistry was made against the SQGQ1 quotient value likely to result in degradation (i.e., anything >0.11), sediment toxicity was evaluated against the SCCWRP/Bight study values of $>20\%$ mortality is moderately toxic and $>50\%$ mortality is highly toxic, and the benthic community “reference value” was estimated from stations showing no toxicity and no SQGQ1 exceedances.

Table 3. Differential TRIAD responses and possible conclusions. A “+” indicates a degraded or the potential for degradation exists, while A “-“ denotes either reference condition or low potential for degradation.

Scenario	Sediment Chemistry	Sediment Toxicity	Benthic Community	Possible Conclusions
1	+	+	+	Strong evidence for pollution induced degradation
2	-	-	-	Strong evidence there is no pollution induced degradation
3	+	-	-	Chemicals are not bioavailable
4	-	+	-	Unmeasured chemicals or conditions exist with the potential to cause degradation
5	-	-	+	Alteration is not due to toxic chemicals
6	+	+	-	Toxic chemicals are bioavailable in the laboratory, but not <i>in situ</i>
7	-	+	+	Unmeasured toxic chemicals are causing degradation
8	+	-	+	Chemicals are not bioavailable or alteration is not due to toxic chemicals

(After Chapman 1990)

VI. Results

- ***Water Column Measurements***

The results from the field water quality measurements are tabulated in Appendix 3. These results show the depth profile in meters for pH, temperature, conductivity, salinity, density, and dissolved oxygen.

- ***Toxicity Bioassays***

Anaheim Bay and Huntington Harbour water column toxicity and sediment toxicity results are summarized in Table 4.

Water Column Toxicity

There were two incidents of water column toxicity to red abalone larva and no toxicity to any of the other test species (Table 4). These two toxicity hits occurred during the wet season sampling period at Anaheim Bay and Huntington Harbour at Stations 27 and 59 respectively. The toxicity seen in the red abalone test was not corroborated by the other two water column toxicity tests conducted.

Sediment Toxicity

As shown in Table 4, during both the wet and dry season, there were more incidents of sediment toxicity in Huntington Harbor than in Anaheim Bay. These results are not surprising given the minimal tidal flushing of Huntington Harbor compared to Anaheim Bay. Figures 2, 3, 4 and 5 show the spatial distribution of the sediment toxicity found in Anaheim Bay and Huntington Harbor.

The wet season had the highest frequency of sediment toxicity. During the wet season, sediment toxicity was found at the mouth of one the East Garden Grove-Wintersburg channel, a major storm channel that empties into Huntington Harbour (sites 1, 2, 3, 5, 6 and 8 please see Figure 5).

Species	# of Anaheim Bay stations in wet season with measurable toxicity	# of Anaheim Bay stations in dry season with measurable toxicity	# of Huntington Harbor stations in Wet Season with measurable toxicity	# of Huntington Harbor stations in Dry Season with measurable toxicity
Kelp (water column)	0	0	0	0
Red Abalone larva (water column)	1	0	1	0
Purple Sea Urchin (water column)	0	0	0	0
Eohaustorius estuarius (sediment)	14	1	25	17

- ***Sediment Chemistry Data***

As indicated previously, to evaluate the potential for toxic effects, sediment chemistry data for Anaheim Bay and Huntington Harbour were compared to the 303(d) Listing Policy Sediment Quality Guidelines including ERL and ERM values and PEL and TEL values. Graphs, depicting a visual summary of these comparisons, are provided in Appendices 1 and 2. The SQGQ1 results for each station were also evaluated and are summarized in Table 5. The statistical analyses evaluating seasonal differences are discussed below.

Anaheim Bay

In Anaheim Bay, the concentrations of metals and organics in sediments were generally not high enough to exceed ERM values. There were only two instances when the organics concentrations exceeded ERM values: Total DDT and 4,4'-DDT, both of which occurred in station 24 during the dry season.

Comparisons of the seasonal concentrations of various contaminants indicate that there is a difference in the concentration of contaminants in between the two seasons; however, a particular season is not consistently higher than the other. For example, wet season samples had significantly higher concentrations of mercury than the dry season samples (t-test, mercury ($p = 0.003$; wet > dry). However, silver concentrations were higher in the dry season than in the wet season ($p < 0.001$; dry > wet), and total DDT and PCB concentrations were higher in the dry season than in the wet season (Total DDT $p = 0.002$; dry > wet, and total PCB ($p < 0.001$; dry > wet).

The calculated SQGQ1 values for Anaheim Bay are shown in Table 5 and indicate that contaminants likely to be associated with toxicity are present, but at low concentrations. SQGQ1 values ranged from 0.02 at Stations 1, 5, 13, and 19 to 0.23 at Station 9 in August 2001 and 0.01 at Stations 3, and 21 to 0.14 at Station 23 in March 2003 (Table 5). All values were within the low range of expected effects using the scale suggested by Fairey et al. (2001) (see Table 1). There was no statistical difference in the SQGQ1 mean values between the wet season and the dry season as tested with the t-test.

Huntington Harbor

Similar to Anaheim Bay, the concentrations of metals and organics in sediments were generally not high enough to exceed ERM values. There were only a few instances when the organics concentrations exceeded ERM values: Total Chlordane exceeded the ERM at three stations in the wet season and at six stations during the dry season; Total DDT exceeded the ERM at six stations in the wet season and at one station in the dry season.

Comparisons of the seasonal concentrations of various contaminants indicate that there is a difference in the concentration of contaminants in the two seasons but a particular season is not consistently higher than the other. For example, the percent TOC is higher during the wet season than the dry season ($P = 0.004$; wet > dry), but concentrations of cadmium were higher in the dry season than in the wet season ($p = 0.001$; dry > wet), copper concentrations were higher in the wet season than in the dry season ($p = 0.007$; wet > dry), silver concentrations were higher in the dry season than the wet season ($p < 0.001$; dry > wet), zinc concentrations were higher in the wet than in the dry season ($p < 0.001$; wet > dry), and total PCB concentrations were higher in the dry season than in the wet season ($p < 0.001$; dry > wet).

The SQGQ1 values for each station in Huntington Harbour are also shown in Table 5. Similar to Anaheim Bay, the results indicate that the contaminants likely to be associated with toxicity are present at moderate to low concentrations. SQGQ1 values ranged from 0.07 at Station 42 to 0.73 at Station 44 in August 2001 and 0.11 at Station 42 to 0.32 at Station 59 in February 2003 (Table 5). All values were within the low to moderate range of expected effects using the scale suggested by Fairey et al. (2001). There was a statistically significant difference in the SQGQ1 mean values determined in the dry season and wet season. Dry season (August 2001) SQGQ1 values were greater (0.29) than the wet season (February 2003) SQGQ1 values (0.21) and the difference was statistically significant ($p = 0.03$).

