FINAL REPORT

ON

POLYNUCLEAR AROMATIC HYDROCARBON CONTAMINATION IN SEDIMENTS FROM COASTAL WATERS OF SOUTHERN CALIFORNIA

TO

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
P.O. BOX 100
SACRAMENTO, CA 95801

UNDER STANDARD AGREEMENT
NO. 5-174-250-0

FROM

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EXECUTIVE SUMMARY

While extensive analyses have been conducted in Southern California over the past seventeen years regarding the concentrations of trace metals and chlorinated organics (DDTs and PCBs), few data are available concerning the contamination of sediments or biota from polynuclear aromatic hydrocarbons (PAH). This study for the California State Water Resources Control Board (CSWRCB) was designed to provide an overview of the nature of PAH contamination at 24 sites in Southern California, extending from Santa Monica Bay to San Diego Bay. The locations, which include several river sites, receive a wide range of contaminant inputs. The data were evaluated on a basis of potential sources and the likelihood of the levels of PAH contamination producing an impact on benthic species.

The analyses of PAH generated in this study included 24 stations, three samples per station and 43 individual PAH (including isomers of naphthalenes and phenanthrenes) concentrations for each sample. Background concentrations of total PAH were about 150 ppb (ng/g dry weight). The SCCWRP reference station at San Mateo Point (R52-60) near Dana Point and the Point Loma outfall station both exhibited this level of total PAH. When total organic carbon (TOC) content of the sediment is used to "normalize" PAH concentrations, the values for San Mateo Point and Point Loma become 13 μg/g TOC (ppm) and 22 μg/g TOC, respectively. If the remaining contaminated sites are evaluated on a basis of ng/g dry weight, the highly contaminated locations contain two orders of magnitude higher PAH than the baseline values.

The highest contamination (13-16 μg/g) was found at stations in Los Angeles (Station 6) and San Diego (Station 24) Harbors. Two outfall stations (Santa Monica Bay 7-mile and Palos Verdes 7-3) contained about 10 μg PAH/g dry weight, which was similar to the concentration found in Queensway Bay at the mouth of the Los Angeles River. Two other stations in San Diego Bay (22 and 23) contained total PAH concentrations above 5 μg/g. These seven

stations seem to be separated from the remaining 17 by about 2 to 4 µg PAH/g dry weight.

TOC normalized total PAH concentrations provide a somewhat different distribution pattern. The same two harbor stations (6 and 24) are still the most contaminated, and stations 7, 22, and 23 are among those sites containing the highest levels. However, due to the higher organic carbon content at the outfall stations (3 and 4), these normalized concentrations decreased to a level observed at several other sites. The Orange County outfall (station 12) and some river stations which were relatively low on a basis of µg/g dry weight, increased to levels that were in the upper 50 percentile after TOC normalization.

In addition to producing the total PAH values described above, it was important to examine the data for trends in specific component distribution that might help determine sources of the PAH. Changes are evident in the composition (mean percentage contribution) of PAH contamination for three dominant groups of stations. There is a gradual shift in the distribution of the petroleum derived PAH referred to as naphthalenes and phenanthrenes (compounds 5-16) corresponding to a decrease in the fossil fuel pollution index (FFPI) from group 3 to group 5 stations. As the naphthalenes and phenanthrenes decrease there is a trend toward a pyrogenic PAH pattern exhibited in group 5. These higher molecular weight compounds are less water soluble and therefore exhibit lower bioavailability. While acute (short term) toxicity is not likely to result from exposure to sediments containing the pattern of group 5, there are still possible chronic effects, including mutagenicity and carcinogenicity.

From examination of the literature on the biological effects of PAH bound to sediment, it appears that threshold levels of PAH contamination might be between 5 and 15 µg/g dry weight and around 200 to 500 µg/g TOC. The sediments studied in this project are well within the range of PAH concentrations that may produce acute or chronic effects on benthic organisms. To avoid the loss of time and to make the most cost-effective use of chemical analyses already conducted, it is recommended that sediment toxicity testing with selected sediments be initiated as soon as possible.

ACKNOWLEDGEMENTS

The authors wish to thank Harold Stubbs and Dario Diehl of SCCWRP for collecting the marine sediment samples. Henry Schafer was responsible for obtaining river samples and he was aided by Allan Chartrand of the Los Angeles Regional Water Quality Control Board and Joann Schneider of the Santa Ana Regional Water Quality Control Board. Samples were extracted and carefully prepared for analyses by Skip Westcott and Charles Ward of SCCWRP. Analyses of total organic carbon (TOC) were conducted by Global Geochemistry, Inc. We also thank our sponsors, the City of Los Angeles, the Los Angeles County Sanitation District, Orange County Sanitation District, and the City of San Diego for making available at no cost the use of their vessels and staff for the collection of these samples. Finally, we appreciate the advise and discussion provided by Dr. Robin Severeid, the technical representative of the California State Water Resources Control Board, who funded this project.

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INTRODUCTION

For the past 17 years there has been a major effort to determine the levels of trace metals and chlorinated hydrocarbons in water, tissue and sediments from the coastal waters of southern California. There is a massive amount of data available on the results of these analyses conducted by the Southern California Coastal Water Research Project (SCCWRP), and the ocean dischargers in the region. Additional studies have been conducted by academic scientists as well as state and federal agencies. Findings from the studies on metals, DDTs and PCBs can be found in journal publications and reports from SCCWRP and state agencies. We are in a rather strong position in southern California to define the levels of these contaminants in sediments extending from Ventura to San Diego.

There is a stark contrast between the expansive data base on chlorinated hydrocarbons and minute bits of information on the levels of aromatic hydrocarbons including polynuclear aromatic hydrocarbons (PAH). To our knowledge the study by Swartz et al (1985) describing sediment collections in 1980, with the aid of SCCWRP, along the Palos Verdes shelf contains the first PAH analyses of a southern California coastal region influenced by ocean discharge of municipal wastes. Recent data (unpublished) supplied by these researchers shows some decrease in the levels of PAH at the same stations from 1980 to 1983. The California State Water Resources Board funded an investigation by Malins et al in 1985 which included PAH analyses at six stations between Santa Monica Bay and Dana Point. The results of the above studies will be used in comparisons to the data on aromatic hydrocarbons generated in this study.

OBJECTIVES

This study was designed to sample sediment from Santa Monica Bay to San Diego Bay suspected of containing high amounts of aromatic hydrocarbons. The sites included a reference station (San Mateo Point) and several river stations to provide a wider view of the range of contaminant levels in the region. Among the sites suspected to be contaminated, were outfalls, inner harbors and back bay stations. The selection of stations incorporated some sites previously sampled by Swartz et al (1985, 1986) and Malins et al (1986). The primary objective of the study was therefore to confirm analytical data on PAH concentrations reported in previous studies at a few stations and to extend the survey to many sites receiving non-point source inputs of contaminants. These results will provide an overview of the relative nature of PAH contamination at 24 sites in southern California (Figure 1) receiving a wide range of contaminant inputs and allow the State Water Resources Board and the Regional Water Quality Control Boards to focus their concern on sites requiring further investigation.

METHODS

The techniques used to obtain sediment samples from offshore stations are well established and standardized. The grabs used are modified (SCCWRP) Van Veens which take a 0.1 m^2 sample. Only the top 2 cm are taken for analyses and several small cores from the surface of each grab are combined to produce one sample. At each station, three separate grabs were taken producing three replicates for analyses. In the appendix, marine stations are listed with either Loran values or Longitude and Latitude readings, or both. At the two stations in Anaheim Bay (13 and 14), a small boat was used and a Birge Ekman dredge was used to take a sample of 125 cm^2 and 4 cm deep. The five river stations (8-11 and 17) were sampled by wading or walking to the center of the river channel. Sediments were scooped from the upper two centimeters of the river bed with a clean glass jar. The excess water was decanted and the jar sealed with a Teflon lined cap.

After sampling, sediments in pre-cleaned jars were placed on ice and transferred to the SCCWRP laboratory in Long Beach (0.5-2.0 hours) where they were placed in a freezer at -20^{o}C until extraction. The extraction and analysis procedure followed the guidelines of NOAA Technical Memorandum F/NWC-92 (October 1985).

The basic procedure was to thaw out the samples to room temperature, homogenize by stirring with a glass rod, then weigh out 20-30 g of sample into a centrifuge bottle and an additional 10-15 g into an aluminum pan for dry weight determination. Approximately 50 g of sodium sulfate, 100 ml of methylene chloride and 1 ml of surrogate spike solution (12.5 μg/ml of Naphthalene-d8, Acenaphthene-d10, Phenanthrene-d10, Chrysene-d12, and Perylene-d12) was added to each sample and the bottle rolled on a sediment extractor for 16 hours. The methylene chloride was decanted, then replenished and the sample was rolled for 6 more hours. The methylene chloride was again decanted and replenished and the sample rolled for a final 16 hours. The 3 washings were combined and reduced to approximately 2 ml by roto-evaporation.

Part of the total extract was archived and the remainder was cleaned on activated silica gel (JT Baker 40-140 mesh) and separated into 2 fractions. The hexane elution contained the aliphatic hydrocarbons (Fraction 1) and was stored, while the hexane/benzene (60:40) elution contained the aromatic hydrocarbons of interest (Fraction 2).

Analysis of the F-2 extracts was performed on a Hewlett Packard 5970 MSD and a 5880 gas chromatograph which was temperature programmed from 50^{o}C to 274^{o}C at 4^{o}C/min, then held isothermally at 274^{o}C for 35 min. Chromatographic separation was performed by a splitless injection onto a J & W Scientific DB5 30m x 0.25 mm ID capillary column with a Helium carrier flow velocity of 25 cm/sec. Mass spectra data were collected by scanning from 50-400 amu per second with an ionizing voltage of 1400 volts.

Quantification was accomplished by single mass fragment integration for each compound (Table 1). Limit of Quantification (LOQ) was determined for each component by determining the standard deviation of peak area for 7 low-level sample injections, then multiplying that standard deviation by 10. No results were quantified or reported with peak areas below this limit. All results were quantified using response factors obtained from the analysis of individual standards and were corrected for instrument response by an internal standard of either Anthracene-d10 or Benzo(g,h,i)perylene-d12. When one or more less than (<) values were present, these numbers were used in the derivation of the mean.

As indicated earlier, each sample was spiked with five different surrogate PAHs. The percent recovery was calculated for each surrogate and results for each sample were corrected for these recoveries according to Table 1. Information from these recoveries is an indication of how well each group of compounds with similar characteristics, i.e., volatility and number of rings, was extracted from each sample matrix. Surrogate recovery results are presented in the appendix on data sheets along with the mean and standard deviation for each station. As can be seen from these data, sample matrix can have an effect on the mass recovered, as well as their reproducibility. For example, station 1 had low percent TOC and low PAH concentrations and the surrogate recoveries were high with low variability. Station 7 had high concentrations of PAHs, low Chrysene and Perylene recoveries but low variability; while station 3 had high concentrations and quite variable recoveries due to matrix interference caused by the high organics present from the sludge outfall.

Due to its volatility, naphthalene-d8 recoveries averaged about 48% $\pm$ 27% with most of the loss occurring in the concentrating steps of the procedure. Several naphthalene-d8 recoveries were zero, probably due to the samples reaching dryness. For the remaining surrogates, recoveries were better. Acenaphthene-d10 averaged 82% $\pm$ 18%, Phenanthrene-d10 averaged 103% $\pm$ 18%, Chrysene-d12 averaged 89% $\pm$ 20%, and Perylene-d12 averaged 88% $\pm$ 14%.

Table 1.

SURROGATE HYDROCARBONS USED TO CORRECT PAH VALUES FOR RECOVERY

Surrogate	Major Fragment (AMU)	Aromatic Hydrocarbon
Naphthalene - d8	117	Indane
	91	n-Propylbenzene
	105	iso-Propylbenzene
	119	1,2,3,4-Tetramethylbenzene
	128	Naphthalene
Acenaphthene - d10	142	1-Methylnaphthalene
	142	2-Methylnaphthalene
	156	2,6-Dimethylnaphthalene
	156	1,3-Dimethylnaphthalene
	156	1,6-Dimethylnaphthalene
	156	2,3-Dimethylnaphthalene
	156	1,4-Dimethylnaphthalene
	156	1,2-Dimethylnaphthalene
	170	2,3,6-Trimethylnaphthalene
	170	2,3,5-Trimethylnaphthalene
	154	Biphenyl
	152	Acenaphthylene
	154	Acenaphthene
	166	Fluorene
Phenanthrene - d10	178	Phenanthrene
	192	C1-Phenanthrenes(4)
	206	C2-Phenanthrenes(4)
	220	C3-Phenanthrenes(2)
	178	Anthracene
	202	Fluoranthene
Chrysene - d12	202	Pyrene
	216	2,3-benzofluorene
	228	Benz(a)anthracene
	228	Chrysene/Triphenylene
Perylene - d12	252	Benzo(b)fluoranthene
	252	Benzo(k)fluoranthene
	252	Benzo(a)pyrene
	252	Benzo(e)pyrene
	252	Perylene
	330	9,10-Diphenylanthracene
	278	Dibenz(a,h)anthracene
	276	Benzo(g,h,i)perylene

Most of the variation in these recoveries, including values greater than 100%, can be explained by the procedure used to measure the final volume of the extract. All the samples were reduced to less than 400 µl and our ability to measure these small volumes with accuracy was not optimal. We are presently developing alternative methods that will not increase the potential for contamination. Because the surrogate recoveries were not systematically low or high in all samples, problems with the amount of surrogate added to each sample can be ruled out, but the problem of interfering mass fragments from the sample matrix cannot be ruled out.

Several steps were taken in this study to provide interlaboratory comparisons of PAH analyses for purposes of quality control and quality assurance. Table 2 shows a comparison of our recent findings for the same three stations sampled by Malins et al (1986) in a previous study for the California State Water Resources Control Board (CSWRCB). SCCWRP results are generally higher, except for Reservation Point (Table 2). One would expect our values to be greater, since a larger number of isomers within a class of compounds was quantitated in the SCCWRP study. Many of the concentrations for individual compounds are very similar. The higher concentration reported by Malins et al for our station 5 is due to a few high values for the high molecular weight compounds (particularly pyrene).

One station that has been sampled frequently is the outfall of the Los Angeles County Sanitation District (PV-7-3 or our Station 4). Table 3 compares the analyses conducted by Swartz et al (1985), Malins et al (1986), SCCWRP (1986), and Battelle Northwest. Samples analyzed by Swartz et al (1985) were collected in 1980, so direct comparisons are not appropriate. Most of our concentrations are lower than the 1980 levels, which would be expected as a result of reductions in mass emissions from this outfall. Looking at data produced by Malins et al (1986) was quite confusing until it was recognized that two of the three samples taken on their cruise and used in the composite analysis were collected a considerable distance from the outfall. Those data can, therefore, not be compared directly to ours. The relatively

Table 2. **COMPARISON OF SPECIFIC AROMATIC HYDROCARBON ANALYSES. CONDUCTED BY SCCWRP AND THE NATIONAL MARINE FISHERIES SERVICE (MALINS, 1986)**

	San Mateo Pt.		Queensway Bay		Cerritos Channel		Reservation Point	
	Malins	SCCWRP	M	SC	M	SC	M	SC
naphthalene	<3.6	<24	61	57	18	54	6.6	<31
2-methylnaphthalene	<3.7	<12(2)*	55	57(2)	8.1	39(2)	<4.4	<11(2)
1-methylnaphthalene	<3.5		25		6.0		<4.3	
biphenyl	<3.5	<12	8.8	10	1.9	<8	<4.0	<11
2,6-dimethylnaphthalene	<3.3	<12(6)	17	243(6)	5.2	112(6)	<4.0	<20(6)
acenaphthene	<3.3	<18	<6.2	9	<1.9	<12	<4.3	<18
fluorene	<3.2	<13	14	45	3.4	49	<3.8	<13
phenanthrene	9.5	43	220	591	65	487	10	16
anthracene	<2.9	6	20	41	6.2	199	11	<3
1-methylphenanthrene	<2.6	69(4)	14	640(4)	4.3	591(4)	<3.4	14(4)
fluoranthene	22	31	430	725	180	991	29	41
pyrene	13	47	560	658	180	1292	670	101
benz(a)anthracene	<2.4	9	240	292	53	645	51	42
chrysene	<2.6	24	530	578	160	1342	160	81
benzo(e)pyrene	8.8	18	250	439	93	1139	160	107
benzo(a)pyrene	<2.4	20	210	405	73	1171	180	129
perylene	<2.3	22	140	141	39	214	400	349
dibenz(a,h)anthracene	<2.6	10	63	125	26	305	14	21
TOTALS	53	299	2858	5056	922	8630	1692	401

*parenthetical values represent the number of isomers quantitated.

small standard deviations (SD) on our three separate grab samples with separate extractions provide evidence that both the sampling procedure and the extraction and analysis steps exhibit good quality control.

Replicate number 3 was divided and sent to Battelle Northwest in Sequim, Washington and the Lawrence Livermore Laboratory in California. At the time of this report, only Battelle had completed the analyses, which are shown in the last column of Table 3. For many compounds, there is reasonably good agreement between SCCWRP data and the findings of Battelle, using an additional clean-up step and capillary gas chromatography. Their values are consistently higher than ours, except where we quantitated more isomers (methylnaphthalenes). Total values are less than a factor of two different, but the list of compounds analyzed is not exactly the same.

The final interlaboratory comparison is based on analyses from three laboratories of the same reference sediments, called Duwamish III. Table 4 compares the findings of NOAA, Lawrence Livermore, and SCCWRP. All three sets of data are very similar providing perhaps the best evaluation of the quality assurance provided by SCCWRP in this study for the CWRCB.

RESULTS

To simplify the presentation of the data, only the means will be presented in the results section, combined with a description of the collection site. The remaining details of the analytical data can be found in the appendix.

A summary of the mean total concentrations of detectable aromatic hydrocarbons on a dry weight and total organic carbon (TOC) basis from each station is presented in Table 5. The range of concentrations detected was from 142 ng/g dry wt. at San Mateo Pt. (station 19) to 15,470 ng/g dry wt. at the Inner Long Beach Harbor (station 6). Also shown in Table 5 are the mean percent dry weights, which ranged from 22% at the Hyperion 7-mile Outfall (station 3) to 81% at the Chevron Outfall (station 1), and the mean percent TOC values, which ranged from 0.42% at the Chevron Outfall (station 1) to 6.38% at the Hyperion 7-mile Outfall (station 3). Percent dry weight

Table 3.

ANALYSES OF PAH IN SEDIMENTS FROM THE LOS ANGELES COUNTY OUTFALL (PV-7-3)
(ng/g dry)

Compound	Swartz et al (1980*)	Malins et al (1985)	SCCWRP Mean ± SD	SCCWRP Rep #3	Battelle Rep #3
Naphthalene	-	7	87 ± 21	90	139
Trimethylnaphthalene	-	-	701 ± 263	962	510
Acenaphthene	160	<2	<16	<16	68
Fluorene	-	<2	16 ± 4	20	286
Anthracene	623	<2	52 ± 17	49	268
Phenanthrene	290	<2	197 ± 39	231	395
Methylphenanthrenes	-	<2	773 ± 244	1053	709
Fluoranthene	294	67	157 ± 61	109	907
Benzofluoranthenes	-	-	746 ± 53	689	1344
Pyrene	838	290	401 ± 43	387	1969
Benzo(a)anthracene	1,330	4	166 ± 15	170	475
Chrysene	606	9	274 ± 13	261	1549
Benzo(a)pyrene	-	19	317 ± 8	309	1278
Benzo(g,h,i)perylene	-	-	217 ± 26	192	273
			Totals**	9082	14956

*Time of collection but publication was in 1985.
**Includes compounds not listed above

Table 4.

CONCENTRATIONS (ng/ dry g) OF PAHs IN DUWAMISH III SEDIMENTS FROM THREE DIFFERENT LABORATORIES

	SCCWRP (n=1)	Lawrence Livermore* (n=8)	NOAA (n=?)
Naphthalene	300	163 ± 92	340
Acenaphthylene	67	198 ± 120	NA**
Acenaphthene	302	196 ± 76	330
Fluorene	465	241 ± 90	340
Phenanthrene	2279	1931 ± 278	2400
Anthracene	512	515 ± 103	616
Fluoranthene	3795	3423 ± 465	3800
Pyrene	4228	4254 ± 412	4100
Chrysene	1691	4088 ± 1698	NA
Benz(a)anthracene	2117	2250 ± 567	1800
Benzo(b)fluoranthene	2898	3782 ± 534	NA
Benzo(k)fluoranthene	1441	1147 ± 685	NA
Benzo(e)pyrene	3126	2790 ± 241	2000
Benzo(a)pyrene	3617	3244 ± 522	1800
Benzo(g,h,i)perylene	3613	1560 ± 313	NA

*Personal communication
**Not analyzed

Group 3
Group 4
Group 5 - Pyr

TABLE 5. SUMMARY OF PAH ANALYSES FOR SOUTHERN CALIFORNIA SEDIMENT STATIONS

Sta.	Location	Mean % dry	Mean % TOC	Total PAH (mean) ng/g dry	Total PAH (mean) µg/g TOC
1	Chevron Outfall	81	0.42	218	76
2	5-Mile Outfall	64	0.79	393	50
3	7-Mile Outfall	22	6.38	11317	190
4	PV Outfall	37	4.28	7902	189
5	Mid-LA Harbor	52	1.45	1384	97
6	LB-Inner Harbor	48	2.78	15470	568
7	LA River Mouth	53	2.56	8599	336
8	Upper LA River	66	1.97	3564	181
9	Mid LA River	82	0.44	892	236
10	Lower LA River	83	1.20	712	83
11	San Gabriel River	43	2.49	3242	131
12	Orange Co. Outfall	65	2.11	3528	182
13	Warner Bridge	66	1.42	1204	76
14	PCH Bridge	72	1.06	165	15
15	Rhine Channel	39	1.86	2208	115
16	Back Bay Newport	49	1.17	706	59
17	Santa Ana River	68	0.56	270	48
18	Dana Pt. Harbor	53	1.13	477	42
19	San Mateo Pt.	58	1.06	142	13
20	San Diego Outfall	64	0.69	154	22
21	San Diego Bay (N)	65	0.62	1205	197
22	San Diego Bay (NASSCO)	43	1.89	7588	401
23	San Diego Bay (Chollas)	49	1.63	5459	336
24	San Diego Bay (7th St.)	50	2.28	12802	562

gives an indication of the grain size of collected sediments. Sand, about 80% dry weight, is found at the Chevron Outfall (station 1); while the finest sediments contain more water, and are found at the Hyperion 7-mile Outfall and the Palos Verdes Outfall (stations 3 and 4, respectively). Percent TOC is a normalization approach gaining acceptance in the scientific community, as it provides some estimate of the bioavailability of the bound hydrocarbons.

The remaining portion of this section will provide a review of the potential sources of contamination to the sediments, followed by the results of the analyses. Figure 1 illustrates the locations of the stations.

Station 1. Chevron Outfall (4/21/86)*

Station 1 is located approximately 250 meters off the beach in 3.6 meters of water at the end of the Chevron El Segundo Petroleum Refinery outfall. The sample consisted of medium grain sand. The outfall discharges approximately seven million gallons per day (MGD) of process and cooling water. Seaward of the outfall, petroleum products are transfered between the refinery and tankers by means of submerged pipelines.

It might be expected that a considerable amount of petroleum would be incorporated into the sediments surrounding this outfall. However, relatively low concentrations of aromatics, ranging from phenanthrene to benzo(g,h,i)perylene were detected in the three replicates from this station. The total of all measured aromatic hydrocarbons was only 218 ng/dry g (ppb), or 76 μg/g TOC. The energy of this nearshore environment and the corresponding large grain size (sand with 19% water content) are the factors likely producing the relatively low concentration. Since the organic content was low at this station, normalization resulted in a value that is greater than station 2 (5-mile outfall), which exhibited a higher TOC content.

Station 2. Hyperion Five Mile Outfall (4/21/86)

Station 2 is located in 60 meters of water between the two diffuser legs of the five mile outfall. The sediment sample consisted of silty sand. The

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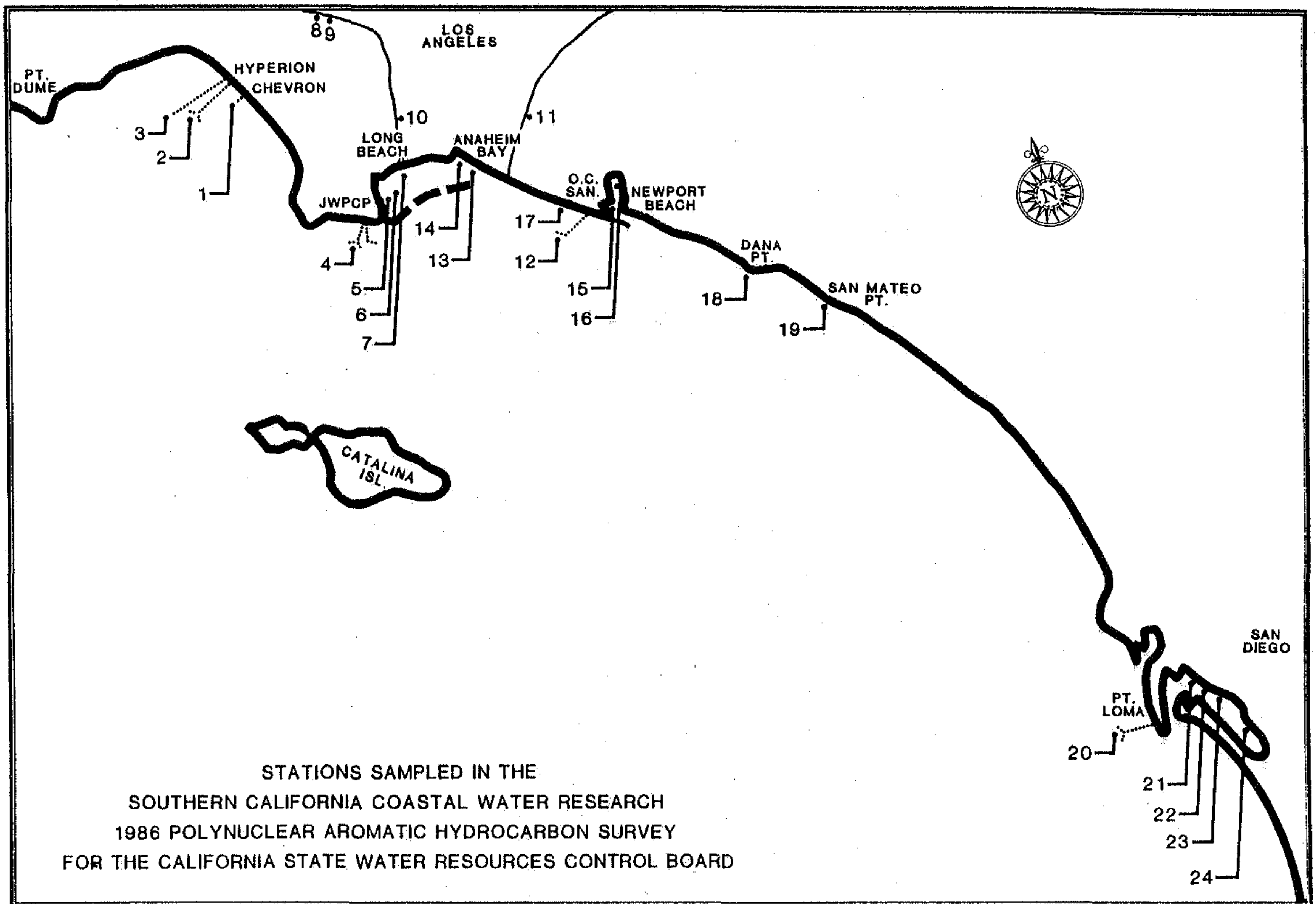
*Date of Sampling


PT. DUME
HYPERION
CHEVRON
LOS ANGELES
8
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LONG BEACH
ANAHEIM BAY
JWPCP
O.C. SAN.
NEWPORT BEACH
DANA PT.
SAN MATEO PT.
CATALINA ISL.
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STATIONS SAMPLED IN THE
SOUTHERN CALIFORNIA COASTAL WATER RESEARCH
1986 POLYNUCLEAR AROMATIC HYDROCARBON SURVEY
FOR THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

Figure 1.

outfall discharges approximately 400 MGD of 3:1 primary:secondary effluent. The seven mile outfall is closest additional potential source of contaminants.

PAH analyses of these sediments show relatively low concentrations of individual components (generally 10-30 ng/dry g) producing a total value of 393 ng PAH/dry g or 50μg/g TOC. Naphthalenes and phenanthrenes are present at about the same concentration as higher molecular weight compounds. It should be noted that the concentration of particulate matter in the 5-mile effluent is much lower than from the discharge of sludge from the 7-mile outfall. The flow of the 5-mile pipe is about 2 orders of magnitude greater than that at the 7-mile outfall and the total mass emission of solids is about the same (40,000 mt/y). The concentration of solids is therefore about 2 order of magnitude higher in the 7-mile outfall. The findings at Station 2 should therefore be compared to those at the 7-mile site below.

Station 3. Hyperion Seven Mile Outfall (4/21/86)

Station 3 is located in 154 meters of water near the head of the Santa Monica Canyon. The sample was black with a very high organic content. The outfall discharges approximately 3 MGD of digested sludge diluted with 2 MGD of secondary effluent at the head of the canyon in 100 meters of water. The concentrations of metals and organics in the sludge are likely to be relatively high.

The total concentration of PAH found at this site (11,317 ng/dry g) was about 30 times greater than the value for the 5-mile outfall. Most components quantitated were well represented in the sediments at generally 100 to 1000 ng/dry g. Therefore, the majority of the contaminants deposited in Santa Monica Bay are from the discharge of sludge. It is expected that this major input will be drastically reduced in the near future as the sludge line is terminated and the material is combusted. Due to the high organic content of the sludge, the normalized PAH concentration is less than four times (190 μg/g TOC) the concentration at the 5-mile outfall.

Station 4. White Point Outfall (7/25/86)

Station 4 is in 64 meters of water near the diffuser at the end of Los Angeles County Sanitation District's outfall. The sediment was silt with a strong sulfide smell. The Joint Water Pollution Control Plant (JWPCP) dicharges about 350 MGD of 0.9:1.0 advanced-primary:secondary effluent. This station is also identified as Palos Verdes 7-3 in reports from JWPCP and SCCWRP. Historic discharges from this outfall are also a potential source of contaminants.

The samples taken from this location contained a total PAH concentration of 7,902 ng/g dry weight of sediment. There were detectable amounts of all quantitated aromatic hydrocarbons, except benzo(k)fluoranthene. Significant amounts of naphthalenes and phenanthrenes were present which indicates the presence of petroleum products in the discharged wastes. As will be noted later, naphthalenes are not present in a majority of the samples, probably due to both higher solubility (than most other compounds) and relatively rapid rates of degradation. There are multiple sources for most of the other high molecular weight compounds and it is not surprising to find these in discharge that collects wastes from an exceptionally large area. The relatively high TOC content of the sediment (4.28%) produced a normalized value of 189 μg/g TOC.

Station 5. Mid-Los Angeles Harbor (6/27/86)

Station 5 is near Fish Harbor in the outer portion of the Los Angeles Harbor, midway between the San Pedro and Long Beach entrance in the breakwater, in seven meters of water. The sediment contained silt and clay with no sulfide smell. The site is near the Terminal Island Sewage Treatment Plant outfall which discharges about 15 MGD of secondary effluent. There are many potential sources of petroleum contamination in the general harbor area.

The Station in mid-harbor is intermediate in contamination with a total concentration of 1,384 ng of PAH per g dry weight. The lowest molecular weight compound detected was phenanthrene at 16 ng/dry g. The majority of contamination was from pyrene, benzo(b)fluoranthene, benzo(e and a)pyrene and perylene. These compounds could have been contributed by aerial transport, storm runoff, waste discharge from terminal island and spillage of petroleum products. The lack of low molecular weight compounds indicates no recent spills of petroleum. The normalized value was 97 μg/g TOC.

Station 6. Long Beach Inner Harbor (6/27/86)

Station 6 is in the East Turning Basin within the inner Long Beach Harbor in 15 meters of water. The sample was silty clay with a slight sulfide smell. The largest probable source of contaminants is the Dominguez Channel which historically discharged highly contaminated petroleum effluents but there is also considerable industrial and shipping activity in this region.

The concentration of aromatic hydrocarbons measured at this station is the highest of the 24 sites sampled in this study. The total concentration of 15,470 ng/dry g is high even for harbor areas as will be clear after reviewing our remaining stations. Most compounds on our list were present in significant quantities including the naphthalenes and phenanthrenes. Numerous compounds between phenanthrene and benzo(g,h,i)perylene are present at concentrations of 0.5 to over 1.0 parts per million (μg/g). Petroleum related activities (past and present) combined with the fueling of large vessels are likely responsible for the contamination. Even after dividing by a TOC value of 2.78%, the normalized concentration is the highest observed in this study (568 μ/g TOC). It is unlikely that benthic organisms could survive in these sediments, but bioassays would be required to test the specific toxicity.

Station 7. Los Angeles River Mouth (6/27/86)

Station seven is located in the middle of Queensway Bay just below the last bridge crossing the Los Angeles River. The sample was black silt with some clay, and had a slight sulfide smell. Storm water runoff down the river is the most likely source of contaminated sediments.

Analyses show that this material is very similar in both total concentration and component composition to the sediment collected from the Palos Verdes outfall of Los Angeles County. The total concentration was 8,599 ng/dry g of aromatic hydrocarbons (336 μg/g TOC) and naphthalenes and phenanthrenes were well represented. It is most interesting that the sediments deposited in a basin at the mouth of the Los Angeles River are very similar to those discharged from a major outfall and both collect drainage from the same region. The inner harbor which lies between the two sites contains about twice as much of the same compounds indicating storm runoff as a major contributor.

Station 8. Los Angeles River (upper) (4/24/86)

Station 8 is located in the San Fernando Valley just below Balboa Avenue. The river bottom is not lined in this area but the sides are rock reinforced. The sample contained sand, silt and a small amount of black organic material. This site is above the oil spill channel which experienced a spill about two weeks before sampling. The site is above any municipal effluent inputs and the flow is principally due to stream and road runoff.

These samples contained about one-half the amounts of most aromatic hydrocarbons found at Station 7. Total concentration (3,564 ng/dry g) and component analyses follow this pattern, except that naphthalenes are not present. This indicates that much of the contamination on particles finally deposited at the river mouth is being "collected" from up-river, but the source of the lower molecular weight compounds is farther down-river. There was a moderatley high organic content (1.97% TOC) producing a normalized value of 181 µg/g TOC.

Station 9. Los Angeles River (mid) (4/24/86)

Approximately 20,000 gallons of oil spilled from a pipe rupture in a small tributary storm channel between 6 and 7 April, 1986.

Station 9 is about 400 meters downstream of Station 8 and 200 meters below the small storm channel. The sample consisted of sand that had a slight petroleum smell.

While it was suspected this sample may contain components of petroleum from a recent spill, there is little evidence of oil. As noted for the Chevron outfall (Station 1), sand does not retain hydrophobic compounds, as petroleum hydrocarbons, as well as silt and clay. The lower total value (892 ng/dry g) found at this site compared to upstream is further evidence of this fact. This sample exhibited a higher normalized value (236 µg/g TOC) because of the low TOC content (0.44%).

Station 10. Los Angeles River (lower) (4/25/86)

Station 10 is in Long Beach just below the Willow Street bridge. The sample was taken at the upper end of the tidal prism where the concrete lining ends. The sample consisted of coarse sand that had a slight petroleum smell. There were still oil booms and vacuum trucks deployed but only traces of oil in the water from the spill two weeks earlier.

These sediments were very similar to those collected at Station 9, up-river. It is likely the nature of the sediments (sand) produced the same relatively low (712 ng/dry g) concentration. There was still no evidence of fresh oil, as the naphthalenes were absent. The TOC content of this sample was about three times higher than station 9 (1.20%) which produced a normalized PAH value of 83 μg/g TOC.

Station 11. San Gabriel River (7/9/86)

Station 11 is located in the upper tidal prism just above the College Park bridge. The San Gabriel River and Coyote Creek combine a short distance above this site. The sample was composed of silt and had a slight petroleum smell. Municipal wastewater effluents and road runoff are responsible for most of the flow.

While no signs of fresh petroleum inputs (naphthalenes) were evident in these sediments, the total concentration of PAH (3,242 ng/dry g) is considerable higher than stations 9 and 10, above, from the L.A. river. The concentrations of each of the components are about one-half of the values shown for the Los Angeles River mouth (Station 7), except the concentrations of naphthalenes and phenanthrenes are considerably lower in the San Gabriel River. There would seem to be more petroleum input to the Los Angeles River, but the sediments from our sampling of stations 9 and 10 do not well represent the concentrations on particles deposited in Queensway Bay (station 7). The concentration of TOC (2.4%) at station 11 was similar to that at the L.A. River mouth (station 7), but the normalized concentration was lower (131 μg/g TOC).

Station 12. Orange County Outfall (6/6/86)

Station 12 is located 8 kilometers off Huntington Beach in 60 meters of water at the end of the Orange County Sanitation Districts outfall. The sample was a silty clay with a slight sulfide smell. The Orange County outfall discharges 230 MGD of 1:2 primary:secondary effluent.

Sediments from the outfall site contain a total of 3,528 ng PAH/dry g and most components measured (including naphthalenes) were present. Concentrations of individual compounds are about one-half those at the Palos Verdes Outfall, except the proportion of naphthalenes and phenanthrenes is lower in sediments from Orange County. This may mean that inputs to the district from petroleum activities are under better control. The sediments contained an intermediate level of TOC (2.11%) and the normalized value for PAH was 182 μg/g TOC. Normalization increases the relative ranking of this station as compared to all other stations. Recent data from the monitoring program and SCCWRP indicate that levels drop sharply during the winter.

Station 13. Anaheim Bay (Warner Bridge) (7/31/86)

Station 13 is located in Anaheim Bay close to the channel that links Bolsa Chica Reserve with Anaheim Bay. The sample was taken in 3 meters of water and consisted of clay, silt and sand with a slight sulfide smell. Possible sources of contaminants are road runoff, yacht slips, and the extensive oil fields bordering Bolsa Chica.

The total concentration of aromatic hydrocarbons (1,204 ng/dry g) was higher than might be expected for this type of small marina. Fluoranthene, pyrene, chrysene and benzo(b)fluoranthene were the major contaminants, but phenanthrenes and high molecular weight compounds were present in significant amounts. It would appear that storm runoff produces a significant input to this site, since Station 14, on the seaward side of this small harbor contains much less PAH contamination. The intermediate TOC content (1.42%) produced a normalized value of 76 μg/g TOC.

Station 14. Anaheim Bay - Edinger Street

(Pacific Coast Highway Bridge) (7/31/86)

Station 14 is located in the entrance channel to Anaheim Bay just seaward of Pacific Coast Highway. The samples were taken in five meters of water and were composed of silty sand. Potential sources of contamination are: storm drains, small boat traffic and any discharges from the Naval weapons depot.

PAH concentrations at this station were about one order of magnitude lower (165 ng/dry g) than those of Station 13. Certainly, the higher flushing rate of the site contributed to the difference, but the inputs from runoff may not be as direct as those for Station 13. It would not appear that Naval activities in the area have contributed any PAH contamination to this channel entrance. TOC content was 1.06%, and the normalized PAH value was near the lowest found in this study (15 μg/g TOC).

Station 15. Newport Bay (Upper Rhine Channel) (6/19/86)

Station 15 is located in the western end of lower Newport Bay near the entrance to Rhine Channel. The sample was taken in 3 meters of water and consisted of silt and clay. In addition to the many yachts there were several boat repair facilities throughout this part of the bay.

This inner harbor station contained higher PAH levels than some of the sites in Los Angeles Harbor and San Diego Bay which receive better exchange with the ocean. The total PAH concentration of 2,208 ng/dry g represented primarily high molecular weight compounds (fluoranthene-benzo(g,h,i)perylene). There was no evidence of recent inputs of fresh petroleum products. The TOC value of 1.86% produced a normalized PAH content of 115 μg/g TOC.

Station 16. Newport Bay (Back bay) (6/19/86)

Station 16 is located in the main inflow channel from back Newport Bay near the Newport Dunes Aquatic Park. The sample was collected in two meters of water and consisted of silty clay. In addition to the general harbor sources of contaminants, upper Newport harbor receives considerable storm runoff and sediments in the rainy season.

There was an unusual pattern of contamination from aromatic hydrocarbons, while the total concentration was relatively low (706 ng/dry g). About one-half of the contamination was from naphthalene (355 ng/dry g), but alkylnaphthalenes and phenanthrenes were not present. Diesel oil which may have been spilled from nearby dredging operations would have contained high amounts of naphthalene and alkylnaphthalenes. The parent compound would also degrade faster than the methylated isomers. Either 2 of the 3 sample containers were contaminated with naphthalene, which is very unlikely, or there was some recent discharge of this compound in the area. After normalization (1.17% TOC), the PAH value was 59 µg/g TOC.

Station 17. Santa Ana River (Prado Dam) (7/3/86)

Station 17 is 100 yards below the Prado Dam release gate, which is approximately 26 miles above the mouth of the Santa Ana River. The sample was taken from mid stream and consisted of dark sandy silt. The drainage basin above the dam is mostly undeveloped or agricultural.

There were very small amounts of several PAH compounds in this sample, but the sediments were, in general, relatively clean (270 ng/dry g). The low TOC content (0.48%) produced a normalized value of 48 µg/g TOC.

Station 18. Dana Point Harbor (5/8/86)

Station 18 is located in 5 meters of water on the eastern side of Dana Point Harbor. The sediment was composed of silty clay. This station is located a short distance from the fuel dock so hydrocarbon contamination might be expected.

Even though this sample was taken in an area near fueling operations and exchange with ocean water is somewhat restricted, the concentration of PAH was not particularly high (477 ng/dry g). There were small amounts of most compounds between phenanthrene and benzo(g,h,i)perylene. After normalization (1.13% TOC), the PAH value was 42 µg/g TOC.

Station 19. San Mateo Point (7/25/86)

Station 19 is located 4.5 kilometers off San Mateo Point (south of Dana Point) in 60 meters of water. The sample was composed of silty clay. This site is considered a reference site due to past studies and because of the distance to any substantial point sources.

Since these samples contained the lowest concentrations of aromatic hydrocarbons found in sediments from this study (142 ng/dry g and 13 μg/g TOC), it is apparently a suitable reference site. After examining all the stations, we will return to the question regarding what is a reasonable background concentration for PAH in coastal southern California sediments.

Station 20. San Diego Outfall (6/30/86)

Station 20 is located between the diffuser legs of the Point Loma outfall in 74 meters of water. The sample consisted of silty clay. The outfall discharges 140 MGD of primary effluent and would be the most likely source of contamination.

It is rather surprising that sediments from this station, very near the outfall, contain concentrations of PAH only slightly higher than the reference site (Station 19) and well below most other stations (154 ng/dry g). Apparently, discharged particulates are not being deposited near the outfall. The relatively low TOC value (0.62%) and the low normalized PAH concentration (22 μg/g TOC) also indicate there is little deposition of contaminated particles.

Station 21. San Diego Bay (North) (7/1/86)

Station 21 is located in the northern part of San Diego Bay adjacent to a large storm outfall that drains San Diego International Airport. The sample was collected in 3.5 meters of water and consisted of silty clay. Runoff from the airport is a likely source of contaminants and other inputs from the harbor activities are possible.

The total concentration of PAH from this site (1,205 ng/dry g) and the component composition is very similar to Station 13 in Anaheim Bay. The types and levels of contaminants entering both of these back bay stations near storm channels appear to be very similar. However, the TOC value for this station is about one-half of station 13, and the normalized PAH concentration is therefore about two times as high (197 μg/g TOC).

Station 22. San Diego Bay (NASSCO Docks) (7/1/86)

Station 22 is located south of the Coronado Bridge near the docks of National Steel and Shipbuilding Company (NASSCO) in 9 meters of water. The sample consisted of silty clay. The ship yard and other shore facilities in the area are potential sources of contaminants. The concentrations of PAH were relatively high (7,588 ng/dry g or 401 μg/g TOC), even when the high TOC value (1.89%) is considered. This station ranks sixth highest on one list and fourth on the normalized list.

Station 23. San Diego Bay (Chollas Creek) (7/1/86)

Station 23 is located among the San Diego Naval Station docks at the mouth of Chollas Creek. The sample was taken in 9 meters of water and was composed of silty clay.

Runoff from Chollas Creek and the Naval ship activities are potential sources of contaminants. The composition of these samples is very similar to that of Station 22, but the amounts of each compound are slightly lower, leading to a total of 5,459 ng PAH/dry g sediment and 336 μg/g TOC. There was even a small amount of naphthalene, as at Station 22, without any contribution from alkylnaphthalenes. After discussing the next sample along San Diego Bay, a comparison of the three will be made.