Anaheim Bay			Huntington Harbor		
Station	Dry Season	Wet Season	Station	Dry Season	Wet Season
1	0.02	0.07	36	0.44	0.17
2	0.06	0.02	37	*	0.24
3	*	0.01	38	0.41	0.29
4	0.04	0.07	39	0.23	0.22
5	0.02	0.04	41	0.36	0.22
6	*	0.06	42	0.07	0.11
7	*	0.11	43	0.29	0.21
8	0.13	0.12	44	0.73	0.24
9	0.23	0.06	46	0.18	0.17
10	0.16	0.05	47	0.12	0.12
11	*	0.05	49	0.12	0.17
12	0.16	0.13	50	0.40	0.25
13	0.02	0.02	51	0.15	*
14	0.05	0.07	52	0.39	0.29
15	0.07	0.13	53	0.35	0.20
16	0.12	0.12	54	0.25	0.26
17	0.12	0.12	55	0.09	0.16
18	0.03	0.07	56	0.23	0.22
19	0.02	*	57	0.37	0.20
20	0.14	0.09	58	0.36	*
21	0.13	0.01	59	0.47	0.32
23	0.07	0.14	60	0.32	0.24
24	0.13	0.12	62	0.29	0.24
25	0.13	0.13	63	0.33	0.27
27	0.07	0.12	64	*	0.24
28	0.13	0.09	65	0.16	0.16
29	0.20	0.05	66	0.43	0.19
30	0.14	0.07	68	0.23	0.18
31	0.04	0.04	69	0.23	0.17
32	0.18	*	70	0.23	0.15
33	0.14	*	71	0.33	0.26
34	0.17	0.13	72	0.27	0.18
35	0.14	0.09			

*no data collected at this station

- ***Benthic Community Analyses***

Community Diversity

Anaheim Bay

During the dry season (August 2001), the number of species ranged from 32 at Station 19 to 114 at station 33 and total abundance ranged from 128 at Station 13 to 1722 at Station 30. The Shannon-Weiner Diversity Index (H') ranged from 1.80 at Station 19 to 3.71 at Station 28, while the Evenness Index (J') ranged from 0.52 at Station 19 to 0.89 at Station 13. In the wet season

(April 2003), the number of species ranged from 16 at Station 2 to 93 at station 9, and total abundance ranged from 42 at Station 2 to 2824 at Station 9. H' ranged from 1.87 at Station 8 to 3.60 at Station 1, while J' ranged from 0.44 at Station 4 to 0.83 at Station 1. These results are summarized on Table 6. The dry season samples had significantly higher values than the wet season samples for H' (t-test, $p = 0.02$), and J' ($p = 0.04$).

Date Sampled	Station	Season	Number of Species	Abundance	Shannon Weiner Diversity Index (H')	Evenness Index (J')	Benthic Response Index (BRI)
8/25/2001	1	Dry	42	288	2.81	0.75	7
8/25/2001	2	Dry	94	622	3.57	0.79	11
8/25/2001	4	Dry	67	914	2.27	0.54	14
8/25/2001	5	Dry	63	251	3.49	0.84	19
8/25/2001	8	Dry	60	842	2.53	0.62	18
8/25/2001	9	Dry	42	216	2.45	0.66	24
8/25/2001	10	Dry	61	487	3.01	0.73	17
8/25/2001	12	Dry	57	326	3.29	0.81	19
8/25/2001	13	Dry	48	128	3.45	0.89	15
8/25/2001	14	Dry	65	609	2.72	0.65	10
8/25/2001	15	Dry	54	284	3.19	0.80	17
8/25/2001	16	Dry	48	314	3.09	0.80	14
8/25/2001	17	Dry	63	606	2.75	0.66	17
8/25/2001	18	Dry	93	1324	3.41	0.75	18
8/25/2001	19	Dry	32	364	1.80	0.52	-5
8/25/2001	20	Dry	64	354	3.24	0.78	18
8/25/2001	21	Dry	64	336	3.25	0.78	14
8/25/2001	23	Dry	49	764	2.34	0.60	26
8/25/2001	24	Dry	57	473	2.89	0.71	20
8/25/2001	25	Dry	47	332	2.93	0.76	15
8/25/2001	27	Dry	71	1138	2.42	0.57	15
8/25/2001	28	Dry	76	325	3.71	0.86	15
8/25/2001	29	Dry	52	222	3.14	0.79	23
8/25/2001	30	Dry	84	1722	2.59	0.59	17
8/25/2001	31	Dry	87	393	3.66	0.82	6
8/25/2001	32	Dry	45	329	2.77	0.73	20
8/25/2001	33	Dry	114	1268	3.04	0.64	14
8/25/2001	34	Dry	42	271	3.03	0.81	18
8/25/2001	35	Dry	64	780	2.64	0.64	19
4/14/2003	1	Wet	78	351	3.60	0.83	6
4/14/2003	2	Wet	16	42	2.25	0.81	-11
4/14/2003	3	Wet	67	1366	2.13	0.51	*
4/14/2003	4	Wet	84	1395	1.97	0.44	18
4/14/2003	5	Wet	49	375	3.01	0.77	22
4/14/2003	6	Wet	77	753	2.53	0.58	11
4/14/2003	7	Wet	61	956	2.35	0.57	20
4/14/2003	8	Wet	48	773	1.87	0.48	19
4/14/2003	9	Wet	93	2824	2.13	0.47	23
4/14/2003	10	Wet	75	1246	2.59	0.60	15
4/14/2003	11	Wet	25	313	1.99	0.62	5

Table 6. Summary of Benthic Infauna Data for Anaheim Bay in August 2001 and March 2003.

Date Sampled	Station	Season	Number of Species	Abundance	Shannon Weiner Diversity Index (H')	Evenness Index (J')	Benthic Response Index (BRI)
4/14/2003	12	Wet	44	399	2.44	0.64	17
4/14/2003	13	Wet	43	168	3.08	0.82	2
4/14/2003	14	Wet	57	413	3.19	0.79	12
4/14/2003	15	Wet	47	276	3.06	0.80	19
4/14/2003	16	Wet	70	2149	2.20	0.52	26
4/14/2003	17	Wet	49	391	2.67	0.69	18
4/14/2003	18	Wet	81	617	2.86	0.65	5
4/14/2003	20	Wet	90	781	3.25	0.72	18
4/14/2003	21	Wet	41	670	2.15	0.58	20
4/14/2003	23	Wet	53	493	2.33	0.59	17
4/14/2003	24	Wet	56	314	3.18	0.79	24
4/14/2003	25	Wet	39	412	2.60	0.71	23
4/14/2003	27	Wet	85	491	3.57	0.80	15
4/14/2003	28	Wet	58	387	2.83	0.70	18
4/14/2003	29	Wet	78	1231	2.96	0.68	25
4/14/2003	30	Wet	78	1101	2.40	0.55	17
4/14/2003	31	Wet	73	486	2.76	0.64	1
4/14/2003	34	Wet	42	545	2.28	0.61	19
4/14/2003	35	Wet	63	330	3.41	0.82	19

Huntington Harbor

In August 2001 (dry season), the number of species ranged from 11 at Station 52 to 79 at station 66 and total abundance ranged from 36 at Station 52 to 910 at Station 56. H' ranged from 0.96 at Station 62 to 3.52 at Station 66, while J' ranged from 0.29 at Station 62 to 0.85 at Station 70. In February 2003 (wet season), the number of species ranged from 15 at Station 63 to 60 at station 47 and total abundance ranged from 51 at Station 62 to 1638 at Station 47. H' ranged from 2.07 at Station 44 to 3.24 at Station 68 and J' ranged from 0.57 at Station 47 to 0.92 at Station 50. These results are summarized on Table 7.