Station 24. San Diego Bay (Seventh Street Channel) (7/1/86)

Station 24 is near the southern end of the San Diego Naval Station at the end of the Seventh Street Channel in 6 meters of water. The sample was silty clay with a slight petroleum and sulfide smell. A small amount of sand and gravel was in the lower portion of the grab. Besides the general harbor traffic, the channel is lined with Naval fuel dock facilities. While some contaminants could enter the channel from storm runoff, the most likely contaminants will be petroleum products from fueling activities.

The total level of PAH contamination at this station (12,802 ng/dry g or 562 μg/g TOC) is second only to the inner Long Beach Harbor sample (Station 6). All of the same components were present at similar concentrations except methylnaphthalenes, which were below the detection limit at Station 24 (<9 ng/g). It appears that Stations 6 and 24 represent the higher end (perhaps not maximum) of contaminated harbor sediments. There are likely multiple inputs including storm drains and petroleum operations.

Napthalene can often be associated with relatively recent inputs of diesel oil and other fuels, but it is generally accompanied by a number of alkylnaphthalenes. At Stations 22 and 23 only naphthalene was detected, but individual isomers of the alkylnaphthalenes may have been present at just below the detection limits for each component (about 10-20 ng/dry g). Since there were ten individual alkylnaphthalene isomers (2 methyl-, 6 dimethyl- and 2 trimethylnaphthalenes) quantitated in this study, there could be from 100 to 200 ng/dry g present in the samples but not detected. This may allow the conclusion that petroleum contributed to the contamination in the last three stations (22-24) but the varying degree of detection somewhat masks the pattern.

CONCLUSIONS

Summary of Findings

The results of our studies show that there may be two sets of stations; those with moderate to low PAH contamination, and those with relatively high contamination. On a dry weight basis, stations with total PAH values below about 3 μg/g (ppm, dry weight) form a group of 17 sites (Figure 2). Three of these stations (8, 11, and 12) might be considered a subgroup, as their concentrations are about two times most others, and they are in the 2-3 ppm range. The stations of greatest concern are those that contain PAH concentrations between about 5 and 15 μg/g dry weight. These seven stations (3, 4, 6, 7, 22, 23, and 24) contain levels of PAH that may be toxic to marine organisms.

When the total PAH values are normalized to total organic carbon content of the sediments, there are changes in the ranking of the stations from low to high (Figure 3). Stations 3 and 4 decrease to levels similar to many of the other sites and stations 8 through 12 are increased to

FIGURE 2.

Plot Of Total PAHs (ppm dry wt + 95% CL)

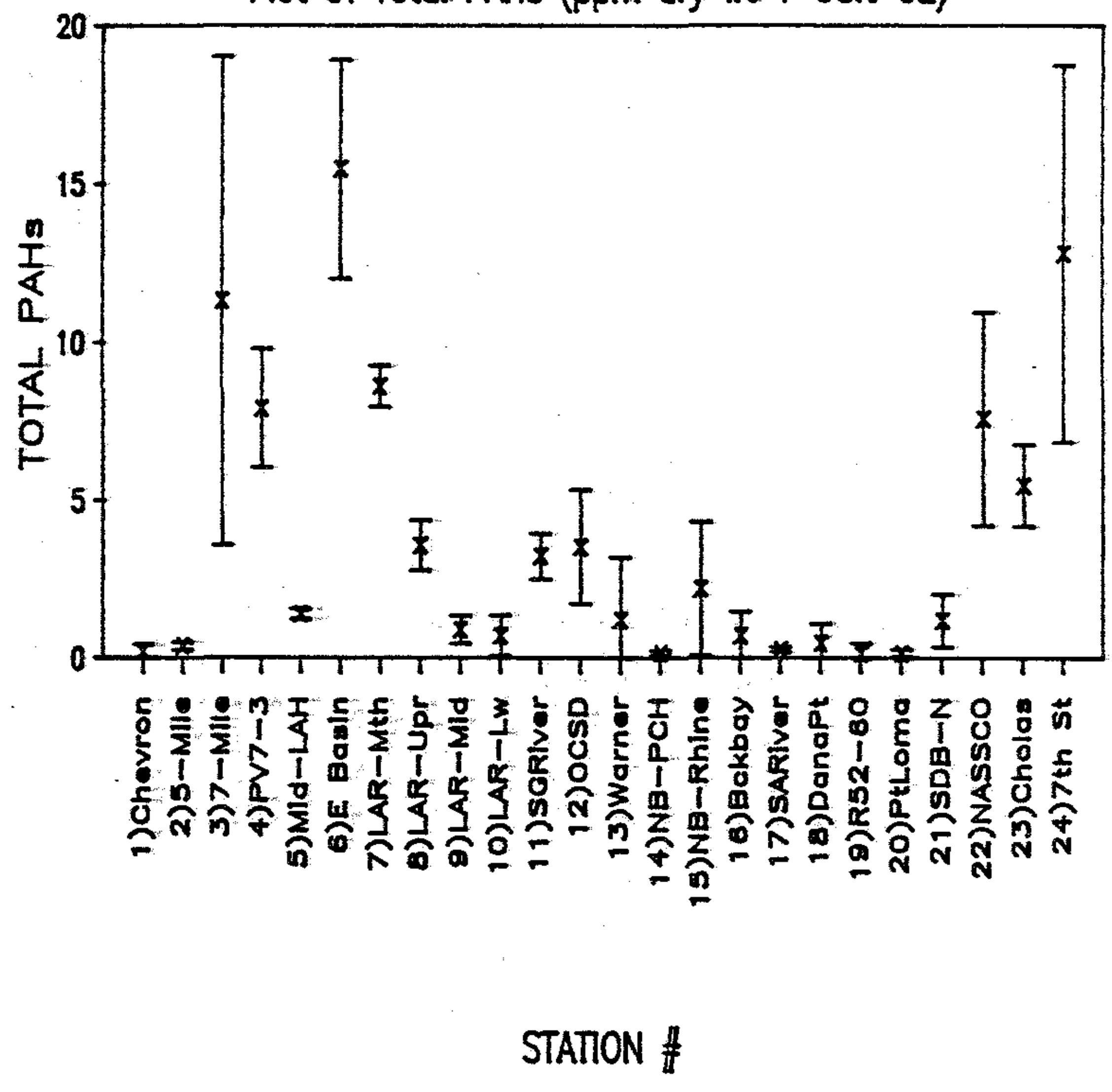
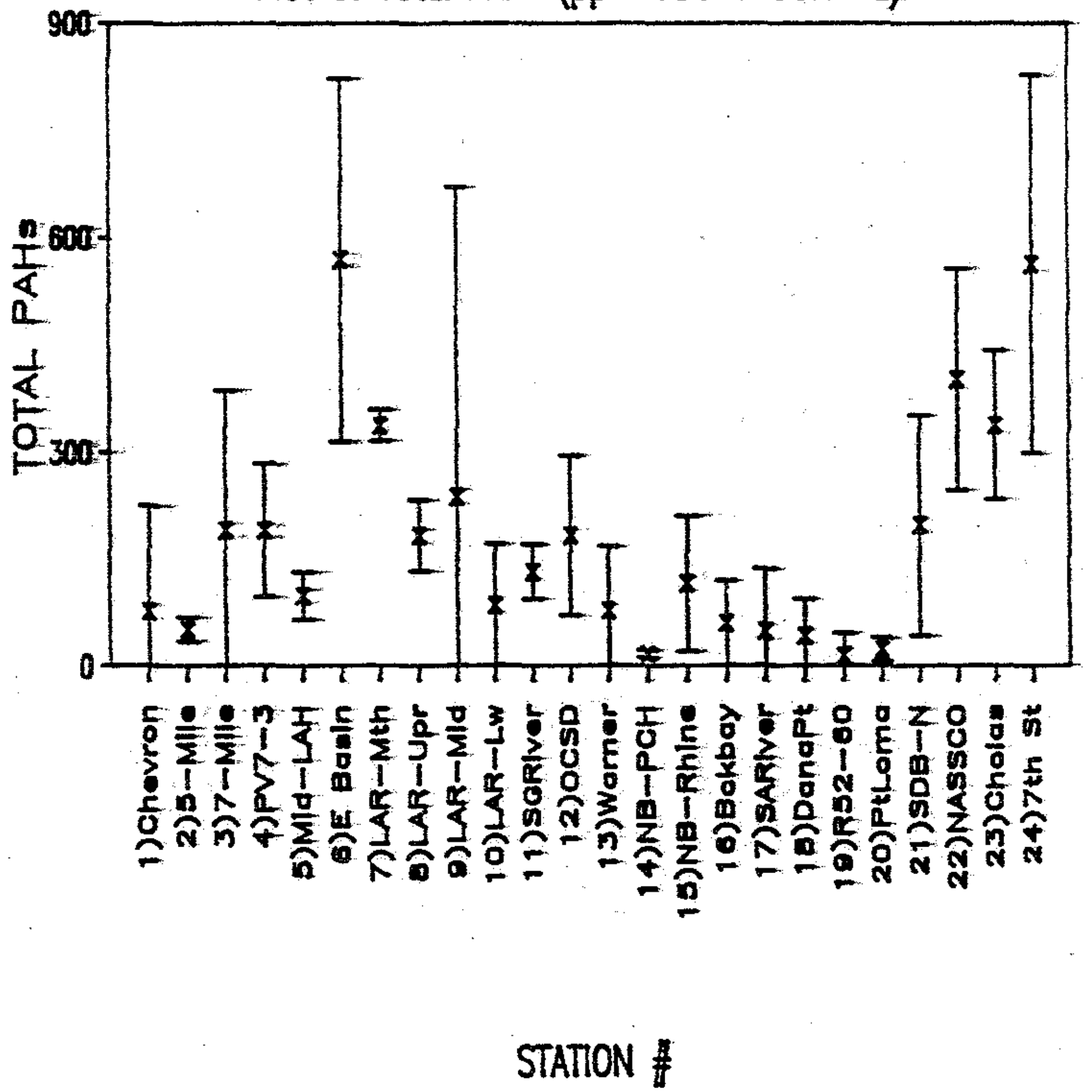


FIGURE 3.

Plot Of Total PAHs (ppm TOC + 95% CL)



concentrations that are in the higher half of the total stations. Since normalization of sediment concentrations by dividing by TOC is generally believed to produce better estimates of the bioavailable fraction of total PAH, stations 8 through 12 should be included in the list of stations with potentially toxic sediments. There are 11 stations with normalized total PAH concentrations above 181 μg/g TOC. It would be logical to select these sediments for toxicity testing to determine if TOC normalization indeed predicts the available and toxic portion of PAH contamination on sediment.

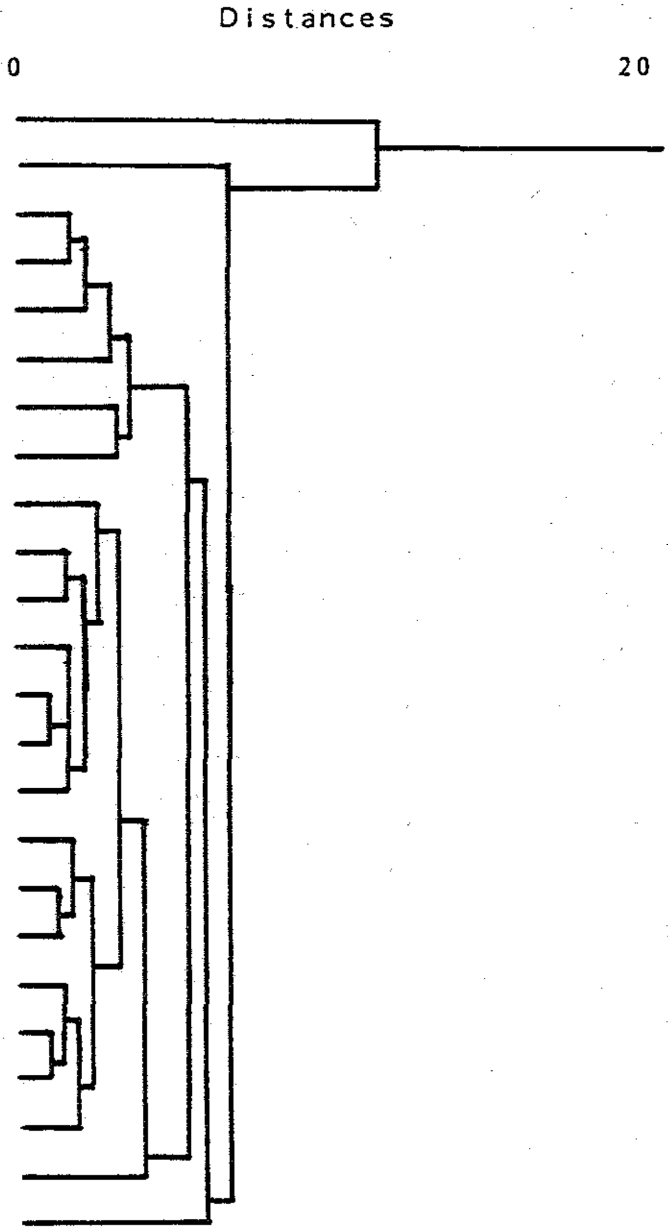
The specific PAH composition of contaminated sediment can be used to describe possible sources of inputs into each location. Boehm and Farrington (1984) discussed ranges of assemblages from pyrogenic to those containing significant amounts of fossil fuel. The ratio of fossil fuel components to pyrogenic ones can be expressed as the fossil fuel pollution index (FFPI) which we have calculated for our samples (Figure 4). Although our results did not include the dibenzothiophenes, the FFPI can still be used to indicate sources i.e. the lower the FFPI, the more abundant the pyrogenic components. The FFPI for our study ranged from .01 for the San Diego Outfall (Station 20) to .51 for Newport Backbay (Station 16).

Further analysis of the PAH assemblages was done using average link clustering of euclidean distances, which grouped our stations into three main groups plus four other stations that were independant (Figure 4). This analysis again shows that stations with a high abundance of fossil fuel PAHs grouped seprately from those with significant amounts of pyrogenic PAHs (Figures 5-9). Starting at the stations with a high influence of fossil fuel PAHs (Figure 5) it can be seen that Group 1 contained a single station, Newport Backbay (Station 16), which contained a high abundance of naphthalene relative to the other PAHs (FFPI=.51). Next, Group 2 contained the Hyperion 7-mile sludge outfall (Station 3), and is also dominated by fossil fuel PAHs (FFPI=.47) contained in the sludge. Also shown in Figure 5 is the other extreme of PAH distribution, exhibited by two stations (24 and 5) which are not closely associated with any of the other groups.

Group 3 contained Stations 10,9,18,7,19, and 4 which were less influ-

Figure 4. Dendrogram of PAH similarity using average link clustering by euclidean distances. Distances are arbitrary numbers, the lower the distance, the more similar the clustering.

Sta#	Location	FFPI*
16	Newport Backbay	.51
3	Hyperion 7-mile	.47
10	Lower L.A. River	.35
9	Mid L.A. River	.28
18	Dana Point Harbor	.35
7	L.A. River Mouth	.25
19	San Mateo R52-60	.38
4	P.V. Outfall 7-3	.44
2	Hyperion 5-mile	.21
21	N. San Diego Bay	.09
6	East Basin	.16
12	O.C. Outfall	.16
11	San Gabriel River	.08
8	Upper L.A. River	.13
1	Chevron Outfall	.08
15	Rhine Channel	.03
23	Chollas Creek	.05
20	Pt. Loma Outfall	.01
13	Warner Avenue	.08
17	Santa Ana River	.06
14	PCH Bridge	.02
22	NASSCO	.05
24	7th Street	.05
5	Mid L.A. Harbor	.05



*Fossil Fuel Pollution Index calculated by the formula: (Total Naphthalenes (C_0-C_3) + 1/2 Phenanthrenes (C_0-C_1) + Total Phenanthrenes (C_2-C_3)) / Total PAHs; Modified from Boehm and Farrington (1984).

enced by fossil fuel PAHs (FFPI=.25-.44) but are still dominated by them. This group contains stations from the LA River and the LA County outfall which my have similar sources of PAHs (Figure 6). Group 4 (Figure 7) contained Stations 2, 21, 6, 12, 11, 8, and 1 and are mid way between fossil fuel PAHs and pyrogenic ones (FFPI=.08-.21). It is interesting to note that Station 8 which is located at the upper end of the LA River grouped separately from the other LA River stations (10, 9, and 7). This may be due to the fact that Station 8 was above an oil spill that ocurred just prior to sampling, and the lower stations were influenced by that spill giving a higher FFPI. Group 5 (Figure 8) also contained several stations (15, 23, 20, 13, 17, 14, and 22) that are beginning to be dominated by pyrogenic PAHs (FFPI=.02-.08). As shown above (Figure 5), Group 6 contained the San Diego Harbor 7th Street sample (Station 24) which was significantly influenced by pyrogenic PAHs (FFPI=.05) and was dominated by Benzofluoranthenes (Figure 5). Finally, Group 7 contained the Mid LA Harbor sample (Station 5) which also had a high degree of pyrogenic PAHs (FFPI=.05), but was separated because it was the only station with a significant amount of perylene.

The final comparison of PAH distribution was prepared by plotting mean percent contribution values for the stations comprising groups 3, 4, and 5 (Figure 9). This illustration demonstrates the shift in PAH distribution from naphthalenes and high phenanthrenes (Group 3) to small amounts of the latter (Group 4) to the absence of naphthalenes and very low amounts of phenanthrenes (Group 5).

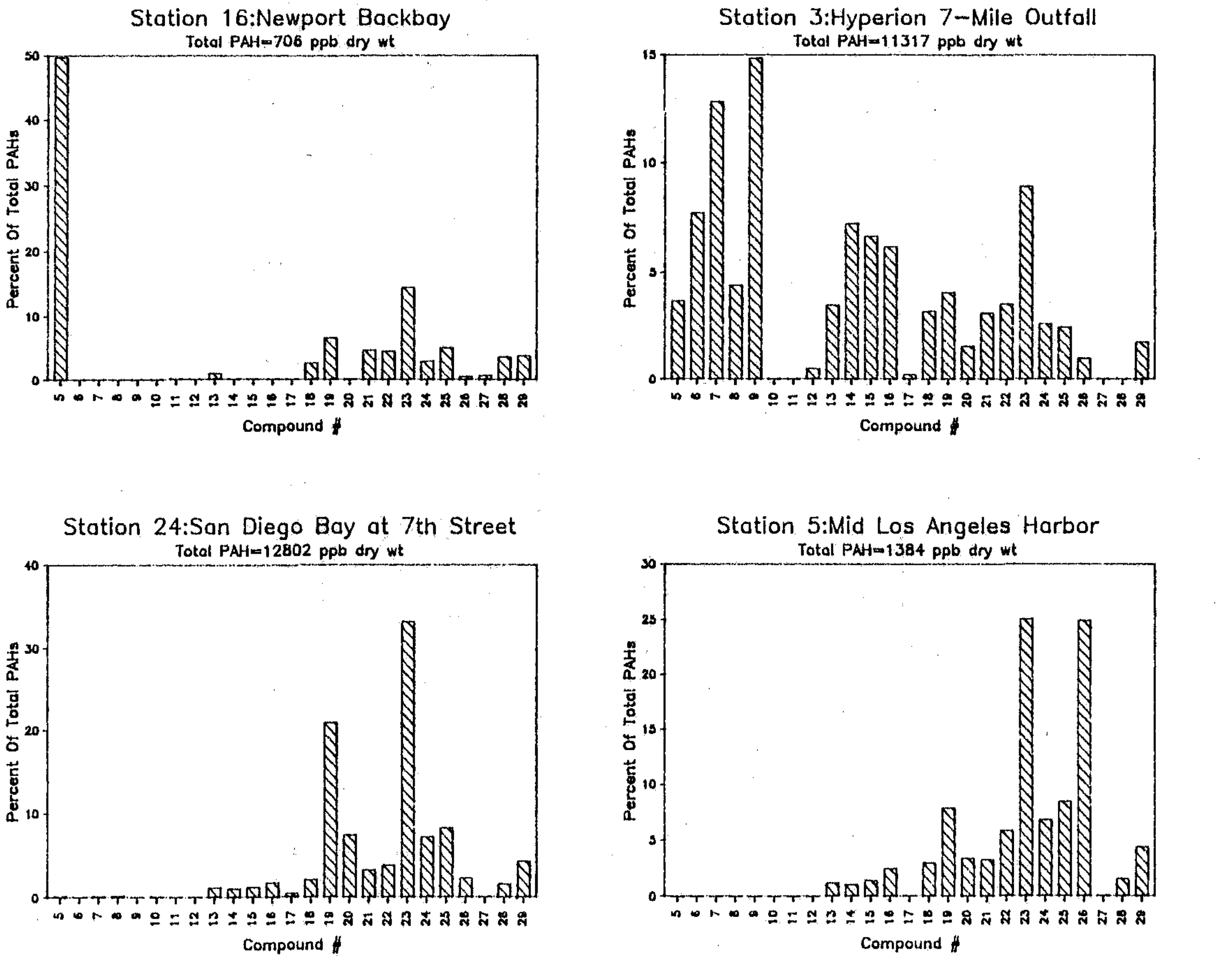
Review of Literature on Petroleum Effects

Recognizing that the most contaminated sites in this study range between 5 and 15 ppm dry weight and about 200 to 570 ppm TOC, the potential biological effects of these concentrations should be evaluated. Following oil spills or near a chronic point discharge of hydrocarbon-contaminated wastewater, hydrocarbons (PAH) tend to accumulate in bottom sediments. Once incorporated into marine sediments, hydrocarbons may be quite persistent, and impacts have tended to be most persistent, and recovery slowest, in benthic

Figures 5-8. Relative abundance (percent) of aromatic hydrocarbons at the sampling stations. Numbers used on figures correspond to the compounds listed below.

Compound #	Name
5	Naphthalene
6	C1-Naphthalenes(2)
7	C2-Naphthalenes(6)
8	C3-Naphthalenes(2)
9	Biphenyl
10	Acenaphthylene
11	Acenaphthene
12	Fluorene
13	Phenanthrene
14	C1-Phenanthrenes(4)
15	C2-Phenanthrenes(2)
16	C3-Phenanthrenes(2)
17	Anthracene
18	Fluoranthene
19	Pyrene
20	2,3-Benzofluorene
21	Benz(a)anthracene
22	Chrysene/Triphenylene
23	Benzofluoranthenes
24	Benzo(e)pyrene
25	Benzo(a)pyrene
26	Perylene
27	9,10-Diphenylanthracene
28	Dibenz(a,h)anthracene
29	Benzo(g,h,i)perylene

Figure 5.



Station 16:Newport Backbay
Total PAH=706 ppb dry wt
Percent Of Total PAHs
Compound #
Station 3:Hyperion 7-Mile Outfall
Total PAH=11317 ppb dry wt
Percent Of Total PAHs
Compound #
Station 24:San Diego Bay at 7th Street
Total PAH=12802 ppb dry wt
Percent Of Total PAHs
Compound #
Station 5:Mid Los Angeles Harbor
Total PAH=1384 ppb dry wt
Percent Of Total PAHs
Compound #

Figure 6.