Seasonal differences were detected by t-test analyses for H' (p=0.05; wet>dry), J' (p=0.01; wet>dry).

Table 7. Summary of Benthic Infauna Data for Huntington Harbor in August 2001 and February 2003.

Date Sampled	Station	Season	Number of Species	Abundance	Shannon Weiner Diversity Index (H')	Evenness Index (J')	Benthic Response Index (BRI)
8/8/2001	36	Dry	12	55	1.76	0.70	55
8/8/2001	38	Dry	24	227	2.11	0.66	57
8/8/2001	39	Dry	27	264	1.42	0.43	73
8/8/2001	41	Dry	25	166	2.23	0.69	47
8/8/2001	42	Dry	65	565	3.30	0.79	23
8/8/2001	43	Dry	33	455	2.28	0.65	47
8/8/2001	44	Dry	25	198	2.09	0.65	59

Date Sampled	Station	Season	Number of Species	Abundance	Shannon Weiner Diversity Index (H')	Evenness Index (J')	Benthic Response Index (BRI)
8/8/2001	46	Dry	42	271	2.70	0.72	25
8/8/2001	47	Dry	61	616	3.28	0.80	24
8/8/2001	49	Dry	57	685	3.04	0.75	20
8/8/2001	50	Dry	28	248	2.43	0.73	42
8/8/2001	51	Dry	60	655	2.79	0.68	25
8/8/2001	52	Dry	11	36	1.98	0.83	57
8/8/2001	53	Dry	27	395	2.12	0.64	41
8/8/2001	54	Dry	25	290	1.36	0.42	47
8/8/2001	55	Dry	24	159	2.31	0.73	16
8/8/2001	56	Dry	31	910	1.08	0.32	66
8/8/2001	57	Dry	21	343	1.24	0.41	57
8/8/2001	58	Dry	28	187	2.48	0.75	36
8/8/2001	59	Dry	14	118	1.69	0.64	60
8/8/2001	60	Dry	19	139	2.17	0.74	52
8/8/2001	62	Dry	28	371	0.96	0.29	63
8/8/2001	63	Dry	18	98	1.96	0.68	60
8/8/2001	65	Dry	35	191	2.90	0.82	33
8/8/2001	66	Dry	79	503	3.52	0.81	23
8/8/2001	68	Dry	59	448	3.25	0.80	25
8/8/2001	69	Dry	38	661	2.07	0.57	39
8/8/2001	70	Dry	31	100	2.91	0.85	35
8/8/2001	71	Dry	48	408	2.75	0.71	38
8/8/2001	72	Dry	52	413	2.93	0.74	24
2/27/2003	36	Wet	30	404	2.17	0.64	40
2/27/2003	37	Wet	30	356	2.25	0.66	47
2/27/2003	38	Wet	26	213	2.56	0.79	57
2/27/2003	39	Wet	28	311	2.76	0.83	54
2/27/2003	41	Wet	34	219	2.64	0.75	43
2/27/2003	42	Wet	34	159	2.81	0.80	31
2/27/2003	43	Wet	22	257	2.28	0.74	44
2/27/2003	44	Wet	22	232	2.07	0.67	48
2/27/2003	46	Wet	36	204	2.62	0.73	28
2/27/2003	47	Wet	60	1638	2.31	0.57	20
2/27/2003	49	Wet	49	430	3.09	0.80	27
2/27/2003	50	Wet	22	80	2.83	0.92	62
2/27/2003	52	Wet	25	104	2.62	0.81	41
2/27/2003	53	Wet	23	89	2.38	0.76	45
2/27/2003	54	Wet	28	176	2.65	0.80	46
2/27/2003	55	Wet	47	405	2.85	0.74	27
2/27/2003	56	Wet	32	391	2.44	0.70	53
2/27/2003	57	Wet	26	293	2.33	0.72	33
2/27/2003	59	Wet	20	119	2.42	0.81	48
2/27/2003	60	Wet	28	259	2.47	0.74	50
2/27/2003	62	Wet	16	51	2.35	0.84	60
2/27/2003	63	Wet	15	52	2.30	0.85	57

Table 7. Summary of Benthic Infauna Data for Huntington Harbor in August 2001 and February 2003.

Date Sampled	Station	Season	Number of Species	Abundance	Shannon Weiner Diversity Index (H')	Evenness Index (J')	Benthic Response Index (BRI)
2/27/2003	64	Wet	26	464	2.28	0.70	41
2/27/2003	65	Wet	31	98	2.95	0.86	41
2/27/2003	66	Wet	38	510	2.61	0.72	32
2/27/2003	68	Wet	52	229	3.24	0.82	18
2/27/2003	69	Wet	34	380	2.30	0.65	39
2/27/2003	70	Wet	54	468	2.82	0.71	25
2/27/2003	71	Wet	47	366	3.05	0.79	38
2/27/2003	72	Wet	43	276	2.91	0.77	37

Benthic Response Index (BRI)

Anaheim Bay

BRI values for Anaheim Bay are listed in Table 6. Based on the BRI index developed by the staff at the Southern California Coastal Water Research Project, the Anaheim Bay BRI values indicate that a large majority of sites in Anaheim Bay fall under the reference sites category. BRI values range from 5 at Station 19 to 26 at Station 23 in August 2001, while March 2003 values range from 1 at Station 31 to 26 at Station 16. All values for both seasons indicated reference conditions except Station 23 in August 2001 and Stations 16 and 29 in March 2003, which indicated marginal deviations from reference conditions. Marginal deviations are not considered to be an indication of impacts to the benthic community.

Huntington Harbor

BRI values for Huntington Harbour (Table 7) indicate that a large majority of sites in Huntington Harbor are classified as impacted. BRI values ranged from 16 at Station 55 to 73 at Station 39 in August 2001, while March 2003 values range from 18 at Station 68 to 62 at Station 50. In August 2001, only six stations had BRI values that indicated reference conditions, three had a marginal deviation from reference, seven a loss of biodiversity, thirteen a loss of function, and one indicated defaunation. Similarly, in March 2003, only two stations had BRI values that indicated reference conditions; seven had a marginal deviation from reference, nine a loss of biodiversity; and twelve had loss of function. It is important to note however, that these scores do not correlate to the diversity data (see above) that indicated a relatively healthy benthic community for Huntington Harbor. This is explained in more detail in the Discussion Section of this report.

- ***Relationship Between Biological Responses and Sediment Chemistry***

In order to determine whether there was a relationship between biological response and sediment contaminant exposure, correlation and regression analyses were conducted on sediment geochemistry data versus sediment toxicity and infaunal community measures for each water body. Because differences between wet and dry seasons were detected with the t-test analysis (see above), correlation and regression analyses were performed separately on each season's data set. The sediment quality guidelines quotient (SQGQ1) calculated as shown in Table 5 and individual sediment chemical measurements were evaluated against sediment toxicity test results and benthic community analyses. The statistical analyses results are summarized below for each

biological response. Note that only statistically significant correlations between sediment chemistry or sediment toxicity and benthic community analyses (positive or negative) are discussed below.