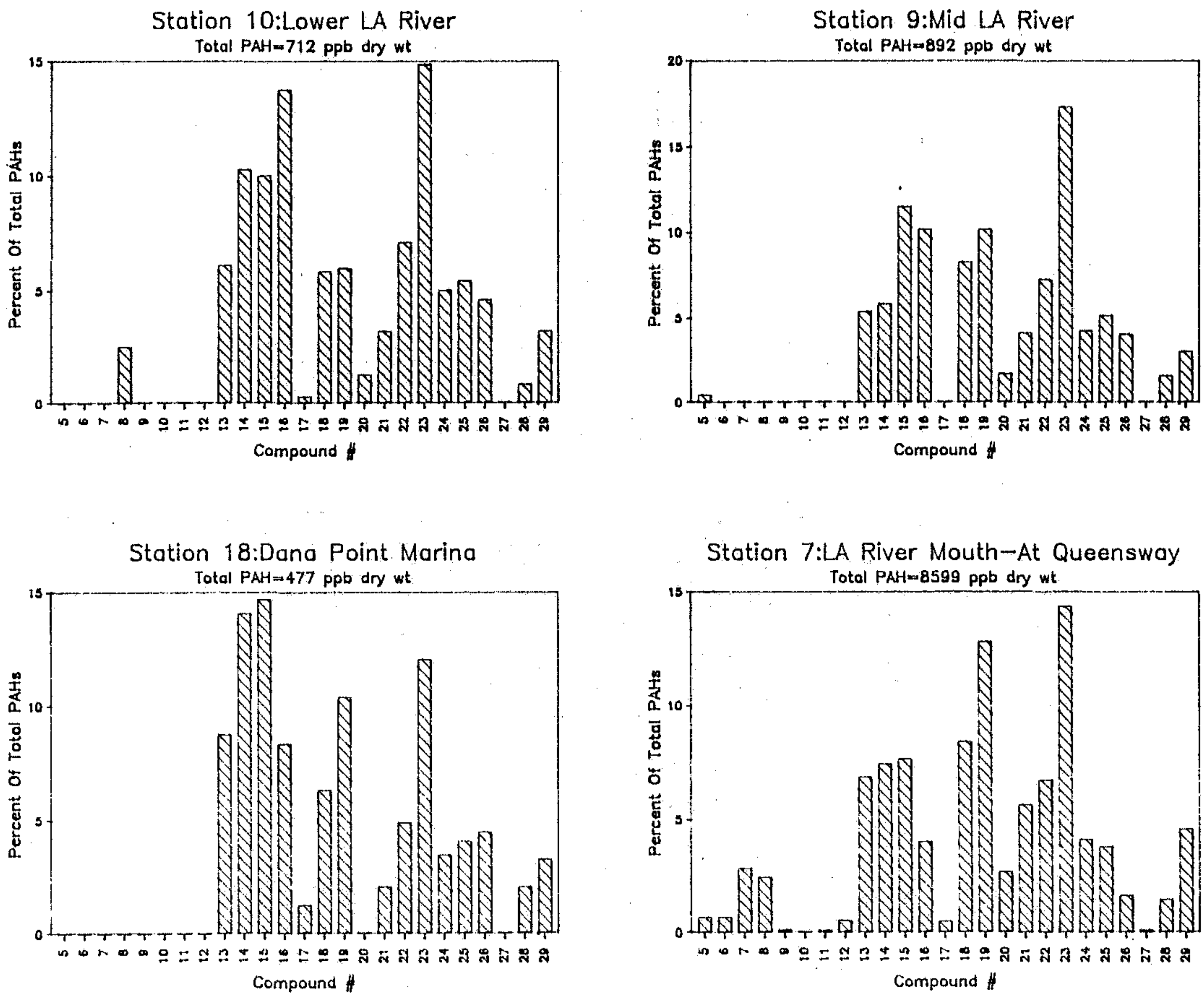
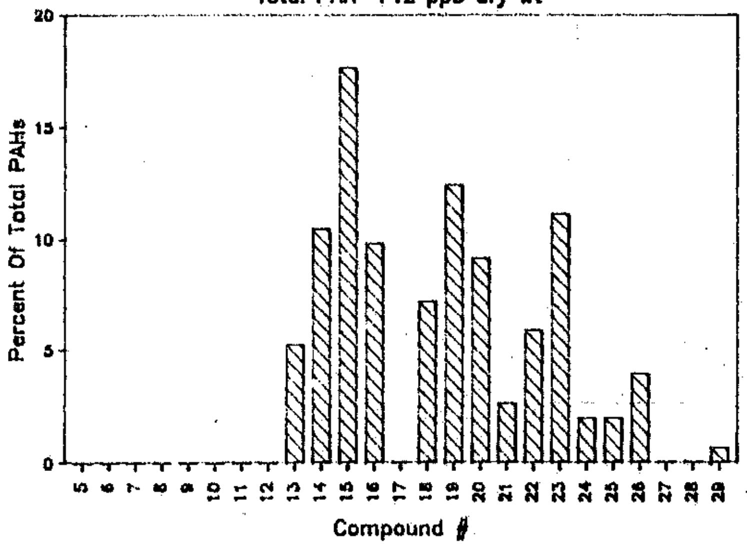

Station 10:Lower LA River
Total PAH=712 ppb dry wt
Percent Of Total PAHs
Compound #
Station 9:Mid LA River
Total PAH=892 ppb dry wt
Percent Of Total PAHs
Compound #
Station 18:Dana Point Marina
Total PAH=477 ppb dry wt
Percent Of Total PAHs
Compound #
Station 7:LA River Mouth—At Queensway
Total PAH=8599 ppb dry wt
Percent Of Total PAHs
Compound #

Figure 6, Continued.

Station 19:Reference Site R52-60

Total PAH=142 ppb dry wt



Station 4:PV Outfall Station 7-3

Total PAH=7902 ppb dry wt

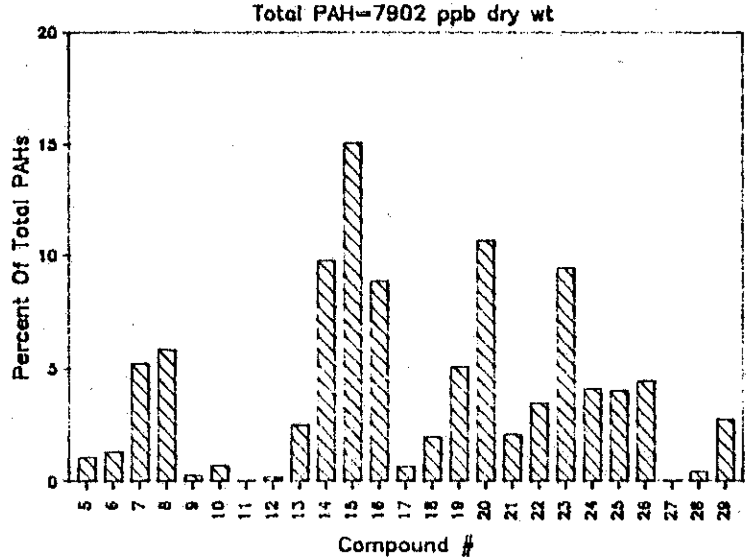


Figure 7.

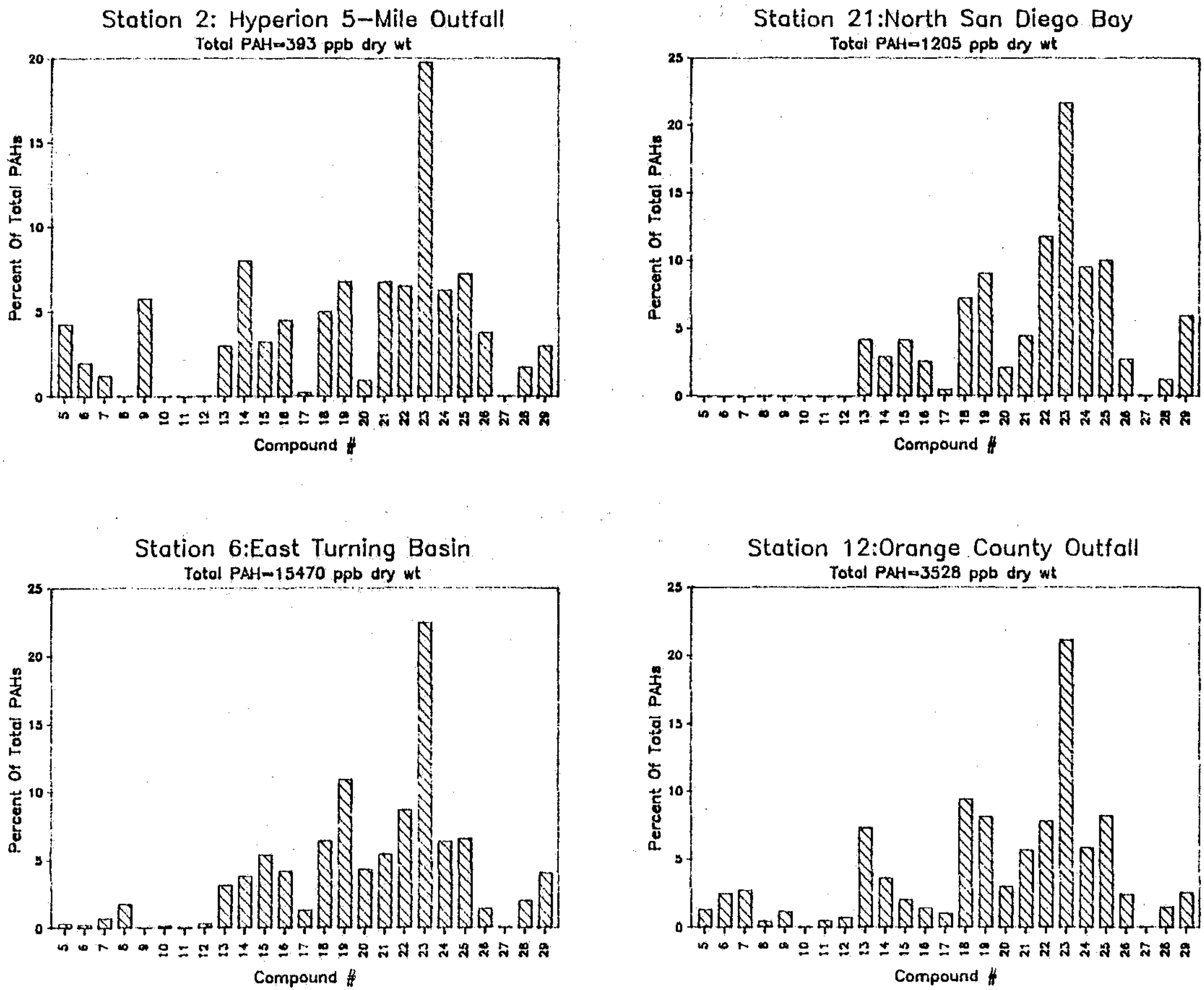

Station 2: Hyperion 5-Mile Outfall
Total PAH=393 ppb dry wt
Station 21:North San Diego Bay
Total PAH=1205 ppb dry wt
Station 6:East Turning Basin
Total PAH=15470 ppb dry wt
Station 12:Orange County Outfall
Total PAH=3528 ppb dry wt
Percent Of Total PAHs
Compound #

Figure 7, Continued.

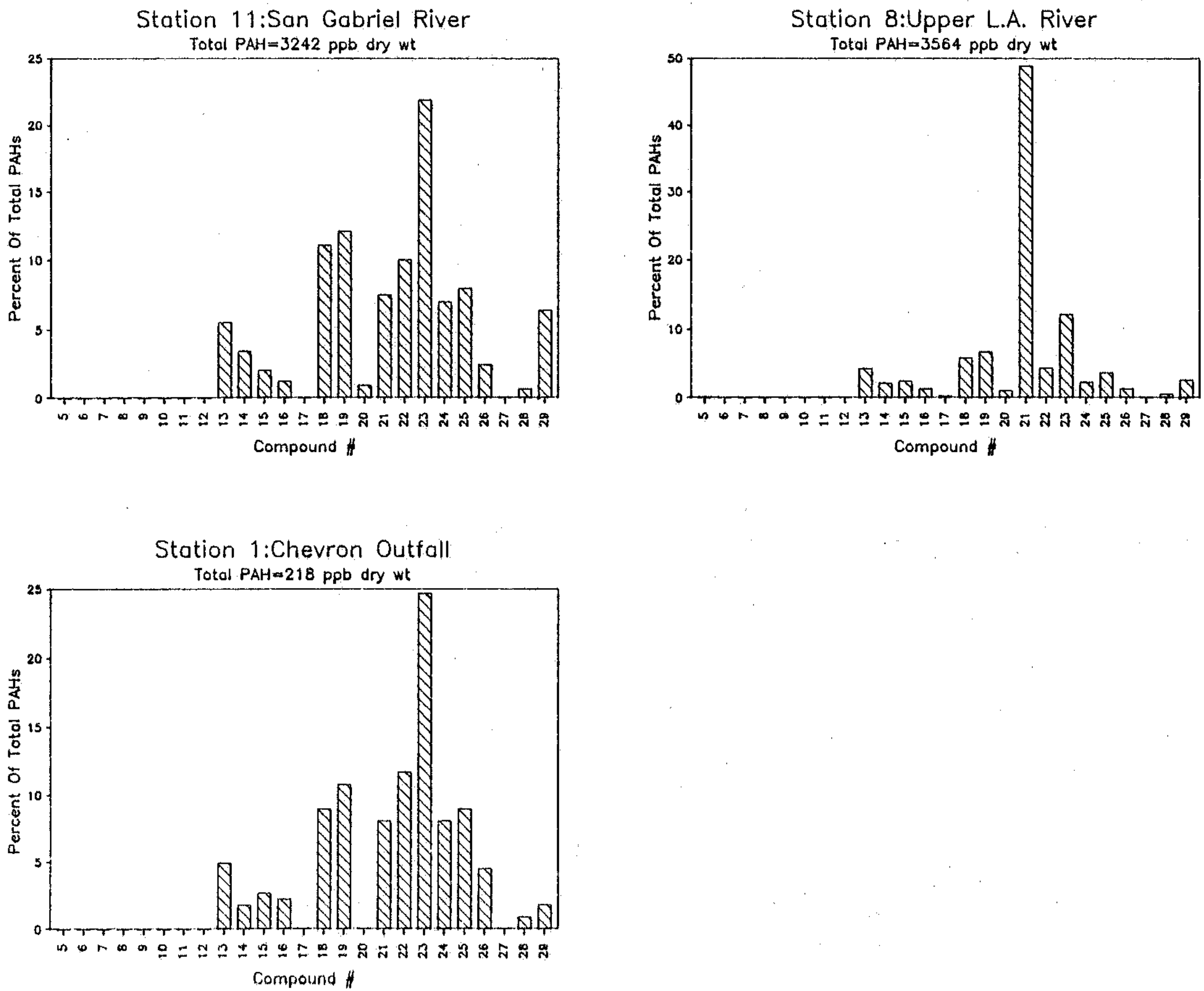
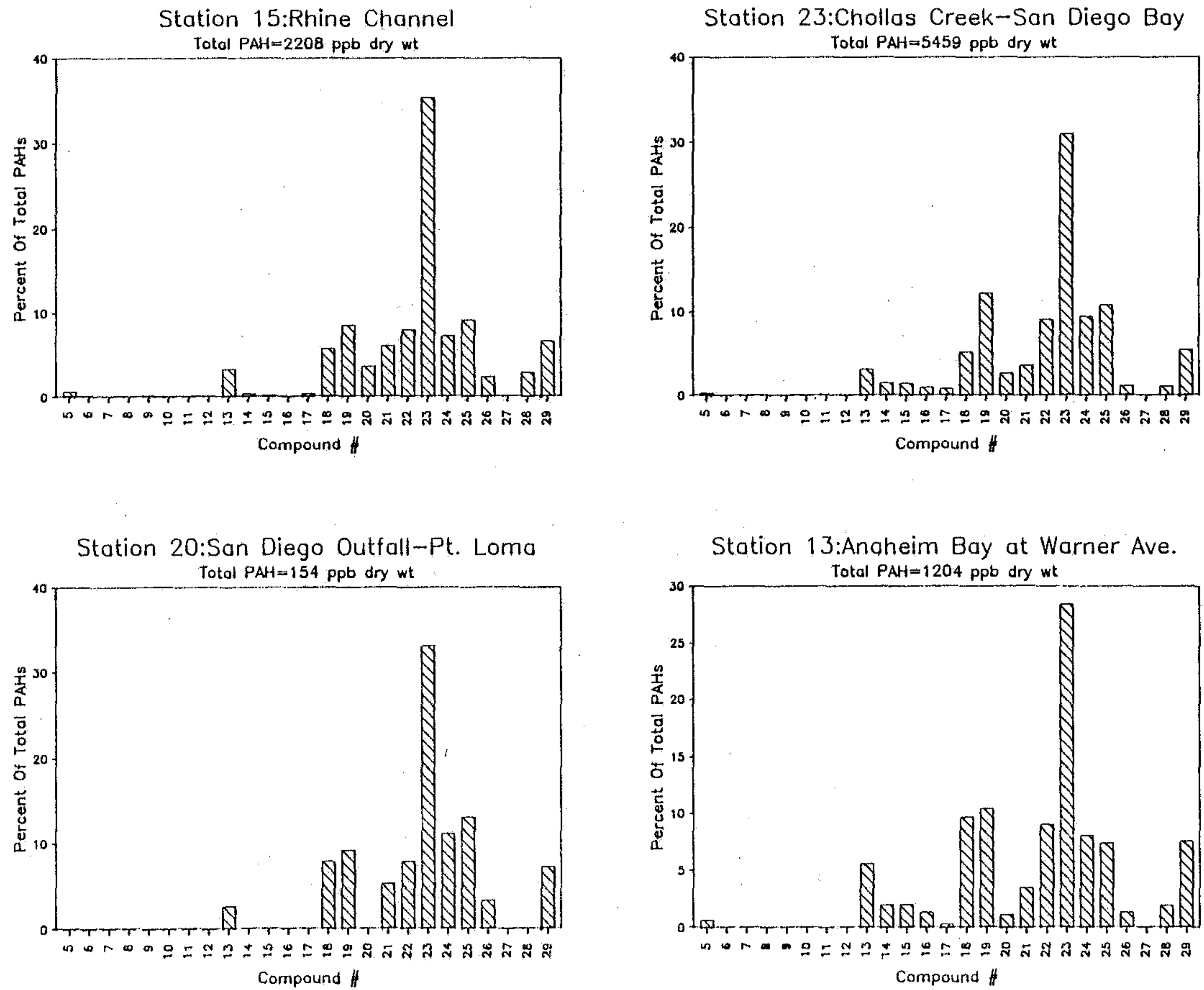
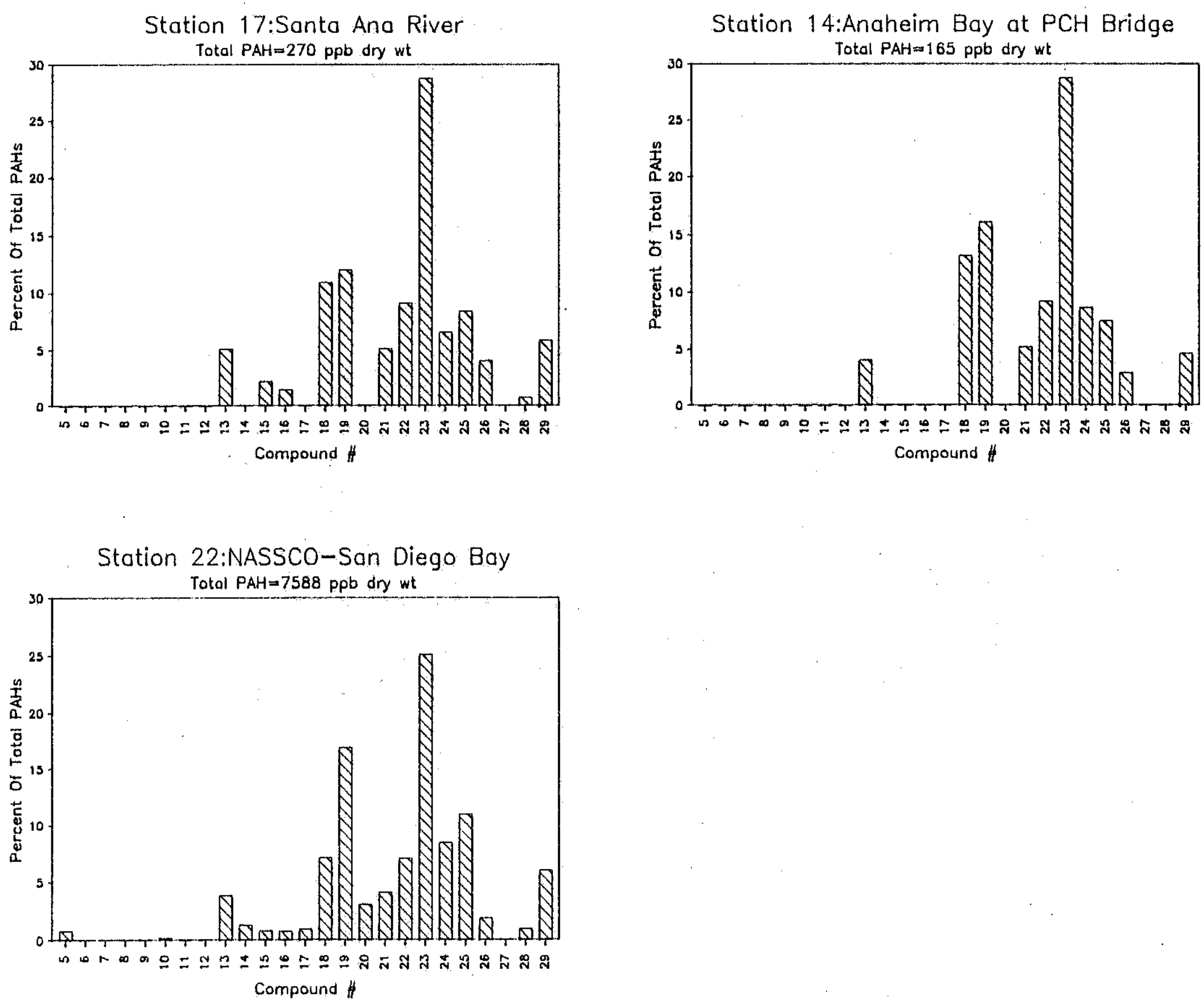


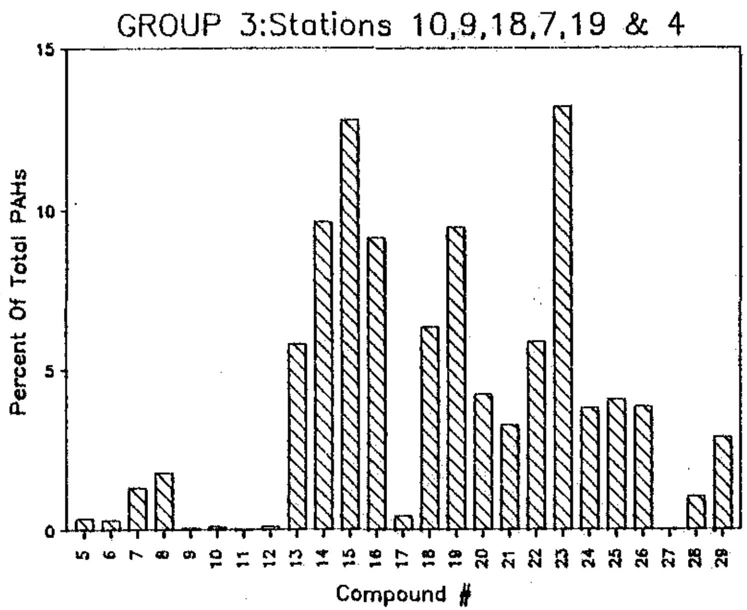
Figure 8.

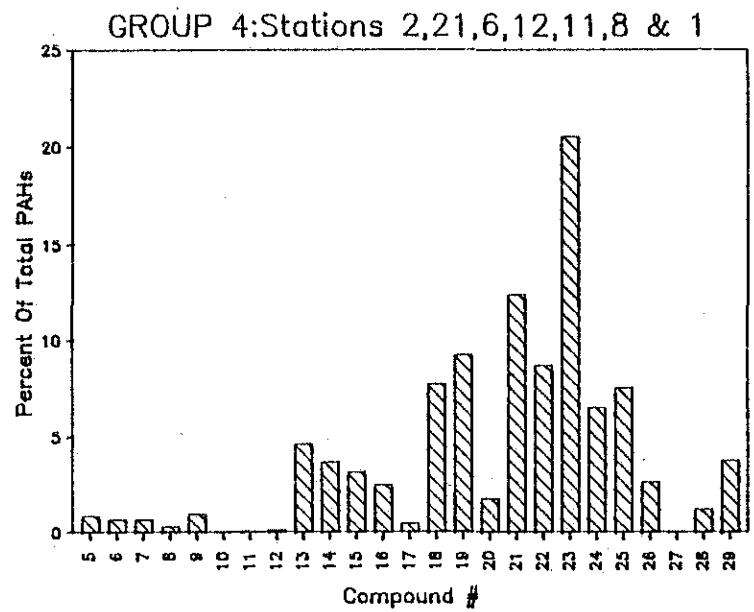


Station 15:Rhine Channel
Total PAH=2208 ppb dry wt
Station 23:Chollas Creek–San Diego Bay
Total PAH=5459 ppb dry wt
Station 20:San Diego Outfall–Pt. Loma
Total PAH=154 ppb dry wt
Station 13:Anaheim Bay at Warner Ave.
Total PAH=1204 ppb dry wt
Percent Of Total PAHs
Compound #

Figure 8, Continued.







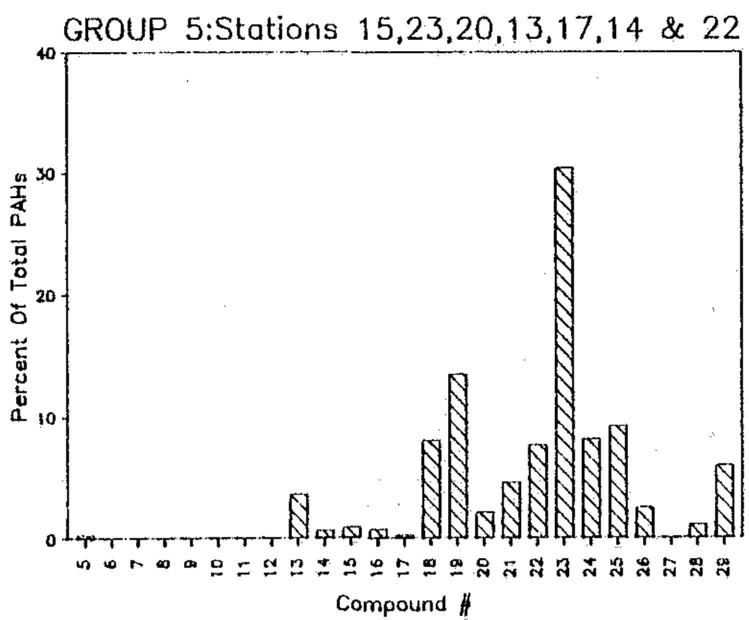


Figure 9. Mean percentage contribution of aromatic hydrocarbons for groups of stations exhibiting a similar pattern (see Figure 4.).

sedimentary environments. (see recent reviews by Teal and Howarth, 1984; and National Academy of Sciences, 1985). Much of our knowledge of the effects of PAH contaminated sediments on benthic populations and communities comes from opportunistic studies following oil spills. In many cases, an incomplete understanding of the structure and dynamics of the benthic communities prior to the spill has hampered interpretation of the magnitude and duration of adverse impacts from the spill. There have been relatively few carefully designed and executed laboratory studies of the effects of PAH-contaminated sediments on benthic marine organisms.

Before considering the concentrations of individual or total PAH on sediments that have produced effects on marine species, it should be noted that much of the research has quantitated exposures on a basis of oil added to sediment or measured total hydrocarbons (infrared analysis). A relatively small portion of these total oil concentrations is represented by aromatic hydrocarbons, Anderson et al. (1983) mixed oil with sediment to produce a total oil concentration of about 1,000 ppm, but only about 2% of that concentration consisted of aromatics between alkylbenzenes and dibenzothiophenes. A percentage of between 2 and 4% is a reasonably accurate estimate of the PAH content of sediments contaminated with fresh oil and measured on a volume basis or by infrared spectrometry. With this conversion factor in mind, it is useful to review the limited literature on the effects of oil (and PAH) contaminated sediments. Several studies have shown a lack of significant mortality of benthic animals during exposures to concentrations of oil in sediments in excess of 1000 ppm (Wells and Sprague, 1976; Anderson et al., 1977; Roesijadi et al., 1977 and 1978). Krebs and Burns (1977) reported the mortality and adverse responses of the fiddler crab, Uca, living in sediment containing 1000 to 7000 ppm of petroleum hydrocarbons. Shaw et al. (1976) reported mortality of the clam, Macoma balthica, from sediment containing 640-3890 ppm (dry weight).

Investigations have also been performed of the sublethal responses of benthic marine invertebrates to oil-contaminated sediment or food (Percy, 1976; Shaw et al., 1976; Taylor and Karinen, 1977; Roesijadi and Anderson, 1979; and Augenfeld, 1980). The Arctic amphipod, Onisimus affinis, avoided oil-tainted food as well as oil masses, but the response diminished with pre-exposure to oil and with the use of weathered oil (Percy, 1976). Taylor and Karinen (1977) studied the behavior of the detritivore, Macoma balthica, in response to oil-contaminated substrate and oil extracts flowing over clean substrates. Since the clams burrow to the surface before dying (95%), they determined that 50% of those exposed for three days to 0.37 ppm naphthalene equivalents surfaced, and 0.2 ppm inhibited burrowing within 60 minutes. Since a 1% (v/v) mixture of oil to seawater stirred for 20 h produces a naphthalene equivalent concentration of about 0.38 ppm, the above values are relatively high. Surface oiling of 670 mg oil/cm^2 produced 50% surfacing by the clams in 24 h. No death was recorded in these four- to six-day experiments involving only a single oiling of the sediment. Shaw et al. (1976) produced significant mortality in the same species by applying fresh oil at doses of 5 mg of oil/cm^2 daily for five days. Roesijadi and Anderson (1979) found that Macoma inquinata exhibited reduced survival, reduced condition index and reduced levels of free amino acids, particularly glycine, when exposed in the laboratory or field to sediments contaminated to about 1,200 mg oil per kg. Augenfeld et al. (1980) determined that the filter-feeding clam, Protothaca staminea, was more resistant to oiled substrates (about 1200 ppm) than Macoma inquinata (detritivore) as demonstrated by both higher survival and smaller alterations in free amino acid levels and condition index. Similar studies on the polychaete, Abarenicola pacifica, have shown that concentrations of 500 and 1000 ppm oil in sediment produced reduced feeding (measured by egestion rate) and decreased tissue glycogen concentrations (Augenfeld, 1980; Augenfeld et al., 1983). Clams (Protothaca staminea) less than 30 mm in size showed reduced growth after one year in sediments contaminated with oil (1,251 - 5,176 ppm). Greater effects were shown when the lower concentration of oil was mixed to depth (10 cm) in exposure trays (Anderson et al., 1983). Four- and six-month exposures of the same species to layers of sediment containing either oil or oil plus chemical dispersant (1:10) at about 2,000 to 3,000 ppm also reduced the rate of Protothaca staminea growth (Anderson et al., 1985).

In a study with the English sole, Parophrys vetulus conducted in Puget Sound, McCain et al. (1978) carefully examined the change in petroleum hydrocarbon concentrations in the fish tissues and the exposure sediments. They found an effect on the growth of the English sole and liver pathology resulting from exposure to sediments containing 700 ppm (dry weight) Prudhoe Bay crude oil. Aromatic hydrocarbons, including trimethylbenzene and naphthalenes, were found in the skin, muscle and liver of the fish at the first time interval (11 d). Later in the exposure (27 and 51 d) hydrocarbons were only found in the liver.

Several behavioral studies have been conducted with oil (Prudhoe Bay crude) contaminated sediments and bivalves or fish. Pearson et al. (1981) showed that the crab, Cancer magister, consumed more littleneck clams (Protothaca staminea) from field enclosures containing oiled sediment (about 1,000 ppm) than from those with clean sand. They found in subsequent tests that clams in oiled sand exhibited more shallow burial and slower reburrowing than in control sand. Olla and Bjeda (1983) conducted a similar series of experiments with the hard clam (Mercenaria mercenaria) and also found oiling of sediments reduced the depth and rate of burrowing. The number of clams buried in 96 h was reduced, from control values, at 1,000 ppm with further reduction at 3,000 ppm.

Sand lance Ammodytes hexapterus, is a prominent forage fish from California through Alaska and is known to bury in sand during the night and for long overwintering periods. Pearson et al. (1984) showed significantly decreased time spent buried in oiled (306 ppm) sand. In another experiment, oiled sand at 28 and 256 ppm did not reduce burial, but 3,384 ppm did. The lack of effect at 256 ppm corresponded to a higher condition index in the test group than that of fish used earlier (306 ppm). There was an apparent interaction between the use of a contaminated refuge and the nutritional state of the fish. Interaction between oil contamination and sediment grain size preference for A. hexapterus was studied by Pinto et al. (1984). Sand lance avoided gravel and silt and preferred to bury in fine or coarse sands. The fish preferred clean gravel when sand was oiled at about 120 or 1,000 ppm. If only silt and oiled sand are provided as choices, sand lance prefered to remain in the water column.

The long-term environmental impacts of chronic low-level point-source effluents containing PAH are quite different from those of massive oil spills. There usually is no massive die-off of marine fauna and flora. Instead, there may be a gradient of impact, characterized by altered community structure, abundance, and diversity extending around the pollutant source. There have been several investigations of impacts of refinery effluents and oil tanker terminals on the coastal marine environment (see review of Dicks and Hartley, 1982), and a few studies of impacts of produced water discharges (see review of Neff, 1985).

Reported impacts of effluents from oil refineries have been quite variable. Impacts of a refinery effluent to Littlewick Bay in Milfor Haven were restricted to an area of about 200 meters around the outfall. However a refinery effluent to the Medway estuary on the east coast of Great Britain caused substantial damage to intertidal macrofauna extending out to at least 1.5 km from the outfall (Warfe, 1975). Discharge of refinery effluent to a salt marsh environment on the south coast of Great Britain caused substatial damage to the salt marsh vegetation (Dicks and Hartley, 1982). Subtidal benthic communities also were damaged. Only two benthic polychaete species survived near the outfall. Effluent quality (hydrocarbon concentration) was improved and volume decreased between 1972-1974. This resulted in a gradual recovery of the salt marsh vegetation. After about ten years, the marsh appeared healthy, though species composition of plants and animals still was different from that in nearby uncontaminted areas. Subtidally, there was little evidence of recovery.

Perhaps the best investigation of the impacts of produced water and related production discharges from oil platforms is that in Trinity Bay, Texas. Trinity Bay is a shallow, low-salinity estuary. During the 20-month timecourse of the Trinity Bay study, produced water with a mean total hydrocarbon concentration of 15 ppm was discharged from the separator platform through an outfall one meter above the bottom, at a rate of 650,000 to 1,590,000 liters/day (Armstrong et al., 1979). Hydrocarbons were diluted nearly 2,500-fold in the water column within 15 meters of the outfall. Bottom sediments were heavily contaminated with medium molecular weight alkanes (C_{10}-C_{28} n-paraffins) and aromatics (C_3 benzenes-trimethylphenanthrenes).

There was a gradient of decreasing naphthalenes concentrations; from a mean of about 21 ppm, 15 m from the outfall, to background, 500 to 4800 m from the outfall, depending on direction. There was an inverse gradient of numbers of organisms and numbers of species of benthic infauna, with distance from the outfall. Within 15 m of the outfall, the bottom was almost devoid of organisms. Benthic faunal abundance was significantly reduced out to approximately 150 m in all directions from the outfall. At stations located 685-1675 meters from the outfall, there was an apparent enhancement of the benthic fauna, with greater numbers of individuals and species at these stations than at reference stations 4,000-5,800 m from the outfall. Thus, a 150-m radius zone of adverse impact was observed, with an apparent zone of enhanced faunal abundance and diversity further out from the discharge, and impacts were correlated to contamination of sediments with petroleum hydrocarbons. Armstrong et al., (1979) estimated that a nominal concentration greater than about 2 ppm total naphthalenes was necessary to significantly reduce benthic infaunal populations of Trinity Bay. Results of these investigations should be extrapolated to offshore situations with extreme caution. The shallow, turbid nature of the receiving water is unlike the situation encountered offshore, with the possible exception of some near shore areas of the Beaufort Sea. Where water depth is greater, and suspended sediment concentrations are lower, than those encountered in Trinity Bay, a much smaller fraction of the hydrocarbons in the produced water discharged will be deposited in bottom sediments near the outfall, and adverse effects on the benthos will be much less severe.

In summary, the oil-related studies reviewed above describe effects on marine species from concentrations of oil in sediments at levels between about 300 ppm (behavioral response) and 1000 ppm. Using the 2% values discussed above, the estimated total PAH concentrations would range between 6 and 20 ppm. This range is quite near the 5 to 15 ppm concentration range we observed at the seven most contaminated sites in southern California.

Review of Point and Non-Point Source Effects

Recent studies related to the effects of sewage, sludge, or harbor sediments contaminated from multiple sources, provide additional insight into determining threshold levels of PAH on sediments. Swartz et al. (1984a) tested the toxicity of samples of sewage sludge collected from treatment facilities in Oregon, California, and New Jersey. Sludge contained varying amounts of contaminants, related to the industrial contribution to the treatment facility. Tests were designed to determine the relative contributions of organic enrichment (measured as total volatile solids, TVS) and toxics, to the impacts (survival) on amphipods (Swartz et al., 1984b). When toxics were low, the LC_{50} value for TVS was 2.8%, but sludge containing significant amounts of contaminants lowered the tolerance of amphipods to an LC_{50} of about 0.1%. The chemical parameter in the contaminated sludge, which was most highly correlated with amphipod survival, was hydrocarbon oil and grease. Malins et al. (1984) also reported that prevalences of hepatic neoplasms and other hepatic lesion types in English sole and sculpin were most strongly correlated with the total aromatic contamination of sediments from various sites in Puget Sound. In a later study of Eagle Harbor, Washington, where the sediments are highly contaminated by PAH from creosote, Malins et al. (1985) concluded that English sole liver bile was highly contaminated with PAH (and their metabolites) and the prevalence of hepatic lesions was well in excess of that at reference sites. Stations in this harbor contained some of the highest concentrations of total aromatic hydrocarbons ever reported on sediments (118 ppm).

Extensive field and laboratory studies have been conducted on sediments collected in 1980 and 1983 along a contamination gradient extending northwest from the sewage outfall of the Los Angeles County Sanitation Districts offshore of Palos Verdes, California (Swartz et al., 1985 and 1986). Total (measured) aromatic hydrocarbon content of the sediments was only reported for collections in 1980, and the highest value was 4.9 ppm. Significant reductions in amphipod survival were found in tests with sediments (1980 collection) from the three sites nearest the outfall. The highest number of correlations between biological and geochemical parameters measured were for total oil and grease, hydrocarbon oil and grease, and lead. They did not attempt to relate the concentration of total aromatics in the sediments to the biological measurements, but statistical analyses showed that levels of total oil and grease of 3,600 ppm were present in sediments not exhibiting toxic effects. A comparison of the sediments collected in 1980 and 1983 is presented in Swartz et al. (1986). Amphipod survival was not reduced by exposure to sediments from any of the stations, and the degree of benthic degradation observed in 1980 was reduced in 1983. The greatest changes in chemical parameters at the nearest stations between 1980 and 1983, were a 71% reduction in BOD and a 67% decrease in oil and grease concentration. Both DDT and zinc actually showed minor increases.

It is difficult or impossible to directly relate the non-specific measurement of organic material called "oil and grease" either to specific polyaromatic hydrocarbons or biological effects. It is only useful as an estimate of PAH; but it is, perhaps, time to eliminate oil and grease determinations and concern ourselves with analyses of specific PAH. Furthermore, research should be directed toward identification of the concentrations, of both total PAH and individual PAH compounds, on sediments producing toxic effects for benthic organisms. Malins et al. (1986) measured 18 PAH compounds in the sediments of stations in the Los Angeles - Long Beach Harbor areas, and found total concentrations between 0.9 and 2.9 ppm. They reported higher than normal prevalence of fish diseases in white croaker from these sites. Tetra Tech (1985) reported on extensive investigations of the sediment chemistry and toxicity for stations located in the nearshore areas of Commencement Bay, Washington. After examining the data base, the authors derived factors called "apparent effect thresholds" (AET) for sediment contaminants on a basis of toxicity (laboratory tests) and benthic effects (field). They have produced AETs for individual PAH and for the summations of low molecular weight compounds (7) and high molecular weight compounds (10). On a dry weight basis, the values are 5.2 ppm and about 15.0 ppm for low and high molecular weight PAH, respectively. Converting these values to mg/kg TOC (ppm TOC) they become about 400 and 1000 ppm TOC, respectively.

In a report available from EPA, submitted by Battelle (1986), an analysis of marine data bases on sediment chemistry and infauna analyses produced species screening level concentrations and screening level concentrations (SLCs) for marine sediments. The latter are concentrations of individual PAH, which are protective of 95% of the infauna. For reasons explained earlier, the PAH concentrations were first normalized to TOC such that the final SLCs are in mg/kg TOC (ppm). The SLCs for compounds between naphthalene and benzo(a)pyrene were about 40 ppm each. If it is assumed that about 10 of the PAH may be important in producing acute and chronic effects on benthic species, the summation of SLCs may be appropriate, resulting in a value of about 400 ppm (TOC).

Recommendations

After this extensive review of available information on the effects of PAH bound to sediment, it is logical to return to the data produced in this study. There are numerous indications that concentrations of PAH on sediments between 5 and 15 ppm dry weight and 200 to 500 ppm TOC will produce toxic effects on benthic species. If the most bioavailable compounds measured in this study, the naphthalenes, are prominent in sediments, the critical concentration might be reduced to 2 ppm dry weight, or about 80 ppm TOC.

There is certainly strong evidence that the PAH levels measured in sediments from some of the sites examined in this study are likely to produce toxic effects on organisms. We, therefore, highly recommend that, as a natural extension of the present program, sediment bioassays be conducted on sediments from selected stations. Since the major concern is for protection of marine life, these extensive chemical analyses will be of little use unless they are combined with an assessment of biological impacts.

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APPENDIX

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PAH SAMPLING STATIONS

PAH STATIONS	LORAN	LONG. AND LAT.
#1. Chevron outfall	28176.6 - 41099.3	$33^{\circ}54.41$ - $118^{\circ}25.91$
2. L.A. City - 5 mile	28162.0 - 41126.5	$33^{\circ}54.91$ - $118^{\circ}31.50$
3. L.A. City - 7 mile	28158.5 - 41139.0	$33^{\circ}55.50$ - $118^{\circ}33.25$
4. L.A. County PV-7-3	28176.8 - 41034.4	$33^{\circ}42.24$ - $118^{\circ}20.80$
5. Mid L.A. Harbor	28192.1 - 41011.1	$33^{\circ}43.80$ - $118^{\circ}15.07$
6. Long Beach Harbor	28193.8 - 41011.5	$33^{\circ}45.94$ - $118^{\circ}15.20$
7. L.A. River mouth	28201.8 - 40999.8	$33^{\circ}45.51$ - $118^{\circ}11.68$
8. L.A. River mouth	Balboa overpass, above spill	
9. L.A. River - mid river	0.4 KM below Balboa overpass	
10. L.A. River - lower river	Willow Street overpass, Long Beach	
11. San Gabriel River	200 m. below Prado Dam outlet, Riverside	
12. Orange County outfall	28217.2 - 40915.0	$33^{\circ}34.49$ - $118^{\circ}00.51$
13. Warner Ave.	Warner Bridge	$33^{\circ}42.40$ - $118^{\circ}03.35$
14. Edinger Ave. (Anaheim Bay)	PCH Bridge	$33^{\circ}56.50$ - $118^{\circ}05.06$
15. Newport (Rhine Channel)	28230.7 - 40896.9	$33^{\circ}36.64$ - $117^{\circ}55.61$
16. Newport (Back Bay)	28235.9 - 40888.7	$33^{\circ}37.23$ - $117^{\circ}53.61$
17. Santa Ana River	College Park overpass, Long Beach	
18. Dana Pt. Marina	28253.1 - 40805.8	$33^{\circ}27.55$ - $117^{\circ}41.40$
19. San Mateo Pt. R-56-60	28252.8 - 40790.0	$33^{\circ}23.73$ - $117^{\circ}39.90$
20. San Diego outfall		$32^{\circ}40.28$ - $117^{\circ}17.27$
21. No. San Diego Bay		$32^{\circ}43.68$ - $117^{\circ}11.05$
22. NASSCO		$32^{\circ}41.43$ - $117^{\circ}08.68$
23. Challas Creek		$32^{\circ}41.02$ - $117^{\circ}08.03$
24. Seventh St.		$32^{\circ}40.04$ - $117^{\circ}06.93$

MEAN (n=3) CONCENTRATIONS (nG/dry G) OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SEDIMENTS FROM SOUTHERN CALIFORNIA.