Sediment Toxicity

Anaheim Bay

Dry season (August 2001), SQGQ1 inversely correlated with amphipod survival ($r = -0.43$, $p = 0.02$) and positively correlated with percent TOC ($r = 0.90$, $p < 0.001$) and percent fines ($r = 0.91$, $p < 0.001$). Amphipod survival of less than 80% (toxic) seems to be associated with SQGQ1 values above 0.2. For individual chemicals measured during the dry season, amphipod survival was inversely correlated to concentrations of the metals cadmium, ($r = -0.43$, $p = 0.02$), copper ($r = -0.43$, $p = 0.02$), lead ($r = -0.50$, $p = 0.006$), silver ($r = -0.38$, $p = 0.04$), and zinc ($r = -0.40$, $p = 0.03$), and the trace organics acenaphthylene ($r = -0.44$, $p = 0.02$), dibenz (a,h) anthracene ($r = -0.38$, $p = 0.04$), and naphthalene ($r = -0.54$, $p = 0.002$).

Wet season (March 2003), SQGQ1 inversely correlated with amphipod survival ($r = -0.51$, $p = 0.007$) and positively correlated with percent TOC ($r = 0.63$, $p < 0.001$) and percent fines ($r = 0.78$, $p < 0.001$). Amphipod survival in the wet season seems to be associated with SQGQ1 values above 0.08. Amphipod survival was inversely correlated to percent TOC ($r = -0.38$, $p = 0.05$), percent fines ($r = -0.50$, $p = 0.009$), arsenic ($r = -0.49$, $p = 0.01$), cadmium ($r = -0.66$, $p < 0.001$), chromium ($r = -0.53$, $p = 0.005$), copper ($r = -0.54$, $p = 0.004$), lead ($r = -0.54$, $p = 0.005$), nickel ($r = -0.53$, $p = 0.005$), and the trace organics total DDT ($r = -0.73$, $p < 0.001$), and 4,4'-DDT ($r = -0.73$, $p < 0.001$).

Huntington Harbor

Dry season (August 2001), SQGQ1 correlated with percent fines ($r = 0.73$, $p < 0.001$). Amphipod survival was inversely correlated with percent fines ($r = -0.44$, $p = 0.01$) sediment concentrations of copper ($r = -0.49$, $p = 0.007$), lead ($r = -0.51$, $p = 0.004$), silver ($r = -0.50$, $p = 0.005$), and zinc ($r = -0.47$, $p = 0.009$), and the trace organics acenaphthene ($r = -0.39$, $p = 0.03$), total DDT ($r = -0.43$, $p = 0.02$), and 4,4'-DDT ($r = -0.43$, $p = 0.02$).

Wet season (February 2003), SQGQ1 correlated with percent TOC ($r = 0.51$, $p = 0.004$) and percent fines ($r = 0.87$, $p < 0.001$). Amphipod survival was inversely correlated with percent TOC ($r = -0.37$, $p = 0.04$) and the trace organic fluorine ($r = -0.39$, $p = 0.03$).

Infaunal Community Measures

Anaheim Bay

In August 2001 (dry season), the benthic response index BRI was positively correlated with SQGQ1 ($r = 0.57$, $p = 0.001$) and with sediment concentrations of arsenic ($r = 0.54$, $p = 0.002$), cadmium ($r = 0.55$, $p = 0.002$), chromium ($r = 0.57$, $p = 0.001$), copper ($r = 0.60$, $p = 0.001$), lead ($r = 0.58$, $p = 0.001$), mercury ($r = 0.51$, $p = 0.005$), nickel ($r = 0.57$, $p = 0.001$), silver ($r = 0.52$, $p = 0.004$), and zinc ($r = 0.61$, $p < 0.001$), and trace organics acenaphthylene ($r = 0.41$, $p = 0.03$), anthracene ($r = 0.37$, $p = 0.05$), benz (a) anthracene ($r = 0.43$, $p = 0.02$), benzo (a) pyrene ($r = 0.51$, $p = 0.005$), chrysene ($r = 0.47$, $p = 0.01$), dibenz (a,h) anthracene ($r = 0.51$, $p = 0.005$), fluoranthene ($r = 0.37$, $p = 0.05$), naphthalene ($r = 0.49$, $p = 0.007$), pyrene ($r = 0.43$, $p = 0.02$), and total PAH ($r = 0.50$, $p = 0.006$).

In March 2003 (wet season) BRI was positively correlated with SQGQ1 ($r = 0.51$, $p = 0.004$) and arsenic ($r = 0.45$, $p = 0.02$), cadmium ($r = 0.54$, $p = 0.003$), chromium ($r = 0.45$, $p = 0.02$), copper ($r = 0.57$, $p = 0.002$), lead ($r = 0.57$, $p = 0.001$), nickel ($r = 0.44$, $p = 0.02$), silver ($r = 0.42$, $p = 0.03$), and zinc ($r = 0.58$, $p = 0.001$), and the trace organic 4,4'-DDE ($r = 0.40$, $p = 0.03$). The number of species was inversely correlated with sediment concentrations of 4,4'-DDE ($r = -0.39$, $p = 0.04$), while total abundance was correlated with total DDT ($r = 0.38$, $p = 0.04$), 4,4'-DDT ($r = 0.46$, $p = 0.01$), and 4,4'-DDD ($r = 0.46$, $p = 0.01$). The Shannon-Weiner Diversity Index (H') was inversely correlated with 4,4'-DDE ($r = -0.39$, $p = 0.04$).

Huntington Harbor

In August 2001, SQGQ1 was correlated with BRI ($r = 0.55$, $p = 0.002$) and inversely correlated with the number of species ($r = -0.44$, $p = 0.01$) and total abundance ($r = -0.45$, $p = 0.01$). The number of species was inversely correlated with sediment concentrations of the metals copper ($r = -0.52$, $p = 0.003$), lead ($r = -0.65$, $p < 0.001$), silver ($r = -0.44$, $p = 0.005$), and zinc ($r = -0.50$, $p = 0.005$), and the trace organics fluorine ($r = -0.42$, $p = 0.02$), total DDT ($r = -0.53$, $p = 0.003$), 4,4'-DDE ($r = -0.52$, $p = 0.003$), and total PCB ($r = -0.55$, $p = 0.002$). Total abundance was inversely correlated to sediment concentrations of copper ($r = -0.39$, $p = 0.04$), lead ($r = -0.50$, $p = 0.005$), zinc ($r = -0.39$, $p = 0.04$), acenaphthylene ($r = -0.50$, $p = 0.005$), anthracene ($r = -0.50$, $p = 0.005$), benzo (a) pyrene ($r = -0.36$, $p = 0.05$), fluoranthracene ($r = -0.40$, $p = 0.03$), fluorene ($r = -0.56$, $p = 0.001$), phenanthrene ($r = -0.39$, $p = 0.03$), pyrene ($r = -0.40$, $p = 0.03$), total PAH ($r = -0.45$, $p = 0.01$), total DDT ($r = -0.50$, $p = 0.005$), 4,4'-DDE ($r = -0.49$, $p = 0.006$), and total PCB ($r = -0.50$, $p = 0.005$). H' was inversely correlated to copper ($r = -0.46$, $p = 0.01$), lead ($r = -0.58$, $p = 0.001$), silver ($r = -0.47$, $p = 0.01$), zinc ($r = -0.45$, $p = 0.01$), acenaphthene ($r = -0.49$, $p = 0.006$), 4,4'-DDE ($r = -0.38$, $p = 0.04$), and total PCB ($r = -0.44$, $p = 0.02$), while J' was inversely correlated with acenaphthene ($r = -0.52$, $p = 0.003$). BRI was correlated with copper ($r = 0.66$, $p < 0.001$), lead ($r = 0.75$, $p < 0.001$), silver ($r = 0.51$, $p = 0.004$), zinc ($r = 0.64$, $p < 0.001$), acenaphthene ($r = 0.36$, $p = 0.05$), total DDT ($r = 0.62$, $p < 0.001$), 4,4'-DDE ($r = 0.61$, $p < 0.001$), and total PCB ($r = 0.61$, $p < 0.001$).