	STATION											
COMPOUND	#1 Chevron	#2 5-Mile	#3 7-Mile	#4 PV7-3	#5 Mid LAH	#6 EastBas	#7 Queens	#8 LAR-Upr	#9 LAR-Mid	#10 LAR-Lwr	#11 SGRiver	#12 ORCO
Indane	<12	<6	<80	<35	<50	<25	<10	<12	<6	<14	<22	<6
n-Propylbenzene	<8	<4	<47	<18	<31	<17	<6	<8	<5	<8	<14	<3
iso-Propylbenzene	<10	<5	<62	<27	<40	<21	<7	<10	<6	<10	<17	<5
Tetramethylbenzene	<11	<6	<68	<27	<47	<24	<8	<10	<6	<11	<20	<5
Naphthalene	<8	17	417	87	<31	54	57	13	4	<8	<14	46
C1-Naphthalenes (2)	<4	8	875	104	<11	39	57	<5	<3	<4	<11	87
C2-Naphthalenes (6)	<6	5	1450	415	<20	112	243	<8	<5	<7	<19	96
C3-Naphthalenes (2)	<6	<4	497	462	<20	272	209	<8	<5	18	<19	15
Biphenyl	<4	23	1678	22	<11	<8	10	<5	<3	<4	<11	40
Acenaphthylene	<3	<2	<28	57	<8	29	<4	<3	<2	<3	<7	<1
Acenaphthene	<6	<4	<65	<16	<18	<12	9	<7	<4	<7	<17	17
Fluorene	<4	<3	57	16	<13	49	45	<5	<3	<5	<12	25
Phenanthrene	11	12	395	197	16	487	591	281	48	44	180	257
C1-Phenanthrenes (4)	4	32	819	773	14	591	640	142	52	74	112	127
C2-Phenanthrenes (4)	6	13	754	1193	19	834	659	161	103	72	66	71
C3-Phenanthrenes (2)	5	18	700	701	34	648	345	86	91	99	40	50
Anthracene	<1	1	26	52	<3	199	41	19	<1	2	<4	35
Fluoranthene	20	20	362	157	41	991	725	382	74	42	361	332
Pyrene	24	27	460	401	110	1690	1099	442	91	43	394	287
2,3-Benzofluorene	<3	4	177	842	47	667	229	70	15	9	30	106
Benz (a) anthracene	18	27	353	166	45	845	487	210	37	23	244	201
Chrysene/Triphenylene	26	26	402	274	81	1342	578	285	65	51	326	275
Benzofluoranthenes	55	79	1011	746	351	3471	1235	796	155	107	713	746
Benzo (e) pyrene	18	25	295	323	95	988	354	150	38	36	227	206
Benzo (a) pyrene	20	29	278	317	118	1020	326	238	46	39	259	289
Perylene	10	15	112	353	349	214	139	84	36	33	79	85
9,10-Diphenylanthracene	<1	<1	<18	4	<3	7	8	<2	<1	<1	<5	<1
Dibenz (a,h) anthracene	2	7	<23	36	21	305	124	38	14	6	21	51
Benzo (g,h,i) perylene	4	12	199	217	61	625	393	170	27	23	208	89
TOTAL	218	393	11317	7902	1384	15470	8599	3564	892	712	3242	3528

MEAN (n=3) CONCENTRATIONS (nG/dry G) OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SEDIMENTS FROM SOUTHERN CALIFORNIA. PAGE 2

COMPOUND	#13 Warner	#14 Edinger	#15 Crows	#16 Backbay	#17 SARiver	#18 DanaPt	#19 R52-60	#20 PtLoma	#21 NSD BAY	#22 NASSCO	#23 Chollas	#24 7th St
Indane	<7	<5	<18	<22	<8	<35	<9	<9	<47	<81	<18	<34
n-Propylbenzene	<3	<3	<12	<12	<5	<24	<6	<6	<31	<51	<11	<19
iso-Propylbenzene	<5	<4	<14	<18	<8	<32	<9	<7	<46	<69	<16	<25
Tetramethylbenzene	<5	<4	<15	<18	<8	<29	<9	<8	<46	<64	<14	<26
Naphthalene	8	<3	14	355	<5	<24	<6	<6	<31	59	18	27
C1-Naphthalenes (2)	<3	<3	<6	<6	<3	<12	<7	<7	<3	<14	<6	<9
C2-Naphthalenes (6)	<7	<5	<10	<15	<6	<19	<14	<14	<7	<25	<10	26
C3-Naphthalenes (2)	<6	<5	<11	<13	<6	<19	<14	<14	<7	<25	<10	32
Biphenyl	<3	<3	<6	<6	<3	<12	<7	<7	<3	<14	<6	<10
Acenaphthylene	<3	<3	<4	<6	<2	<8	<7	<6	<3	16	6	12
Acenaphthene	<5	<5	<9	<12	<5	<18	<10	<10	<6	<22	<9	<16
Fluorene	<4	<3	<7	<8	<3	<13	<8	<9	<5	<16	<7	<11
Phenanthrene	67	7	72	7	14	43	8	4	43	293	171	148
C1-Phenanthrenes (4)	24	<3	8	<4	<2	69	16	<2	30	97	80	131
C2-Phenanthrenes (4)	24	<3	4	<4	6	72	27	<2	43	60	78	155
C3-Phenanthrenes (2)	16	<3	<3	<4	4	41	15	<2	27	56	53	219
Anthracene	4	<1	8	<2	<1	6	<2	<2	5	71	44	63
Fluoranthene	117	23	127	19	30	31	11	12	74	543	283	258
Pyrene	126	28	189	47	33	51	19	14	93	1293	670	2686
2,3-Benzofluorene	14	<3	80	<7	<2	<10	14	<3	22	232	144	946
Benz (a) anthracene	42	9	134	33	14	10	4	8	46	312	198	410
Chrysene/Triphenylene	109	16	177	32	25	24	9	12	121	538	497	484
Benzofluoranthenes	344	50	786	103	79	59	17	51	223	1918	1692	4265
Benzo (e) pyrene	97	15	160	21	18	17	3	17	98	645	518	917
Benzo (a) pyrene	89	13	203	36	23	20	3	20	103	838	592	1055
Perylene	16	5	52	4	11	22	6	5	28	140	61	284
9,10-Diphenylanthracene	<1	<1	<2	5	<1	<4	<1	<2	<1	<4	2	3
Dibenz (a,h) anthracene	23	<1	63	26	2	10	<1	<2	13	72	60	195
Benzo (g,h,i) perylene	91	8	147	27	16	16	1	11	61	459	298	546
TOTAL	1204	165	2208	706	270	477	142	154	1205	7588	5459	12802

DETAILED PAH ANALYSES BY SCCWRP PRESENTED ON A

BASIS OF NG/G DRY WEIGHT

SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #1:Chevron Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<10	<14	<12	<12	*
n-Propylbenzene	<7	<7	<9	<8	*
iso-Propylbenzene	<10	<11	<9	<10	*
Tetramethylbenzene	<10	<11	<12	<11	*
Naphthalene	<7	<7	<9	<8	*
C1-Naphthalenes(2)	<4	<3	<5	<4	*
C2-Naphthalenes(6)	<7	<5	<8	<6	*
C3-Naphthalenes(2)	<7	<5	<8	<6	*
Biphenyl	<4	<3	<5	<4	*
Acenaphthylene	<3	<3	<3	<3	*
Acenaphthene	<5	<5	<6	<6	*
Fluorene	<4	<4	<5	<4	*
Phenanthrene	<2	18	14	11	8
C1-Phenanthrenes(4)	<2	7	<2	4	3
C2-Phenanthrenes(4)	<2	8	7	6	3
C3-Phenanthrenes(2)	<2	3	9	5	4
Anthracene	<1	<1	<1	<1	*
Fluoranthene	5	23	31	20	13
Pyrene	8	27	37	24	15
2,3-benzofluorene	<3	<3	<4	<3	*
Benz(a)anthracene	7	20	26	18	10
Chrysene/Triphenylene	9	25	45	26	18
Benzofluoranthenes	28	38	99	55	38
Benzo(e)pyrene	6	25	24	18	11
Benzo(a)pyrene	5	27	28	20	13
Perylene	2	20	9	10	9
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	<2	3	<2	2	<1
Benzo(g,h,i)perylene	2	<1	9	4	5
TOTAL DETECTABLE PAHs	72	244	338	218	135
PERCENT DRY WEIGHT	81.44	79.44	81.77	80.90	1.26
PERCENT TOC	.26	.81	.20	.42	.34

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	41	28	33	34	7
Acenaphthene-d10	74	78	64	72	7
Phenanthrene-d10	98	104	78	93	14
Chrysene-d12	97	101	82	93	10
Perylene-d12	94	96	80	90	9

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #2:Hyperion 5-Mile Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<5	<5	<8	<6	*
n-Propylbenzene	<3	<3	<5	<4	*
iso-Propylbenzene	<4	<3	<8	<5	*
Tetramethylbenzene	<4	<5	<8	<6	*
Naphthalene	19	17	16	17	1
C1-Naphthalenes(2)	7	7	10	8	2
C2-Naphthalenes(6)	<4	5	<5	5	<1
C3-Naphthalenes(2)	<4	<4	<5	<4	*
Biphenyl	22	24	23	23	<1
Acenaphthylene	<2	<2	<2	<2	*
Acenaphthene	<4	<3	<4	<4	*
Fluorene	<3	<2	<2	<3	*
Phenanthrene	12	12	13	12	1
C1-Phenanthrenes(4)	16	35	46	32	15
C2-Phenanthrenes(4)	<2	<3	34	13	18
C3-Phenanthrenes(2)	14	9	31	18	12
Anthracene	<1	<1	2	1	<1
Fluoranthene	22	18	19	20	2
Pyrene	34	24	23	27	6
2,3-benzofluorene	<4	<3	4	4	1
Benz(a)anthracene	37	31	13	27	12
Chrysene/Triphenylene	35	28	16	26	10
Benzofluoranthenes	136	60	42	79	50
Benzo(e)pyrene	38	25	12	25	13
Benzo(a)pyrene	41	34	11	29	16
Perylene	19	12	13	15	4
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	12	<1	8	7	5
Benzo(g,h,i)perylene	13	16	8	12	4
TOTAL DETECTABLE PAHs	477	357	344	393	73
PERCENT DRY WEIGHT	61.16	61.09	69.02	63.76	4.56
PERCENT TOC	.79	.84	.74	.79	.05

SURROGATE RECOVERIES IN PERCENT					
Naphthalene-d8	98	85	44	76	28
Acenaphthene-d10	130	119	95	115	18
Phenanthrene-d10	107	137	121	122	15
Chrysene-d12	98	104	101	101	3
Perylene-d12	84	83	100	89	10

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

STATION #3:Hyperion 7-Mile Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<68	<83	<89	<80	*
n-Propylbenzene	<43	<51	<47	<47	*
iso-Propylbenzene	<53	<67	<65	<62	*
Tetramethylbenzene	<58	<75	<71	<68	*
Naphthalene	<43	711	498	417	341
C1-Naphthalenes(2)	265	1226	1133	875	530
C2-Naphthalenes(6)	1146	1825	1378	1450	345
C3-Naphthalenes(2)	241	557	692	497	231
Biphenyl	1122	1879	2034	1678	488
Acenaphthylene	<36	<29	<20	<28	*
Acenaphthene	<84	<67	<42	<65	*
Fluorene	<60	<48	62	57	8
Phenanthrene	340	359	486	395	79
C1-Phenanthrenes(4)	474	1417	567	819	520
C2-Phenanthrenes(4)	620	1214	427	754	410
C3-Phenanthrenes(2)	797	968	336	700	327
Anthracene	<17	<17	43	26	15
Fluoranthene	250	493	343	362	122
Pyrene	346	635	400	460	154
2,3-benzofluorene	244	195	93	177	77
Benz(a)anthracene	204	620	235	353	232
Chrysene/Triphenylene	272	643	290	402	209
Benzofluoranthenes	672	1665	697	1011	566
Benzo(e)pyrene	180	481	174	295	204
Benzo(a)pyrene	236	611	222	278	176
Perylene	149	85	103	112	33
9,10-diphenylanthracene	<21	<20	<13	<18	*
Dibenz(a,h)anthracene	<26	<27	<16	<23	*
Benzo(g,h,i)perylene	164	351	80	199	139
TOTAL DETECTABLE PAHs	7722	15935	10293	11317	4201
PERCENT DRY WEIGHT	20.73	20.79	24.12	21.88	1.94
PERCENT TOC	7.22	5.13	6.78	6.38	1.10

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	0	98	56	51	49
Acenaphthene-d10	64	121	102	96	29
Phenanthrene-d10	90	133	139	121	27
Chrysene-d12	64	96	107	89	22
Perylene-d12	71	106	97	91	18

SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #4:Los Angeles County Outfall Station PV7-3
COLLECTION DATE 25 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<19	<64	<23	<35	*
n-Propylbenzene	<11	<32	<11	<18	*
iso-Propylbenzene	<15	<48	<17	<27	*
Tetramethylbenzene	<15	<48	<17	<27	*
Naphthalene	105	64	90	87	21
C1-Naphthalenes(2)	137	68	109	104	35
C2-Naphthalenes(6)	394	271	579	415	155
C3-Naphthalenes(2)	285	392	708	462	220
Biphenyl	38	<10	18	22	14
Acenaphthylene	71	63	35	57	19
Acenaphthene	<16	<18	<16	<16	*
Fluorene	16	<13	20	16	4
Phenanthrene	205	154	231	197	39
C1-Phenanthrenes(4)	610	655	1053	773	244
C2-Phenanthrenes(4)	998	1075	1507	1193	274
C3-Phenanthrenes(2)	436	704	962	701	263
Anthracene	70	37	49	52	17
Fluoranthene	225	137	109	157	61
Pyrene	449	367	387	401	43
2,3-benzofluorene	778	841	907	842	65
Benz(a)anthracene	149	178	170	166	15
Chrysene/Triphenylene	274	286	261	274	13
Benzofluoranthenes	754	795	689	746	53
Benzo(e)pyrene	329	320	320	323	5
Benzo(a)pyrene	318	325	309	317	8
Perylene	353	329	377	353	24
9,10-diphenylanthracene	6	2	<5	4	2
Dibenz(a,h)anthracene	87	15	<8	36	43
Benzo(g,h,i)perylene	215	243	192	217	26
TOTAL DETECTABLE PAHs	7302	7321	9082	7902	1022
PERCENT DRY WEIGHT	38.24	39.04	34.67	37.32	2.33
PERCENT TOC	4.75	4.42	3.67	4.28	.55

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	98	26	82	68	38
Acenaphthene-d10	106	82	104	97	13
Phenanthrene-d10	108	105	117	110	6
Chrysene-d12	92	71	79	81	11
Perylene-d12	104	87	83	91	11

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #5:Mid Los Angeles Harbor
COLLECTION DATE 27 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<112	<27	<11	<50	*
n-Propylbenzene	<65	<20	<7	<31	*
iso-Propylbenzene	<84	<27	<9	<40	*
Tetramethylbenzene	<103	<27	<11	<47	*
Naphthalene	<65	<20	<7	<31	*
C1-Naphthalenes(2)	<20	<7	<5	<11	*
C2-Naphthalenes(6)	<40	<11	<9	<20	*
C3-Naphthalenes(2)	<40	<11	<9	<20	*
Biphenyl	<23	<7	<5	<11	*
Acenaphthylene	<17	<4	<3	<8	*
Acenaphthene	<37	<9	<8	<18	*
Fluorene	<27	<7	<6	<13	*
Phenanthrene	<11	24	12	16	7
C1-Phenanthrenes(4)	<11	26	<4	14	11
C2-Phenanthrenes(4)	<11	42	<4	19	20
C3-Phenanthrenes(2)	<11	87	<4	34	46
Anthracene	<6	<1	<1	<3	*
Fluoranthene	48	43	33	41	7
Pyrene	124	108	99	110	13
2,3-benzofluorene	26	103	13	47	49
Benz(a)anthracene	57	38	41	45	10
Chrysene/Triphenylene	92	84	65	81	14
Benzofluoranthenes	293	377	382	351	50
Benzo(e)pyrene	99	95	91	95	4
Benzo(a)pyrene	131	112	110	118	12
Perylene	360	272	417	349	73
9,10-diphenylanthracene	<5	<1	<2	<3	*
Dibenz(a,h)anthracene	28	20	16	21	6
Benzo(g,h,i)perylene	70	57	56	61	8
TOTAL DETECTABLE PAHs	1328	1488	1335	1384	90
PERCENT DRY WEIGHT	51.01	55.16	50.99	52.39	2.40
PERCENT TOC	1.54	1.26	1.54	1.45	.16

SURROGATE RECOVERIES IN PERCENT

	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Naphthalene-d8	17	22	71	37	30
Acenaphthene-d10	47	66	103	72	28
Phenanthrene-d10	82	105	108	98	14
Chrysene-d12	80	87	82	83	4
Perylene-d12	91	96	84	90	6

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION   #6:East Turning Basin- Inner Long Beach Harbor
COLLECTION DATE   27 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<38	<16	<21	<25	*
n-Propylbenzene	<26	<11	<14	<17	*
iso-Propylbenzene	<34	<13	<17	<21	*
Tetramethylbenzene	<38	<16	<17	<24	*
Naphthalene	<26	71	66	54	25
C1-Naphthalenes(2)	30	45	42	39	8
C2-Naphthalenes(6)	97	135	102	112	21
C3-Naphthalenes(2)	380	208	228	272	94
Biphenyl	<9	<6	<8	<8	*
Acenaphthylene	17	45	25	29	14
Acenaphthene	<14	<10	<12	<12	*
Fluorene	53	47	46	49	4
Phenanthrene	489	464	508	487	22
C1-Phenanthrenes(4)	612	521	640	591	62
C2-Phenanthrenes(4)	939	682	881	834	135
C3-Phenanthrenes(2)	773	532	638	648	121
Anthracene	194	190	214	199	13
Fluoranthene	1023	719	1233	991	258
Pyrene	1375	1922	1774	1690	283
2,3-benzofluorene	484	644	873	667	196
Benz(a)anthracene	661	811	1064	845	204
Chrysene/Triphenylene	1192	1274	1560	1342	193
Benzofluoranthenes	2688	4256	3469	3471	784
Benzo(e)pyrene	737	1110	1118	988	218
Benzo(a)pyrene	745	1243	1073	1020	253
Perylene	18	308	315	214	169
9,10-diphenylanthracene	6	5	8	7	1
Dibenz(a,h)anthracene	259	356	300	305	49
Benzo(g,h,i)perylene	556	648	670	625	60
TOTAL DETECTABLE PAHs	13328	16236	16847	15470	1880
PERCENT DRY WEIGHT	46.88	50.12	48.46	48.48	1.63
PERCENT TOC	2.84	3.19	2.32	2.78	.44

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	40	61	47	49	11
Acenaphthene-d10	109	99	86	98	12
Phenanthrene-d10	117	113	89	106	15
Chrysene-d12	89	80	62	77	14
Perylene-d12	105	84	76	88	15

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #7:Los Angeles River Mouth At Queensway
COLLECTION DATE 27 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<7	<12	<10	<10	*
n-Propylbenzene	<4	<7	<6	<6	*
iso-Propylbenzene	<5	<9	<8	<7	*
Tetramethylbenzene	<5	<11	<8	<8	*
Naphthalene	55	64	53	57	6
C1-Naphthalenes(2)	54	56	60	57	3
C2-Naphthalenes(6)	271	246	212	243	30
C3-Naphthalenes(2)	237	218	174	209	33
Biphenyl	14	<5	11	10	5
Acenaphthylene	<3	<4	<4	<4	*
Acenaphthene	7	<9	10	9	2
Fluorene	50	34	51	45	10
Phenanthrene	579	611	582	591	18
C1-Phenanthrenes(4)	544	697	681	640	84
C2-Phenanthrenes(4)	641	668	668	659	16
C3-Phenanthrenes(2)	228	398	409	345	101
Anthracene	45	43	35	41	5
Fluoranthene	784	696	696	725	51
Pyrene	1188	1059	1050	1099	77
2,3-benzofluorene	299	169	219	229	66
Benz(a)anthracene	589	410	462	487	92
Chrysene/Triphenylene	524	531	679	578	87
Benzofluoranthenes	1185	1093	1426	1235	172
Benzo(e)pyrene	339	336	386	354	28
Benzo(a)pyrene	311	302	366	326	35
Perylene	126	150	142	139	12
9,10-diphenylanthracene	16	3	5	8	7
Dibenz(a,h)anthracene	120	120	132	124	7
Benzo(g,h,i)perylene	376	349	453	393	54
TOTAL DETECTABLE PAHs	8582	8253	8962	8599	355
PERCENT DRY WEIGHT	50.72	53.93	54.45	53.03	2.02
PERCENT TOC	2.47	2.55	2.67	2.56	.10

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	90	83	91	88	4
Acenaphthene-d10	110	110	116	112	3
Phenanthrene-d10	112	110	117	113	4
Chrysene-d12	64	60	67	64	4
Perylene-d12	73	83	80	79	5

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #8:Upper Los Angeles River At Balboa Avenue
COLLECTION DATE 24 April 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<15	<10	<11	<12	*
n-Propylbenzene	<10	<8	<6	<8	*
iso-Propylbenzene	<12	<10	<9	<10	*
Tetramethylbenzene	<12	<10	<9	<10	*
Naphthalene	<10	<8	22	13	8
C1-Naphthalenes(2)	<5	<5	<4	<5	*
C2-Naphthalenes(6)	<8	<8	<7	<8	*
C3-Naphthalenes(2)	<8	<8	<7	<8	*
Biphenyl	<5	<5	<4	<5	*
Acenaphthylene	<4	<3	<3	<3	*
Acenaphthene	<8	<6	<7	<7	*
Fluorene	<5	<5	<4	<5	*
Phenanthrene	226	256	362	281	71
C1-Phenanthrenes(4)	133	97	195	142	49
C2-Phenanthrenes(4)	147	102	235	161	67
C3-Phenanthrenes(2)	61	54	144	86	50
Anthracene	16	12	30	19	9
Fluoranthene	395	343	410	382	35
Pyrene	467	372	486	442	61
2,3-benzofluorene	123	34	54	70	47
Benz(a)anthracene	232	171	228	210	34
Chrysene/Triphenylene	287	267	303	285	18
Benzofluoranthenes	883	731	775	796	78
Benzo(e)pyrene	64	185	201	150	75
Benzo(a)pyrene	264	220	230	238	23
Perylene	86	81	86	84	3
9,10-diphenylanthracene	<2	<1	<1	<2	*
Dibenz(a,h)anthracene	77	19	17	38	34
Benzo(g,h,i)perylene	195	148	166	170	24
TOTAL DETECTABLE PAHs	3656	3092	3944	3564	433
PERCENT DRY WEIGHT	65.65	66.21	67.05	66.30	.70
PERCENT TOC	1.89	2.06	1.97	1.97	.09

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	50	47	55	51	4
Acenaphthene-d10	89	80	82	84	5
Phenanthrene-d10	116	90	92	99	14
Chrysene-d12	89	74	75	79	8
Perylene-d12	98	76	80	85	12

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

STATION #9: Mid Los Angeles River Below Balboa Avenue
COLLECTION DATE 24 April 1986

RESULTS (nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<7	<7	<5	<6	*
n-Propylbenzene	<5	<5	<4	<5	*
iso-Propylbenzene	<5	<7	<5	<6	*
Tetramethylbenzene	<5	<7	<5	<6	*
Naphthalene	5	<5	<4	4	<1
C1-Naphthalenes(2)	<2	<3	<2	<3	*
C2-Naphthalenes(6)	<3	<6	<5	<5	*
C3-Naphthalenes(2)	<3	<6	<5	<5	*
Biphenyl	<2	<3	<2	<3	*
Acenaphthylene	<1	<2	<2	<2	*
Acenaphthene	<3	<4	<4	<4	*
Fluorene	<2	<3	<2	<3	*
Phenanthrene	18	44	82	48	32
C1-Phenanthrenes(4)	72	66	17	52	30
C2-Phenanthrenes(4)	151	143	16	103	76
C3-Phenanthrenes(2)	120	136	18	91	64
Anthracene	<1	<1	<1	<1	*
Fluoranthene	45	72	105	74	30
Pyrene	80	84	108	91	15
2,3-benzofluorene	23	15	7	15	8
Benz(a)anthracene	16	45	49	37	18
Chrysene/Triphenylene	29	94	72	65	34
Benzofluoranthenes	40	235	189	155	102
Benzo(e)pyrene	16	52	46	38	19
Benzo(a)pyrene	15	62	60	46	27
Perylene	21	46	40	36	13
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	6	19	16	14	7
Benzo(g,h,i)perylene	10	34	37	27	15
TOTAL DETECTABLE PAHs	667	1147	862	892	241
PERCENT DRY WEIGHT	81.58	81.78	81.16	81.51	.32
PERCENT TOC	.65	.37	.29	.44	.19

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	42	57	56	52	8
Acenaphthene-d10	87	88	82	86	3
Phenanthrene-d10	112	98	101	104	7
Chrysene-d12	87	86	83	85	2
Perylene-d12	100	83	83	89	10

SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #10:Lower Los Angeles River At Willow Street
COLLECTION DATE 25 April 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<11	<16	<15	<14	*
n-Propylbenzene	<7	<8	<9	<8	*
iso-Propylbenzene	<7	<12	<11	<10	*
Tetramethylbenzene	<9	<12	<13	<11	*
Naphthalene	<7	<8	<9	<8	*
C1-Naphthalenes(2)	<3	<3	<6	<4	*
C2-Naphthalenes(6)	<5	<6	<11	<7	*
C3-Naphthalenes(2)	38	<6	<11	18	17
Biphenyl	<3	<3	<6	<4	*
Acenaphthylene	<2	<3	<5	<3	*
Acenaphthene	<4	<6	<11	<7	*
Fluorene	<3	<4	<8	<5	*
Phenanthrene	66	27	41	44	20
C1-Phenanthrenes(4)	179	35	7	74	92
C2-Phenanthrenes(4)	143	56	17	72	65
C3-Phenanthrenes(2)	244	50	<4	99	127
Anthracene	2	<1	<2	2	<1
Fluoranthene	41	30	56	42	13
Pyrene	47	27	55	43	14
2,3-benzofluorene	15	8	<5	9	5
Benz(a)anthracene	23	16	31	23	8
Chrysene/Triphenylene	62	39	52	51	12
Benzofluoranthenes	66	102	154	107	44
Benzo(e)pyrene	42	27	38	36	8
Benzo(a)pyrene	40	28	50	39	11
Perylene	57	19	23	33	21
9,10-diphenylanthracene	<1	<1	<2	<1	*
Dibenz(a,h)anthracene	16	<1	<2	6	8
Benzo(g,h,i)perylene	32	12	24	23	10
TOTAL DETECTABLE PAHs	1113	476	548	712	349
PERCENT DRY WEIGHT	83.54	82.57	82.25	82.79	.67
PERCENT TOC	2.45	.35	.80	1.20	1.11

SURROGATE RECOVERIES IN PERCENT

	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Naphthalene-d8	44	25	44	38	11
Acenaphthene-d10	91	66	62	73	16
Phenanthrene-d10	108	83	88	93	13
Chrysene-d12	95	94	87	92	4
Perylene-d12	101	82	83	89	11

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #11:San Gabriel River
COLLECTION DATE 09 July 1986

RESULTS (nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<18	<26	<22	<22	*
n-Propylbenzene	<11	<16	<14	<14	*
iso-Propylbenzene	<14	<20	<18	<17	*
Tetramethylbenzene	<16	<24	<21	<20	*
Naphthalene	<11	<16	<14	<14	*
C1-Naphthalenes(2)	<7	<12	<12	<11	*
C2-Naphthalenes(6)	<14	<21	<22	<19	*
C3-Naphthalenes(2)	<14	<21	<22	<19	*
Biphenyl	<7	<12	<12	<11	*
Acenaphthylene	<5	<9	<8	<7	*
Acenaphthene	<12	<19	<19	<17	*
Fluorene	<9	<13	<13	<12	*
Phenanthrene	215	189	137	180	39
C1-Phenanthrenes(4)	113	43	181	112	69
C2-Phenanthrenes(4)	122	35	41	66	49
C3-Phenanthrenes(2)	79	30	<11	40	35
Anthracene	<3	<4	<5	<4	*
Fluoranthene	365	382	334	361	24
Pyrene	395	414	373	394	21
2,3-benzofluorene	59	<13	<17	30	25
Benz(a)anthracene	231	252	248	244	11
Chrysene/Triphenylene	326	334	318	326	8
Benzofluoranthenes	971	650	517	713	233
Benzo(e)pyrene	227	233	221	227	6
Benzo(a)pyrene	272	251	254	259	11
Perylene	93	72	71	79	13
9,10-diphenylanthracene	<4	<4	<6	<5	*
Dibenz(a,h)anthracene	7	48	<8	21	24
Benzo(g,h,i)perylene	204	201	219	208	10
TOTAL DETECTABLE PAHs	3679	3134	2914	3242	394
PERCENT DRY WEIGHT	45.59	42.07	42.66	43.44	1.89
PERCENT TOC	2.41	2.44	2.62	2.49	.11

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	70	67	83	73	9
Acenaphthene-d10	99	89	98	95	6
Phenanthrene-d10	110	104	99	104	6
Chrysene-d12	97	94	77	89	11
Perylene-d12	92	92	86	90	3

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #12: Orange County Outfall
COLLECTION DATE 06 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<7	<5	<5	<6	*
n-Propylbenzene	<4	<3	<3	<3	*
iso-Propylbenzene	<6	<4	<4	<5	*
Tetramethylbenzene	<6	<4	<4	<5	*
Naphthalene	64	72	<3	46	38
C1-Naphthalenes(2)	108	67	87	87	21
C2-Naphthalenes(6)	113	75	101	96	19
C3-Naphthalenes(2)	17	<3	24	15	11
Biphenyl	41	43	36	40	3
Acenaphthylene	<1	<2	<1	<1	*
Acenaphthene	25	8	17	17	9
Fluorene	23	17	34	25	9
Phenanthrene	272	175	325	257	76
C1-Phenanthrenes(4)	154	74	152	127	45
C2-Phenanthrenes(4)	77	43	92	71	25
C3-Phenanthrenes(2)	41	48	61	50	10
Anthracene	37	24	43	35	10
Fluoranthene	365	211	419	332	108
Pyrene	254	244	362	287	65
2,3-benzofluorene	72	87	159	106	47
Benz(a)anthracene	124	201	277	201	77
Chrysene/Triphenylene	377	153	294	275	113
Benzofluoranthenes	1191	363	684	746	417
Benzo(e)pyrene	248	137	233	206	60
Benzo(a)pyrene	368	176	322	289	100
Perylene	97	64	93	85	18
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	59	15	78	51	33
Benzo(g,h,i)perylene	34	88	146	89	56
TOTAL DETECTABLE PAHs	4161	2385	4039	3528	992
PERCENT DRY WEIGHT	65.13	66.42	63.81	65.12	1.31
PERCENT TOC	1.70	1.33	3.31	2.11	1.05

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	62	88	87	79	15
Acenaphthene-d10	96	131	116	114	18
Phenanthrene-d10	122	140	130	131	9
Chrysene-d12	137	105	119	120	16
Perylene-d12	98	92	96	95	3

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #13: Anaheim Bay At Warner Avenue
COLLECTION DATE 31 July 1986

RESULTS (nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<4	<8	<9	<7	*
n-Propylbenzene	<2	<4	<4	<3	*
iso-Propylbenzene	<3	<6	<6	<5	*
Tetramethylbenzene	<3	<6	<6	<5	*
Naphthalene	<4	<4	15	8	5
C1-Naphthalenes(2)	<4	<3	<3	<3	*
C2-Naphthalenes(6)	<10	<5	<6	<7	*
C3-Naphthalenes(2)	<8	<5	<6	<6	*
Biphenyl	<4	<3	<3	<3	*
Acenaphthylene	<4	<3	<1	<3	*
Acenaphthene	<8	<4	<4	<5	*
Fluorene	<6	<4	<3	<4	*
Phenanthrene	35	35	131	67	45
C1-Phenanthrenes(4)	7	<2	63	24	27
C2-Phenanthrenes(4)	15	<2	56	24	23
C3-Phenanthrenes(2)	8	<2	37	16	15
Anthracene	2	<1	9	4	4
Fluoranthene	61	55	235	117	83
Pyrene	58	92	229	126	91
2,3-benzofluorene	4	<5	34	14	17
Benz(a)anthracene	23	32	70	42	25
Chrysene/Triphenylene	52	50	225	109	82
Benzofluoranthenes	168	151	713	344	320
Benzo(e)pyrene	47	46	198	97	87
Benzo(a)pyrene	44	39	185	89	83
Perylene	19	15	14	16	2
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	11	10	48	23	18
Benzo(g,h,i)perylene	39	48	185	91	67
TOTAL DETECTABLE PAHs	593	573	2447	1204	1076
PERCENT DRY WEIGHT	74.06	74.61	50.96	66.54	11.02
PERCENT TOC	1.25	1.17	1.84	1.42	.37

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	1	55	74	43	38
Acenaphthene-d10	54	83	105	81	26
Phenanthrene-d10	104	99	122	108	12
Chrysene-d12	116	67	122	102	30
Perylene-d12	104	73	102	93	17

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #14:Anaheim Bay At The Pacific Coast Highway Bridge
COLLECTION DATE 31 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<5	<6	<5	<5	*
n-Propylbenzene	<3	<3	<3	<3	*
iso-Propylbenzene	<5	<4	<4	<4	*
Tetramethylbenzene	<5	<4	<4	<4	*
Naphthalene	<3	<3	<3	<3	*
C1-Naphthalenes(2)	<2	<3	<3	<3	*
C2-Naphthalenes(6)	<4	<6	<5	<5	*
C3-Naphthalenes(2)	<4	<6	<5	<5	*
Biphenyl	<2	<3	<3	<3	*
Acenaphthylene	<2	<3	<3	<3	*
Acenaphthene	<3	<6	<5	<5	*
Fluorene	<2	<4	<4	<3	*
Phenanthrene	13	<3	6	7	5
C1-Phenanthrenes(4)	<2	<3	<4	<3	*
C2-Phenanthrenes(4)	<2	<3	<4	<3	*
C3-Phenanthrenes(2)	<2	<3	<4	<3	*
Anthracene	<1	<1	<2	<1	*
Fluoranthene	19	9	40	23	16
Pyrene	21	13	22	28	17
2,3-benzofluorene	<2	<5	<3	<3	*
Benz(a)anthracene	8	8	11	9	2
Chrysene/Triphenylene	17	12	20	16	4
Benzofluoranthenes	63	33	55	50	16
Benzo(e)pyrene	16	17	12	15	3
Benzo(a)pyrene	14	12	14	13	1
Perylene	7	3	4	5	2
9,10-diphenylanthracene	<1	<2	<1	<1	*
Dibenz(a,h)anthracene	<1	<2	<1	<1	*
Benzo(g,h,i)perylene	4	10	11	8	4
TOTAL DETECTABLE PAHs	182	117	195	165	42
PERCENT DRY WEIGHT	71.81	70.05	72.82	71.56	1.40
PERCENT TOC	1.16	.95	1.07	1.06	.10

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	64	0	0	21	37
Acenaphthene-d10	106	0	0	35	61
Phenanthrene-d10	112	60	52	75	33
Chrysene-d12	104	64	105	91	23
Perylene-d12	99	65	96	87	19

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #15:Rhine CHannel-Crows Nest In Newport Beach
COLLECTION DATE 19 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<17	<23	<14	<18	*
n-Propylbenzene	<12	<15	<9	<12	*
iso-Propylbenzene	<17	<15	<9	<14	*
Tetramethylbenzene	<17	<15	<14	<15	*
Naphthalene	<12	<15	14	14	2
C1-Naphthalenes(2)	<6	<7	<5	<6	*
C2-Naphthalenes(6)	<12	<10	<7	<10	*
C3-Naphthalenes(2)	<12	<10	<10	<11	*
Biphenyl	<6	<7	<5	<6	*
Acenaphthylene	<6	<3	<2	<4	*
Acenaphthene	<9	<10	<7	<9	*
Fluorene	<9	<7	<5	<7	*
Phenanthrene	79	27	109	72	41
C1-Phenanthrenes(4)	<4	<2	19	8	9
C2-Phenanthrenes(4)	<4	<2	6	4	2
C3-Phenanthrenes(2)	<4	<2	<4	<3	*
Anthracene	<5	<2	16	8	7
Fluoranthene	134	59	189	127	65
Pyrene	210	85	271	189	95
2,3-benzofluorene	121	18	102	80	55
Benz(a)anthracene	147	56	198	134	72
Chrysene/Triphenylene	188	82	260	177	90
Benzofluoranthenes	845	374	1139	786	386
Benzo(e)pyrene	181	72	228	160	80
Benzo(a)pyrene	217	84	308	203	113
Perylene	56	17	83	52	33
9,10-diphenylanthracene	<2	<2	<3	<2	*
Dibenz(a,h)anthracene	70	22	98	63	38
Benzo(g,h,i)perylene	158	68	215	147	74
TOTAL DETECTABLE PAHs	2406	964	3255	2208	1158
PERCENT DRY WEIGHT	39.51	39.85	38.06	39.14	.95
PERCENT TOC	1.82	1.69	2.08	1.86	.20

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	35	26	45	35	20
Acenaphthene-d10	70	60	85	72	13
Phenanthrene-d10	115	102	108	108	7
Chrysene-d12	79	74	70	74	5
Perylene-d12	84	78	79	80	3

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #16:Newport Backbay
COLLECTION DATE 19 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<13	<47	<7	<22	*
n-Propylbenzene	<9	<23	<4	<12	*
iso-Propylbenzene	<13	<35	<5	<18	*
Tetramethylbenzene	<13	<35	<5	<18	*
Naphthalene	<9	750	308	355	373
C1-Naphthalenes(2)	<5	<11	<3	<6	*
C2-Naphthalenes(6)	<11	<26	<7	<15	*
C3-Naphthalenes(2)	<11	<21	<6	<13	*
Biphenyl	<5	<11	<3	<6	*
Acenaphthylene	<5	<11	<3	<6	*
Acenaphthene	<8	<21	<6	<12	*
Fluorene	<5	<16	<4	<8	*
Phenanthrene	<3	<5	12	7	5
C1-Phenanthrenes(4)	<3	<5	<3	<4	*
C2-Phenanthrenes(4)	<3	<5	<3	<4	*
C3-Phenanthrenes(2)	<3	<5	<3	<4	*
Anthracene	<2	<2	<1	<2	*
Fluoranthene	5	21	32	19	14
Pyrene	27	17	97	47	43
2,3-benzofluorene	<4	<6	<10	<7	*
Benz(a)anthracene	7	7	84	33	44
Chrysene/Triphenylene	13	18	64	32	28
Benzofluoranthenes	115	94	99	103	11
Benzo(e)pyrene	11	26	27	21	9
Benzo(a)pyrene	30	26	51	36	13
Perylene	7	<2	3	4	3
9,10-diphenylanthracene	<2	<2	11	5	5
Dibenz(a,h)anthracene	<2	<2	75	26	42
Benzo(g,h,i)perylene	18	29	35	27	9
TOTAL DETECTABLE PAHs	233	988	898	706	412
PERCENT DRY WEIGHT	50.83	47.43	49.77	49.34	1.74
PERCENT TOC	1.09	1.29	1.14	1.17	.10

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	36	14	90	47	39
Acenaphthene-d10	59	32	110	67	40
Phenanthrene-d10	96	74	116	95	21
Chrysene-d12	81	86	45	71	22
Perylene-d12	90	86	56	77	19

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #17:Santa Ana River
COLLECTION DATE 03 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<6	<11	<6	<8	*
n-Propylbenzene	<4	<7	<4	<5	*
iso-Propylbenzene	<6	<11	<6	<8	*
Tetramethylbenzene	<6	<11	<6	<8	*
Naphthalene	<4	<7	<4	<5	*
C1-Naphthalenes(2)	<3	<4	<3	<3	*
C2-Naphthalenes(6)	<5	<8	<5	<6	*
C3-Naphthalenes(2)	<5	<8	<5	<6	*
Biphenyl	<3	<4	<3	<3	*
Acenaphthylene	<1	<2	<3	<2	*
Acenaphthene	<4	<6	<4	<5	*
Fluorene	<3	<4	<3	<3	*
Phenanthrene	19	6	16	14	7
C1-Phenanthrenes(4)	<2	<3	<2	<2	*
C2-Phenanthrenes(4)	14	<3	<2	6	7
C3-Phenanthrenes(2)	5	<3	<2	4	2
Anthracene	<1	<2	<1	<1	*
Fluoranthene	32	27	30	30	3
Pyrene	41	27	31	33	7
2,3-benzofluorene	<2	<3	<2	<2	*
Benz(a)anthracene	17	12	13	14	3
Chrysene/Triphenylene	28	21	25	25	3
Benzofluoranthenes	73	72	92	79	11
Benzo(e)pyrene	18	17	20	18	2
Benzo(a)pyrene	18	17	35	23	10
Perylene	11	10	13	11	1
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	3	<1	<1	2	1
Benzo(g,h,i)perylene	16	14	17	16	1
TOTAL DETECTABLE PAHs	295	223	292	270	41
PERCENT DRY WEIGHT	67.74	69.20	68.72	68.55	.74
PERCENT TOC	.56	.51	.61	.56	.05

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	58	33	60	50	19
Acenaphthene-d10	90	58	86	78	17
Phenanthrene-d10	110	77	103	97	17
Chrysene-d12	92	83	117	97	18
Perylene-d12	98	77	104	93	14

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #18:Dana Point Marina
COLLECTION DATE 08 May 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<31	<56	<17	<35	*
n-Propylbenzene	<21	<40	<10	<24	*
iso-Propylbenzene	<26	<56	<14	<32	*
Tetramethylbenzene	<26	<48	<14	<29	*
Naphthalene	<21	<40	<10	<24	*
C1-Naphthalenes(2)	<10	<21	<5	<12	*
C2-Naphthalenes(6)	<14	<34	<9	<19	*
C3-Naphthalenes(2)	<14	<34	<9	<19	*
Biphenyl	<10	<21	<5	<12	*
Acenaphthylene	<7	<13	<4	<8	*
Acenaphthene	<14	<29	<9	<18	*
Fluorene	<10	<21	<7	<13	*
Phenanthrene	32	93	<4	43	46
C1-Phenanthrenes(4)	68	134	<4	69	65
C2-Phenanthrenes(4)	78	134	<4	72	65
C3-Phenanthrenes(2)	55	62	<4	41	32
Anthracene	12	<6	<1	6	5
Fluoranthene	40	40	13	31	16
Pyrene	39	98	15	51	43
2,3-benzofluorene	<7	<17	<6	<10	*
Benz(a)anthracene	12	14	3	10	6
Chrysene/Triphenylene	22	35	14	24	11
Benzofluoranthenes	29	112	35	59	46
Benzo(e)pyrene	17	24	10	17	7
Benzo(a)pyrene	22	24	13	20	6
Perylene	27	24	16	22	6
9,10-diphenylanthracene	<3	<7	<1	<4	*
Dibenz(a,h)anthracene	16	<10	<3	10	6
Benzo(g,h,i)perylene	16	20	12	16	4
TOTAL DETECTABLE PAHs	485	814	131	477	342
PERCENT DRY WEIGHT	51.72	43.40	62.69	52.60	9.68
PERCENT TOC	1.06	1.21	1.13	1.13	.08

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	30	23	37	30	7
Acenaphthene-d10	65	44	70	60	14
Phenanthrene-d10	93	59	86	79	18
Chrysene-d12	85	50	87	74	21
Perylene-d12	92	51	82	75	21

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #19:San Mateo Pt.- Reference Survey Station R52-60
COLLECTION DATE 25 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<5	<9	<13	<9	*
n-Propylbenzene	<4	<6	<9	<6	*
iso-Propylbenzene	<5	<9	<13	<9	*
Tetramethylbenzene	<5	<9	<13	<9	*
Naphthalene	<4	<6	<9	<6	*
C1-Naphthalenes(2)	<13	<4	<4	<7	*
C2-Naphthalenes(6)	<26	<7	<9	<14	*
C3-Naphthalenes(2)	<26	<7	<9	<14	*
Biphenyl	<13	<4	<4	<7	*
Acenaphthylene	<13	<4	<4	<7	*
Acenaphthene	<19	<5	<6	<10	*
Fluorene	<13	<5	<6	<8	*
Phenanthrene	<3	18	<3	8	9
C1-Phenanthrenes(4)	<3	42	<3	16	22
C2-Phenanthrenes(4)	<3	76	<3	27	42
C3-Phenanthrenes(2)	<3	40	<3	15	22
Anthracene	<2	<1	<2	<2	*
Fluoranthene	8	21	6	11	8
Pyrene	4	46	6	19	24
2,3-benzofluorene	<3	35	<4	14	18
Benz(a)anthracene	<1	9	2	4	4
Chrysene/Triphenylene	<1	18	7	9	9
Benzofluoranthenes	10	28	13	17	10
Benzo(e)pyrene	3	4	<1	3	2
Benzo(a)pyrene	3	3	4	3	<1
Perylene	6	6	7	6	<1
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	<1	<1	<1	<1	*
Benzo(g,h,i)perylene	<1	1	<1	1	<1
TOTAL DETECTABLE PAHs	34	347	45	142	178
PERCENT DRY WEIGHT	55.15	58.04	59.24	57.48	2.10
PERCENT TOC	1.09	1.06	1.03	1.06	.03