In February 2003, SQGQ1 correlated with J' ($r = 0.37$, $p = 0.04$) and BRI ($r = 0.71$, $p < 0.001$), and negatively correlated with the number of species ($r = -0.64$, $p < 0.001$) and total abundance ($r = -0.46$, $p = 0.01$). The number of species was negatively correlated with sediment concentrations of copper ($r = -0.60$, $p < 0.001$), lead ($r = -0.72$, $p < 0.001$), zinc ($r = -0.46$, $p = 0.01$), and 4,4'-DDE ($r = -0.62$, $p < 0.001$). Total abundance was negatively correlated with copper ($r = -0.45$, $p = 0.01$), lead ($r = -0.43$, $p = 0.02$), zinc ($r = -0.42$, $p = 0.02$), and positively with acenaphthalene ($r = 0.41$, $p = 0.03$). H' was negatively correlated with lead ($r = -0.39$, $p = 0.03$), benzo (a) pyrene ($r = -0.36$, $p = 0.05$), and 4,4'-DDE ($r = -0.49$, $p = 0.006$), while J' was correlated with copper ($r = 0.40$, $p = 0.03$) and zinc ($r = 0.39$, $p = 0.04$).

Backwards Stepwise Multiple Linear Regression Analysis

Anaheim Bay

Results for regression analyses showing significant correlations are presented in Table 9. Regression analysis showed no correlations of biological metrics to physical or chemical parameters for Anaheim Bay in August 2001. Four metrics (number of species, H' , BRI, and toxicity) were significantly correlated to one or more parameters in April 2003. Metals were the most common parameters identified, followed by total DDTs, including its metabolite 4,4'-DDE. Grain size was the only physical factor identified that correlated with a biological parameter - the number of species. When data from both seasons were combined, only BRI and toxicity were correlated to chemical parameters and all were correlated to metals (lead for BRI and zinc and copper for toxicity).

Huntington Harbor

The physical and chemical data from Huntington Harbor had considerably more correlations to biological metrics than did Anaheim Bay. Significant relationships occurred for five wet season sediment chemistry and biological parameter pairings, six dry season sediment chemistry and biological parameter pairings, and five occurrences when the dry and wet season data were combined (Table 9). The biological metrics that were significantly correlated to physical/chemical parameters were similar for wet, dry and both seasons combined. However, the parameters identified by the regression analysis as accounting for the largest proportion of data variability differed between seasons. For example, for each season, out of all the parameters identified as affecting the number of species, only lead is identified for both seasons; the total number of constituents identified as affecting the number of species in each season were three for August 2001, four for February 2003, and seven when both surveys were combined. For Huntington Harbor, the primary parameters identified were organic compounds (primarily PAHs; 35/59), metals (19/59), and physical factors only accounted for five of 59 correlations (grain size = 1 and percent TOC = 4). These results indicate that organic and metals contamination account for approximately 31% - 74% of the variability in the data, while physical factors, such as percent TOC and grain size are much less of a factor determining infaunal community differences among sites within Huntington Harbour.

Table 9. Results of the Backwards Stepwise Multiple Linear Regression Analysis. Only those independent variables accounting for >30% of the variability of the biological parameter are reported.				
Stratum	Season	Biological Parameter	Percent Variability	Physical-Chemical Parameter = p-value
Anaheim Bay	Dry	None	NA	NA
	Wet	Species	32	4,4'-DDE = 0.05 Grain Size = 0.06 Mercury = 0.05
		H'	35	tDDT = 0.10 lead = 0.03 zinc = 0.03
		BRI	39	lead = <0.001
		Toxicity	51	tDDT = <0.001
	Combined	BRI	32	lead = <0.001
		Toxicity	40	zinc = <0.001 copper = <0.001
Huntington Harbor	Dry	Species	52	lead = <0.001 fluorene = 0.1 chrysene = 0.03
		Abundance	63	fluorene = 0.002 lead = <0.001 acenaphthalene = <0.001 naphthalene = 0.03
		H'	47	lead = <0.001 acenaphthalene = 0.006
		J'	31	acenaphthalene = 0.003 fluorene = 0.07
		BRI	74	lead = 0.01 acenaphthalene = <0.001

Table 9. Results of the Backwards Stepwise Multiple Linear Regression Analysis. Only those independent variables accounting for >30% of the variability of the biological parameter are reported.				
Stratum	Season	Biological Parameter	Percent Variability	Physical-Chemical Parameter = p-value
				copper = 0.04 mercury = 0.02 fluorene = 0.06
		Toxicity	31	lead = 0.001 fluorene = 0.06
	Wet	Species	63	lead = 0.01 cadmium = 0.01 4,4'-DDE = 0.01 naphthalene = 0.06
		Abundance	35	grain size = 0.03 acenaphthalene = 0.04
		H'	47	4,4'-DDE = <0.001 percent TOC = 0.002 fluorene = 0.07
		J'	36	Percent TOC = 0.02 Benzo-a-anthracene = 0.007 Dibenzo(a,h)anthracene = 0.01 Pyrene = 0.06
		BRI	71	copper = <0.001 percent TOC = 0.001 4,4'-DDE = 0.02
		Toxicity	39	fluorene = 0.02 silver = 0.008 4,4'-DDE = 0.02 anthracene = 0.05
	Combined	Species	59	lead = <0.001 cadmium = 0.008 fluorene = <0.001 acenaphthalene = 0.01 naphthalene = 0.08 4,4'-DDE = 0.006 dibenzo(a,h)anthracene = 0.08
		Abundance	45	acenaphthalene = <0.001 lead = <0.001 fluorene = 0.003 percent TOC = 0.02 tDDT = 0.10
		H'	40	lead = <0.001 acenaphthalene = <0.001
		BRI	58	lead = <0.001 cadmium = 0.02
		Toxicity	43	zinc = <0.001 acenaphthalene = <0.001 anthracene = 0.001 tDDT = 0.005 nickel = 0.06

- **Weight of Evidence (TRIAD) Analysis**

Anaheim Bay

The results of the TRIAD analysis for Anaheim Bay are presented in Table 10. Though a true reference condition (an area free from anthropogenic influence) is not present in Anaheim Bay, there was sufficient evidence from the application of the community metrics (i.e., BRI) and sediment toxicity tests to use the stations that met all reference benchmarks as the standards for comparison.

During the dry season (August 2001), all stations were considered reference for infaunal communities with the exception of Stations 29 and 34, which had moderate sediment toxicity and Station 29 where the BRI value of 26 indicated a marginal deviation from the reference condition. All other community metrics at those two stations were within the range of reference values, as measured by the coefficient of variation¹ of reference condition stations. However, the toxicity values were not corroborated by a measured degradation in infaunal populations at those two stations. As such, the two toxicity test results could be considered anomalous and the stations considered reference stations. SQGQ1 values are within the low-risk category, so measured sediment contaminants do not appear to be degrading the sediments or biota, which suggests that any adverse effects may be due to some unmeasured chemical(s) or conditions.

During the wet season (April 2003), all SQGQ1 values were within the low-risk range, though moderate and high sediment toxicity levels were found at station 7 and station 4, respectively. However, the stations exhibiting toxicity all fell within reference values for infaunal community measures, with the exception of Stations 16 and 29 which had marginal deviations from the reference condition.

Table 10. TRIAD analysis results for Anaheim Bay in A) August 2001 and B) April 2003.
 A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Aug. 01	1	-	-	-	Not degraded
Aug. 01	2	-	-	-	Not degraded
Aug. 01	4	-	-	-	Not degraded
Aug. 01	5	-	-	-	Not degraded
Aug. 01	8	-	-	-	Not degraded
Aug. 01	9	-	-	-	Not degraded
Aug. 01	10	-	-	-	Not degraded
Aug. 01	12	-	-	-	Not degraded
Aug. 01	13	-	-	-	Not degraded
Aug. 01	14	-	-	-	Not degraded
Aug. 01	15	-	-	-	Not degraded
Aug. 01	16	-	-	-	Not degraded
Aug. 01	17	-	-	-	Not degraded
Aug. 01	18	-	-	-	Not degraded
Aug. 01	19	-	-	-	Not degraded
Aug. 01	20	-	-	-	Not degraded
Aug. 01	21	-	-	-	Not degraded

¹ the standard deviation divided by the mean; a unitless quantity indicating the variability around the mean in relation to the size of the mean

Table 10. TRIAD analysis results for Anaheim Bay in A) August 2001 and B) April 2003.

A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Aug. 01	23	-	-	-	Not degraded
Aug. 01	24	-	-	-	Not degraded
Aug. 01	25	-	-	-	Not degraded
Aug. 01	26	-	-	-	Not degraded
Aug. 01	27	-	-	-	Not degraded
Aug. 01	28	-	-	-	Not degraded
Aug. 01	29	-	-	+	Alteration not due to toxic chemicals measured
Aug. 01	30	-	-	-	Not degraded
Aug. 01	31	-	-	-	Not degraded
Aug. 01	32	-	-	-	Not degraded
Aug. 01	33	-	-	-	Not degraded
Aug. 01	34	-	-	+	Alteration not due to toxic chemicals measured
Aug. 01	35	-	-	-	Not degraded
Apr. 03	1	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	2	-	-	-	Not degraded
Apr. 03	3	-	-	-	Not degraded
Apr. 03	4	-	-	-	Not degraded
Apr. 03	5	-	-	-	Not degraded
Apr. 03	6	-	-	-	Not degraded
Apr. 03	7	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	8	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	9	-	-	-	Not degraded
Apr. 03	10	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	11	-	-	-	Not degraded
Apr. 03	12	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	13	-	-	-	Not degraded
Apr. 03	14	-	-	-	Not degraded
Apr. 03	15	-	-	-	Not degraded
Apr. 03	16	-	-	-	Not degraded
Apr. 03	17	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	18	-	-	-	Not degraded
Apr. 03	20	-	-	-	Not degraded
Apr. 03	21	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	23	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	24	-	-	-	Not degraded
Apr. 03	25	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	27	-	-	-	Not degraded
Apr. 03	28	-	-	+	Alteration not due to toxic chemicals measured

Table 10. TRIAD analysis results for Anaheim Bay in A) August 2001 and B) April 2003.

A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Apr. 03	29	-	-	-	Not degraded
Apr. 03	30	-	-	-	Not degraded
Apr. 03	31	-	-	-	Not degraded
Apr. 03	34	-	-	+	Alteration not due to toxic chemicals measured
Apr. 03	35	-	-	-	Not degraded

Huntington Harbor

Huntington Harbor was more difficult to evaluate than Anaheim Bay because it is a much different environment than Anaheim Bay. The sediments are much finer, there is less tidal flushing, and all stations within this stratum are affected by human activity in some way, so a true reference condition is not present. For these analyses, Anaheim Bay sites served as surrogate reference sites.

The results of the TRIAD analysis for Huntington Harbor are presented in Table 11. In the dry season, August 2001, all stations fell within the low risk category for sediment contaminants based on SQGQ1 analysis. The community metrics (minus BRI and toxicity) were within expected normal ranges (based on the Anaheim Bay reference condition), with the exception of Stations 56 and 62, which had low Shannon-Weiner Diversity Index (H') and Species Evenness Index (J') values. However, the number of species and total abundance were comparable to other stations. The low H' and J' values were found to be caused by an unusually large abundance at each station (56 and 62) of the bivalve mollusc *Musculista senhousia*, (718 and 306 individuals at Stations 56 and 62, respectively). *M. senhousia* is not an indicator species of degraded environments and the reason for its large abundances at those two stations is unclear. Sediment toxicity and BRI analyses indicate that more than 50% of the Huntington Harbour stations have degraded biota (BRI scores >25). However, this is inconsistent with the actual biota results (diversity indices), which shows essentially normal populations present.

In the wet season, February 2003, all Huntington Harbor stations fell within the low risk category for sediment contaminants based on SQGQ1 analysis. Similar to August 2001, infaunal community analysis indicated a normal community at all stations, with the exception of BRI values and sediment toxicity. Consistent with the August 2001 results, there are also inconsistencies in the BRI and sediment toxicity results of the wet season compared to the community assessment data. For all stations, neither the BRI values nor sediment toxicity results agrees well, if at all, with the community assessment. The SQGQ1 and infaunal community analyses (minus BRI and sediment toxicity) indicate a low risk level and that normal communities are present. However, one caveat to this statement is that no direct comparison to a natural reference community in Huntington Harbor, either during the dry or wet season could be made.

Table 11. TRIAD analysis results for Huntington Harbor in A) August 2001 and B) February 2003. A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Aug. 01	36	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	38	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	39	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	41	-	+	-	Not degraded
Aug. 01	42	-	-	-	Not degraded
Aug. 01	43	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	44	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	46	-	-	-	Not degraded
Aug. 01	47	-	-	-	Not degraded
Aug. 01	49	-	-	-	Not degraded
Aug. 01	50	-	+	-	Not degraded
Aug. 01	51	-	-	+	Alteration not due to toxic chemicals measured
Aug. 01	52	-	+	-	Not degraded
Aug. 01	53	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	54	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	55	-	-	-	Not degraded
Aug. 01	56	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	57	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	58	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	59	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	60	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	62	-	+	+	Alteration not due to toxic chemicals measured
Aug. 01	63	-	+	+	Unmeasured toxic chemicals are causing degradation
Aug. 01	65	-	-	-	Not degraded
Aug. 01	66	-	-	+	Alteration not due to toxic chemicals measured
Aug. 01	68	-	-	-	Not degraded
Aug. 01	69	-	+	-	Not degraded
Aug. 01	70	-	-	+	Alteration not due to toxic chemicals measured
Aug. 01	71	-	+	-	Not degraded
Aug. 01	72	-	-	-	Not degraded
Feb.03	36	-	+	+	Alteration not due to toxic chemicals measured

Table 11. TRIAD analysis results for Huntington Harbor in A) August 2001 and B) February 2003. A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Feb.03	37	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	38	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	39	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	41	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	42	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	43	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	44	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	46	-	-	-	Not degraded
Feb.03	47	-	-	-	Not degraded
Feb.03	49	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	50	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	52	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	53	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	54	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	55	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	56	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	57	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	59	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	60	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	62	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	63	-	+	+	Alteration not due to toxic chemicals measured
Feb.03	64	-	+	-	Not degraded
Feb.03	65	-	+	-	Not degraded
Feb.03	66	-	-	-	Not degraded
Feb.03	68	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	69	-	+	-	Not degraded
Feb.03	70	-	-	+	Alteration not due to toxic chemicals measured
Feb.03	71	-	+	+	Alteration not due to toxic chemicals measured

Table 11. TRIAD analysis results for Huntington Harbor in A) August 2001 and B) February 2003. A “+” indicates a degraded or the potential for degradation exists; “-“denotes either reference condition or low potential for degradation (see Table 3).

Survey	Station	Sediment Chemistry (SQGQ1 < 0.75)	Infaunal Community Analysis	Water Column and Sediment Toxicity	Conclusion
Feb.03	72	-	+	+	Alteration not due to toxic chemicals measured

Discussion:

In general, sediment toxicity was greater in Huntington Harbor than in Anaheim Bay, even though the sediment geochemistry concentrations and SQGQ1 values were similar in both Anaheim Bay and Huntington Harbour. This suggests that an unmeasured contaminant or physical condition exists in Huntington Harbour that is adversely affecting toxicity. In addition, in Huntington Harbour, there are inconsistencies between infauna community metrics and the high levels of toxicity measured. At most stations, the community metrics, other than BRI, are not indicative of a degraded environment, yet moderate to high levels of sediment toxicity were observed in the laboratory tests. The reason for this disconnect in the two data sets is unknown.

The negative correlation of percent fine sediment to the number of species and BRI in Huntington Harbor may indicate that grain size is a factor in determining the infaunal assemblage. Grain size can be a factor influencing infaunal community structure as was shown by Maurer et al. (1994). However, the correlation of percent TOC to toxicity, coupled with the relationships to chemical contaminants identified with the regression analysis tends to support the supposition that contaminants may be a significant factor in determining infaunal community structure in Huntington Harbour. Of particular importance is DDT and its metabolites 4,4' DDE and 4,4' DDD, which are bioaccumulative organochlorine legacy insecticides. DDT in the environment is water insoluble and binds to soil or organic particulates; if in water it will bind to suspended material, settle and degrade into 4,4' DDE and 4,4' DDD.

Seasonal differences in local benthic infaunal shelf communities have been observed showing that the number of species and total abundance of individuals tends to be lower in the winter and spring and higher in the summer and fall (Maurer et al. 1994). The seasonal results for Huntington Harbor also followed this pattern, though the difference was minimal (Species = 35 and 33, abundance = 339 and 308 in dry vs. wet seasons, respectively). For Anaheim Bay, the number of species followed this pattern (Aug. 2001 = 62; Feb. 2003 = 61), but there was a higher mean total abundance in March 2003 (735) than in August 2001 (562). The high mean abundance in March 2003 was driven by unusually large numbers of individuals at two stations (Sta. 9 = 2824 and Sta. 16 = 2149). At Station 9, the polychaete *Fabricinuda limnicola* totaled 1,452 individuals, while the polychaete *Mediomastus sp.* numbered 985 at Station 16. Neither of these are indicator species of degraded environments and the reason for their high abundances at these two stations is not known.

The individual results from each analyses performed, i.e. sediment chemistry, toxicity, benthic infauna identification, may each be considered as an individual line of evidence to determine whether beneficial uses at a station are of concern and warrants further study. This weight of evidence approach is important because there are numerous environmental factors that may affect the outcome of each independent result. These factors include water depth, sediment grain size, scouring, salinity, dissolved oxygen, concentrations, succession, organic enrichment, and predation. These factors may cause changes in benthic communities with or without the simultaneous effects of toxic chemicals. A better way to analyze the data is by the weight of evidence approach by which a location is evaluated by examining the results of each analysis. The results of each individual analysis are thus lines of evidence that are grouped and

considered in determining those locations in Anaheim Bay and Huntington Harbor that are of concern and should be subject for future studies.

Even though every attempt was made to adhere to the statistical design of this project, upon analysis of the recorded latitude and longitude data for each station, 22 out of 120 sites sampled in these water bodies (60 in the dry and 60 in the wet), had recorded latitudes and longitudes that were significantly off the nominal station latitudes and longitudes. This occurred at 5 stations in the dry season (stations 2 and 32 in Anaheim Bay and stations 29, 52, and 53 in Huntington Harbor) and at 17 stations in the wet season (stations 1, 2, 3, 4, 6, 7, 10, 11, 14, 20, 29 and 34 in Anaheim Bay and stations 50, 55, 62, and 68 in Huntington Harbor). This raises questions on the precision of the locations of these stations. Therefore, the maps that show the locations sampled, and the locations where contamination was found are based on the target latitude and longitude not on the actual latitude and longitudes.

VII. Conclusion:

In conclusion, the data suggests that the infaunal community in Anaheim Bay is not impaired. A diverse infaunal community exists, and sediment geochemistry and sediment toxicity analyses indicate a low probability of adverse effects in this environment. Some seasonal effects were observed, particularly increased sediment toxicity in the wet season, but this appears to be ephemeral and may possibly be related to rainfall runoff from watershed sources.

The data for Huntington Harbor suggest that the benthic community is impaired. Thirty percent of the samples in Huntington Harbor exhibited chemical contamination high enough to indicate a potential negative biological response (toxicity and /or a degraded benthos). However, the infaunal community diversity indices show similar ranges to that of offshore communities with similar sediment grain size habitats, but lower sediment chemistry concentrations, so the lower diversity may be more influenced by grain size than by chemical contamination. The exception to this is the BRI analysis. While most infaunal community metrics indicate a likely normal community, the BRI results indicate that 60% of the stations in August 2001 and 70% in March 2003 were degraded to some degree.

The exact cause of the observed biological response in Huntington Harbour is not easily discernable without further studies, such as toxicity identification evaluation studies, and analyses of sulfide and ammonia concentrations in pore water. The sediment chemistry results don't appear to explain the reason for the observed biological responses. The observed biological responses may be due to a chemical contaminant that was not analyzed, such as chlorpyrifos.

Since resuspension and resettling of sediments is one of the mechanisms for lateral transport of DDT and its metabolites, it is likely that the sources of DDT and its metabolites in the sediments of Anaheim Bay include bioturbation, the open ocean's incoming tides, the bottom sediments in Huntington Harbor, and ultimately urban runoff from the channels tributary to these water bodies. A Toxicity Identification Evaluation (TIE) study on sites that exhibit acute toxicity in the sediments would establish whether DDT is the primary cause of the toxicity observed. Since DDT and its metabolites accumulate in fatty tissues, a study exploring the bioaccumulation of these in fish should be done to determine whether fish consumption would be appropriate for Huntington Harbor and Anaheim Bay. These important fish tissue studies have been initiated; however, data from these samples was not available for review at this time.

Clean Water Act 303 (d) List of Impaired Waterbodies Recommendations:

As indicated previously the 303(d) Listing Policy was used in assessing the data from this study to determine if Anaheim Bay or Huntington Harbour should be proposed for inclusion on the 303(d) List and for which constituent(s). The following table describes the number of sites where exceedances of the Listing Policy's sediment quality guidelines occurred. It should be noted that in 2006 State Board staff

has utilized the data and information from this study to make revisions to the 303(d) List for Anaheim Bay and Huntington Harbour. Based on the number of exceedances, Anaheim Bay and Huntington Harbor were added to the 303(d) List for sediment toxicity. The data also supported the listing of Huntington Harbor for lead and total chlordane.

Sediment toxicity tests in Anaheim Bay indicate that two stations in dry weather and 11 stations in wet weather show significant toxicity. The listing of Anaheim Bay based on these results is in conformance with the 303(d) Listing Policy, yet the infaunal data indicates that there is a large disconnect between the toxicity results and the results of the infaunal community analysis. If sediment toxicity were truly present, it would be reflected in the degradation of the feral invertebrate community; however no degradation was observed. All 13 stations with sediment toxicity indicate normal invertebrate communities are present. Further, while some chemical constituents may be present in concentrations above sediment guideline thresholds, these also do not appear to be adversely affecting feral invertebrate populations.

For Huntington Harbor, sediment toxicity and infaunal analysis (based on the BRI) appear to indicate substantial impairment. The levels of sediment toxicity indicated in the test results should be corroborated by a significant impact to the feral invertebrate populations, which is not case except in the BRI scores and for two stations in July 2001 that show a moderate depression in diversity index scores relative to other stations. BRI scores indicate moderate to severe impacts to the infaunal community, which do not generally correlate with diversity indices.

The lack of a reference station in Huntington Harbour makes the analysis of impairment difficult because it is not known exactly what the communities should look like in an un-impacted environment. Consequently, conclusions must be made based on the data available, related published studies, and benchmarks, like the sediment quality guidelines (SQGs: ERL/ERM) and BRI. However, SQGs are benchmarks and guidelines only and are not intended to be used as the only basis for including a waterbody on the 303 (d) List. SQGs should be used in conjunction with other lines of evidence to reach a valid, defensible conclusion. While the sediment geochemistry data indicate elevated concentrations of some chemical constituents, they do not correlate to the observed infaunal communities, as based on traditional metrics (i.e., Shannon-Weiner diversity, species evenness).

Finally, bay and harbors throughout the Southern California Bight were sampled in the summer of 2003 as part of the Bight'03 regional monitoring study, lead by the Southern California Coastal Water Research Project (SCCWRP). The analyses included sediment geochemistry, infaunal community analysis, and sediment toxicity. The most appropriate analysis of Anaheim Bay and Huntington Harbor data would be to include a comparison of these metrics to natural bays with similar characteristics, but which would represent the reference condition. At this time, the technical reports for sediment geochemistry and infaunal communities are not published from the Bight '03 studies; only the toxicity report has been released. The comparison of Huntington Harbour to the Bight '03 data may be done in the future once the Bight '03 data is available.

Table 12. Anaheim Bay Number of Stations Exceeding SQGs:

Chemical	Wet Season Stations Exceeding ERM	Dry Season Stations Exceeding ERM	Wet Season Stations Exceeding ERL	Dry Season Stations Exceeding ERL	Wet Season Stations Exceeding FED Listing Policy SQG	Dry Season Stations Exceeding FED Listing Policy SQG
Antimony	0	0	N/A	N/A	0	0
Arsenic	0	0	8	1	0	0
Cadmium	0	0	0	0	0	0
Chromium	0	0	0	0	0	0
Copper	0	0	11	14	0	0
Lead	0	0	0	1	0	0
Mercury	1	0	4	0	1	0
Nickel	0	0	11	11	N/A	N/A
Silver	0	0	0	0	0	0
Zinc	0	0	9	2	0	0
Total Chlordane	0	0	30	28	0	0
Dieldrin	0	0	ND	ND	0	0
Total DDT	1	1	30	28	-	-
Endrin	0	0	--	--	0	0
Total PCB	0	1	0	2	0	0
2-methyl naphthalene	0	0	1	0	1	0
Phenanthrene	0	0	1	0	0	0
Low mol wt PAH	0	0	1	0	0	0
Benz(a) anthracene	0	0	2	0	0	0
Benzo(a) Pyrene	0	0	1	0	0	0
Chrysene	0	0	2	0	0	2
Dibenz(a,h)anthracene	0	0	0	0	0	0
Pyrene	0	1	2	0	0	1
High mol wt PAH	0	0	2	0	0	0
Total PAH	0	0	0	0	0	0

Table 13. Huntington Harbor Number of Stations Exceeding SQGs:

Chemical	# of Wet Season Stations \geq ERM	# of Dry Season Stations \geq ERM	# of Wet Season Stations \geq ERL	# of Dry Season Stations \geq ERL	# of Wet Season Stations \geq FED Listing Policy SQG	# of Dry Season Stations \geq FED Listing Policy SQG
Antimony	0	0	N/A	N/A	0	0
Arsenic	0	0	8	9	0	0
Cadmium	0	0	0	0	0	0
Chromium	0	0	0	0	0	0
Copper	0	0	30	27	0	0
Lead	0	0	20	20	3	4
Mercury	0	0	30	30	0	0
Nickel	0	0	0	0	N/A	N/A
Silver	0	0	0	0	0	0
Zinc	0	0	0	0	0	0
Total Chlordane	3	6	29	29	3	6
Dieldrin	0	0	ND	ND	0	0
Total DDT	6	1	30	30	--	--
Endrin	0	0	--	--	0	0
Total PCB	0	0	0	10	0	0
2-methyl naphthalene	0	0	0	0	0	0
Phenanthrene	0	0	0	0	0	0
Low mol wt PAH	0	0	0	0	0	0
Benz(a) anthracene	0	0	0	0	0	0
Benzo(a) Pyrene	0	0	0	0	0	0
Chrysene	0	0	0	0	0	0
Dibenz(a,h)anthracene	0	0	0	0	0	0
Pyrene	0	0	0	0	0	0
High mol wt PAH	0	0	0	0	0	0
Total PAH	0	0	0	0	0	0

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