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	0	48	30	26	24
Acenaphthene-d10	22	78	62	54	29
Phenanthrene-d10	93	92	95	93	2
Chrysene-d12	104	84	108	99	13
Perylene-d12	98	87	96	94	6

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #20:San Diego Outfall At Pt. Loma
COLLECTION DATE 30 June 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<5	<16	<6	<9	*
n-Propylbenzene	<3	<10	<4	<6	*
iso-Propylbenzene	<5	<10	<6	<7	*
Tetramethylbenzene	<5	<13	<6	<8	*
Naphthalene	<3	<10	<4	<6	*
C1-Naphthalenes(2)	<14	<5	<2	<7	*
C2-Naphthalenes(6)	<27	<9	<4	<14	*
C3-Naphthalenes(2)	<27	<9	<4	<14	*
Biphenyl	<14	<5	<2	<7	*
Acenaphthylene	<14	<4	<2	<6	*
Acenaphthene	<20	<7	<3	<10	*
Fluorene	<20	<5	<2	<9	*
Phenanthrene	7	<2	4	4	3
C1-Phenanthrenes(4)	<3	<1	<2	<2	*
C2-Phenanthrenes(4)	<3	<1	<2	<2	*
C3-Phenanthrenes(2)	<3	<1	<2	<2	*
Anthracene	<1	<1	2	<2	*
Fluoranthene	14	9	11	12	3
Pyrene	19	10	13	14	5
2,3-benzofluorene	<4	<4	<2	<3	*
Benz(a)anthracene	12	5	8	8	4
Chrysene/Triphenylene	15	8	13	12	3
Benzofluoranthenes	34	23	97	51	40
Benzo(e)pyrene	22	9	20	17	7
Benzo(a)pyrene	28	11	20	20	9
Perylene	4	3	7	5	2
9,10-diphenylanthracene	<2	<1	<2	<2	*
Dibenz(a,h)anthracene	<2	<3	<2	<2	*
Benzo(g,h,i)perylene	16	7	11	11	5
TOTAL DETECTABLE PAHs	171	85	206	154	62
PERCENT DRY WEIGHT	63.92	64.65	64.12	64.23	.38
PERCENT TOC	.73	.67	.68	.69	.03

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	0	38	66	35	33
Acenaphthene-d10	18	70	112	67	47
Phenanthrene-d10	86	106	134	109	24
Chrysene-d12	86	98	116	100	15
Perylene-d12	59	86	63	69	15

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #21:North San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<8	<117	<15	<47	*
n-Propylbenzene	<4	<78	<10	<31	*
iso-Propylbenzene	<6	<117	<15	<46	*
Tetramethylbenzene	<6	<117	<15	<46	*
Naphthalene	<4	<78	<10	<31	*
C1-Naphthalenes(2)	<2	<4	<4	<3	*
C2-Naphthalenes(6)	<5	<9	<7	<7	*
C3-Naphthalenes(2)	<5	<9	<7	<7	*
Biphenyl	<2	<4	<4	<3	*
Acenaphthylene	<2	<4	<2	<3	*
Acenaphthene	<5	<6	<6	<6	*
Fluorene	<3	<6	<4	<5	*
Phenanthrene	49	51	28	43	13
C1-Phenanthrenes(4)	53	35	<2	30	26
C2-Phenanthrenes(4)	66	58	5	43	33
C3-Phenanthrenes(2)	32	45	<2	27	22
Anthracene	8	6	2	5	3
Fluoranthene	78	89	55	74	17
Pyrene	121	104	55	93	34
2,3-benzofluorene	32	28	6	22	14
Benz(a)anthracene	70	51	16	46	27
Chrysene/Triphenylene	148	152	64	121	49
Benzofluoranthenes	454	478	268	223	208
Benzo(e)pyrene	116	122	56	98	36
Benzo(a)pyrene	116	129	64	103	34
Perylene	36	34	14	28	12
9,10-diphenylanthracene	<1	<1	<1	<1	*
Dibenz(a,h)anthracene	29	<1	8	13	14
Benzo(g,h,i)perylene	70	76	38	61	21
TOTAL DETECTABLE PAHs	1478	1458	679	1205	456
PERCENT DRY WEIGHT	65.89	63.96	64.04	64.63	1.09
PERCENT TOC	.66	.55	.66	.62	.06

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	64	3	31	31	31
Acenaphthene-d10	106	58	68	77	25
Phenanthrene-d10	110	100	106	105	5
Chrysene-d12	93	101	111	102	9
Perylene-d12	95	89	102	95	7

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #22:NASSCO-San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<19	<131	<92	<81	*
n-Propylbenzene	<14	<87	<52	<51	*
iso-Propylbenzene	<19	<109	<79	<69	*
Tetramethylbenzene	<17	<109	<66	<64	*
Naphthalene	36	<87	<52	59	26
C1-Naphthalenes(2)	<12	<18	<15	<14	*
C2-Naphthalenes(6)	<16	<32	<26	<25	*
C3-Naphthalenes(2)	<16	<32	<26	<25	*
Biphenyl	<10	<18	<15	<14	*
Acenaphthylene	<6	32	<11	16	14
Acenaphthene	<14	<28	<26	<22	*
Fluorene	<10	<18	<18	<16	*
Phenanthrene	120	645	114	293	305
C1-Phenanthrenes(4)	95	159	38	97	61
C2-Phenanthrenes(4)	62	59	60	60	1
C3-Phenanthrenes(2)	104	27	38	56	42
Anthracene	44	119	49	71	42
Fluoranthene	391	963	274	543	369
Pyrene	906	1142	1831	1293	481
2,3-benzofluorene	178	340	179	232	93
Benz(a)anthracene	243	460	233	312	128
Chrysene/Triphenylene	458	692	463	538	134
Benzofluoranthenes	1310	2700	1743	1918	711
Benzo(e)pyrene	502	658	774	645	136
Benzo(a)pyrene	628	872	1013	838	195
Perylene	178	11	230	140	115
9,10-diphenylanthracene	<3	<4	<6	<4	*
Dibenz(a,h)anthracene	126	44	44	72	47
Benzo(g,h,i)perylene	347	474	555	459	105
TOTAL DETECTABLE PAHs	5728	9397	7638	7588	1835
PERCENT DRY WEIGHT	44.00	41.64	42.39	42.68	1.21
PERCENT TOC	1.87	2.00	1.79	1.89	.11

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	66	9	14	30	32
Acenaphthene-d10	93	42	51	62	27
Phenanthrene-d10	115	71	70	85	26
Chrysene-d12	98	70	59	76	20
Perylene-d12	101	81	64	82	18

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #23:Chollas Creek-San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<16	<22	<15	<18	*
n-Propylbenzene	<10	<14	<9	<11	*
iso-Propylbenzene	<16	<18	<15	<16	*
Tetramethylbenzene	<13	<18	<12	<14	*
Naphthalene	22	22	<9	18	8
C1-Naphthalenes(2)	<4	<7	<5	<6	*
C2-Naphthalenes(6)	<8	<13	<11	<10	*
C3-Naphthalenes(2)	<8	<11	<11	<10	*
Biphenyl	<4	<7	<5	<6	*
Acenaphthylene	<3	11	<4	6	5
Acenaphthene	<6	<11	<9	<9	*
Fluorene	<5	<7	<7	<7	*
Phenanthrene	161	199	154	171	24
C1-Phenanthrenes(4)	60	97	83	80	18
C2-Phenanthrenes(4)	53	89	93	78	22
C3-Phenanthrenes(2)	23	82	55	53	30
Anthracene	40	49	43	44	5
Fluoranthene	208	344	296	283	69
Pyrene	359	892	759	670	277
2,3-benzofluorene	57	201	174	144	76
Benz(a)anthracene	80	270	243	198	103
Chrysene/Triphenylene	405	537	550	497	80
Benzofluoranthenes	1990	1461	1626	1692	271
Benzo(e)pyrene	451	546	556	518	58
Benzo(a)pyrene	512	628	637	592	70
Perylene	19	13	152	61	79
9,10-diphenylanthracene	<1	4	<2	2	1
Dibenz(a,h)anthracene	<2	40	138	60	70
Benzo(g,h,i)perylene	206	349	339	298	80
TOTAL DETECTABLE PAHs	4646	5834	5898	5459	705
PERCENT DRY WEIGHT	50.01	49.79	48.40	49.40	.87
PERCENT TOC	1.70	1.65	1.54	1.63	.08

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	50	45	56	50	6
Acenaphthene-d10	124	87	93	101	20
Phenanthrene-d10	103	98	100	100	2
Chrysene-d12	152	80	89	107	39
Perylene-d12	127	82	88	99	24

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #24:San Diego Harbor At 7th Street
COLLECTION DATE 01 July 1986

RESULTS(nG/G Dry Weight)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<10	<58	<33	<34	*
n-Propylbenzene	<5	<35	<18	<19	*
iso-Propylbenzene	<8	<42	<25	<25	*
Tetramethylbenzene	<8	<46	<25	<26	*
Naphthalene	28	<35	<18	27	9
C1-Naphthalenes(2)	<3	<14	<11	<9	*
C2-Naphthalenes(6)	27	<29	<22	26	4
C3-Naphthalenes(2)	49	<29	<20	32	15
Biphenyl	<3	<16	<11	<10	*
Acenaphthylene	16	<11	<9	12	4
Acenaphthene	<4	<25	<17	<16	*
Fluorene	<3	<18	<13	<11	*
Phenanthrene	104	178	163	148	39
C1-Phenanthrenes(4)	18	199	175	131	98
C2-Phenanthrenes(4)	97	287	80	155	115
C3-Phenanthrenes(2)	199	327	130	219	100
Anthracene	52	70	66	63	9
Fluoranthene	175	348	252	258	87
Pyrene	3797	2383	1877	2686	995
2,3-benzofluorene	946	1105	787	946	159
Benz(a)anthracene	642	368	219	410	215
Chrysene/Triphenylene	510	661	281	484	191
Benzofluoranthenes	5277	4495	3024	4265	1144
Benzo(e)pyrene	1178	903	669	917	255
Benzo(a)pyrene	1278	1151	735	1055	284
Perylene	371	313	168	284	105
9,10-diphenylanthracene	2	<5	3	3	2
Dibenz(a,h)anthracene	142	256	188	195	57
Benzo(g,h,i)perylene	698	500	440	546	135
TOTAL DETECTABLE PAHs	15606	13544	9257	12802	3239
PERCENT DRY WEIGHT	54.71	51.09	43.63	49.81	5.65
PERCENT TOC	2.24	2.33	2.26	2.28	.05

SURROGATE RECOVERIES IN PERCENT

Naphthalene-d8	58	41	50	50	8
Acenaphthene-d10	99	86	84	90	8
Phenanthrene-d10	107	125	106	113	11
Chrysene-d12	60	120	86	89	30
Perylene-d12	74	122	101	99	24

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DETAILED PAH ANALYSES BY SCCWRP PRESENTED

ON A BASIS OF NG/G TOC

SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #1:Chevron Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<3846	<1728	<6000	<3858	*
n-Propylbenzene	<2692	<864	<4500	<2685	*
iso-Propylbenzene	<3846	<1358	<4500	<3235	*
Tetramethylbenzene	<3846	<1358	<6000	<3735	*
Naphthalene	<2692	<888	<4474	<2685	*
C1-Naphthalenes(2)	<1538	<320	<2293	<1384	*
C2-Naphthalenes(6)	<3846	<641	<3822	<2770	*
C3-Naphthalenes(2)	<3846	<641	<3822	<2770	*
Biphenyl	<1538	<320	<2293	<1384	*
Acenaphthylene	<1154	<320	<1529	<1001	*
Acenaphthene	<1923	<641	<3057	<1874	*
Fluorene	<1538	<494	<2293	<1442	*
Phenanthrene	<768	2271	6863	3301	3175
C1-Phenanthrenes(4)	<768	837	<1248	951	260
C2-Phenanthrenes(4)	<768	956	3744	1823	1667
C3-Phenanthrenes(2)	<768	370	4368	1835	2202
Anthracene	<384	<121	<624	<376	*
Fluoranthene	1920	2869	15599	6796	7638
Pyrene	2929	3363	18512	8268	8874
2,3-benzofluorene	<1098	<370	<1683	<1050	*
Benz(a)anthracene	2563	2436	12903	5967	6007
Chrysene/Triphenylene	3295	3131	22439	9622	11100
Benzofluoranthenes	10957	4735	49610	21767	24317
Benzo(e)pyrene	2267	3035	12114	5805	5477
Benzo(a)pyrene	1889	3278	13845	6337	6539
Perylene	756	2428	4615	2600	1935
9,10-diphenylanthracene	<384	<121	<577	<361	*
Dibenz(a,h)anthracene	<768	364	<1154	758	395
Benzo(g,h,i)perylene	768	<121	4615	1831	2432
TOTAL DETECTABLE PAHs	27332	30073	169227	75544	81143
PERCENT DRY WEIGHT	81.44	79.44	81.77	80.90	1.26
PERCENT TOC	.26	.81	.20	.42	.34

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #2:Hyperion 5-Mile Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<633	<595	<1081	<770	*
n-Propylbenzene	<380	<357	<676	<471	*
iso-Propylbenzene	<506	<357	<1081	<648	*
Tetramethylbenzene	<506	<595	<1081	<727	*
Naphthalene	2375	2022	2136	2178	180
C1-Naphthalenes(2)	894	785	1313	997	279
C2-Naphthalenes(6)	511	654	<658	608	84
C3-Naphthalenes(2)	<511	<523	<658	<564	*
Biphenyl	2811	2877	3126	2938	166
Acenaphthylene	<256	<262	<329	<282	*
Acenaphthene	<511	<392	<494	<466	*
Fluorene	<383	<262	<329	<325	*
Phenanthrene	1512	1370	1815	1566	227
C1-Phenanthrenes(4)	1977	4111	6224	4104	2124
C2-Phenanthrenes(4)	<233	<304	4538	1692	2465
C3-Phenanthrenes(2)	1744	1066	4149	2320	1620
Anthracene	<116	<152	259	176	74
Fluoranthene	2791	2131	2593	2505	339
Pyrene	4266	2811	3046	3374	781
2,3-benzofluorene	<474	<375	580	476	103
Benz(a)anthracene	4740	3748	1740	3409	1528
Chrysene/Triphenylene	4424	3373	2175	3324	1125
Benzofluoranthenes	17186	7198	5741	10042	6230
Benzo(e)pyrene	4805	2985	1619	3136	1598
Benzo(a)pyrene	5174	4038	1472	3561	1896
Perylene	2402	1404	1767	1858	505
9,10-diphenylanthracene	<185	<176	<147	<169	*
Dibenz(a,h)anthracene	1478	<176	1030	895	661
Benzo(g,h,i)perylene	1663	1931	1030	1541	463
TOTAL DETECTABLE PAHs	60242	42504	46353	49700	9331
PERCENT DRY WEIGHT	61.16	61.09	69.02	63.76	4.56
PERCENT TOC	.79	.84	.74	.79	.05

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #3:Hyperion 7-Mile Outfall
COLLECTION DATE 21 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<942	<1618	<1313	<1291	*
n-Propylbenzene	<596	<994	<693	<761	*
iso-Propylbenzene	<734	<1306	<959	<1000	*
Tetramethylbenzene	<803	<1462	<1047	<1104	*
Naphthalene	<601	13860	7338	7266	6630
C1-Naphthalenes(2)	3675	23906	16708	14763	530
C2-Naphthalenes(6)	15868	35580	20319	23922	345
C3-Naphthalenes(2)	3341	10858	10208	8136	4165
Biphenyl	15534	36636	29997	27389	488
Acenaphthylene	<501	<559	<289	<450	*
Acenaphthene	<1169	<1304	<626	<1033	*
Fluorene	<835	<931	915	894	8
Phenanthrene	4713	7004	7169	6295	79
C1-Phenanthrenes(4)	6562	27620	8364	14182	520
C2-Phenanthrenes(4)	8590	23667	6291	12849	410
C3-Phenanthrenes(2)	11036	18865	4955	11619	327
Anthracene	<239	<339	633	404	15
Fluoranthene	3460	9602	5061	6041	122
Pyrene	4795	12380	5901	7692	117
2,3-benzofluorene	3380	3809	1368	2852	56
Benz(a)anthracene	2830	12087	3464	6127	177
Chrysene/Triphenylene	3773	12526	4276	6858	209
Benzofluoranthenes	9311	32451	10286	17349	665
Benzo(e)pyrene	2488	9376	2560	4808	204
Benzo(a)pyrene	3270	11903	3271	6148	257
Perylene	2061	1662	1517	1747	33
9,10-diphenylanthracene	<284	<399	<190	<291	*
Dibenz(a,h)anthracene	<355	<532	<237	<375	*
Benzo(g,h,i)perylene	2274	6849	1185	3436	139
TOTAL DETECTABLE PAHs	106961	310641	151786	189796	107028

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #4:Los Angeles County Outfall Station PV7-3
COLLECTION DATE 25 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<400	<1448	<627	<825	*
n-Propylbenzene	<232	<724	<300	<419	*
iso-Propylbenzene	<316	<1086	<463	<622	*
Tetramethylbenzene	<316	<1086	<463	<622	*
Naphthalene	2211	1449	2466	2042	529
C1-Naphthalenes(2)	2878	1534	2962	2458	801
C2-Naphthalenes(6)	8300	6136	15779	10072	5060
C3-Naphthalenes(2)	6006	8863	19285	11385	6989
Biphenyl	792	<227	484	501	283
Acenaphthylene	1501	1420	967	1296	288
Acenaphthene	<334	<398	<423	<385	*
Fluorene	334	<284	544	387	138
Phenanthrene	4323	3495	6298	4705	1440
C1-Phenanthrenes(4)	12846	14820	28692	18786	8635
C2-Phenanthrenes(4)	21002	24331	41073	28802	10757
C3-Phenanthrenes(2)	9176	15926	26215	17106	8581
Anthracene	1468	841	1346	1218	332
Fluoranthene	4731	3097	2961	3596	985
Pyrene	9444	8296	10554	9431	1129
2,3-benzofluorene	16382	19033	24700	20038	4249
Benz(a)anthracene	3133	4026	4641	3933	758
Chrysene/Triphenylene	5774	6466	7111	6450	669
Benzofluoranthenes	15864	17985	18763	17537	1500
Benzo(e)pyrene	6933	7244	8709	7629	948
Benzo(a)pyrene	6688	7344	8426	7486	878
Perylene	7422	7444	10267	8378	1636
9,10-diphenylanthracene	122	50	<142	105	48
Dibenz(a,h)anthracene	1835	350	<212	799	900
Benzo(g,h,i)perylene	4527	5495	5239	5087	502
TOTAL DETECTABLE PAHs	153692	165645	247482	188940	51050
PERCENT DRY WEIGHT	38.24	39.04	34.67	37.32	2.33
PERCENT TOC	4.75	4.42	3.67	4.28	.55

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #5: Mid Los Angeles Harbor
COLLECTION DATE 27 June 1986

RESULTS (nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<7273	<2143	<714	<3377	*
n-Propylbenzene	<4221	<1587	<455	<2088	*
iso-Propylbenzene	<5455	<2143	<584	<2727	*
Tetramethylbenzene	<6688	<2143	<714	<3182	*
Naphthalene	<4243	<1599	<429	<2090	*
C1-Naphthalenes (2)	<1510	<520	<296	<775	*
C2-Naphthalenes (6)	<2589	<867	<592	<1349	*
C3-Naphthalenes (2)	<2589	<867	<592	<1349	*
Biphenyl	<1510	<520	<296	<775	*
Acenaphthylene	<1079	<347	<197	<541	*
Acenaphthene	<2373	<693	<494	<1187	*
Fluorene	<1726	<520	<395	<880	*
Phenanthrene	<742	1867	755	1121	646
C1-Phenanthrenes (4)	<742	2087	<283	1037	938
C2-Phenanthrenes (4)	<742	3295	<283	1440	1623
C3-Phenanthrenes (2)	<742	6919	<283	2648	3706
Anthracene	<371	<110	<94	<92	*
Fluoranthene	3090	3405	2170	2888	642
Pyrene	8046	8558	6426	7677	1113
2,3-benzofluorene	1681	8186	818	3562	4028
Benz(a)anthracene	3723	2977	2687	3129	534
Chrysene/Triphenylene	6005	6698	4206	5636	1286
Benzofluoranthenes	19042	29900	24788	24577	5432
Benzo(e)pyrene	6418	7531	5913	6621	828
Benzo(a)pyrene	8522	8880	7163	8188	906
Perylene	23356	21582	27062	24000	2796
9,10-diphenylanthracene	<316	<112	<114	<181	*
Dibenz(a,h)anthracene	1788	1574	1023	1462	395
Benzo(g,h,i)perylene	4524	4496	3639	4220	503
TOTAL DETECTABLE PAHs	86195	117955	86650	96933	18207

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #6:East Turning Basin- Inner Long Beach Harbor
COLLECTION DATE 27 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1338	<502	<905	<915	*
n-Propylbenzene	<915	<345	<603	<621	*
iso-Propylbenzene	<1197	<408	<733	<779	*
Tetramethylbenzene	<1338	<502	<733	<858	*
Naphthalene	<901	2222	2864	1996	1001
C1-Naphthalenes(2)	1049	1412	1829	1430	390
C2-Naphthalenes(6)	3424	4237	4406	4022	525
C3-Naphthalenes(2)	13365	6507	9809	9894	3430
Biphenyl	<331	<202	<333	<289	*
Acenaphthylene	608	1412	1081	1034	404
Acenaphthene	<497	<303	<499	<433	*
Fluorene	1878	1463	1995	1779	280
Phenanthrene	17234	14550	21876	17887	3706
C1-Phenanthrenes(4)	21555	16324	27565	21845	5672
C2-Phenanthrenes(4)	33079	21381	37983	30814	8530
C3-Phenanthrenes(2)	27214	16679	27485	23793	6162
Anthracene	6842	5944	9215	7334	1690
Fluoranthene	36011	22534	53127	37224	15373
Pyrene	48411	60245	76472	61709	14088
2,3-benzofluorene	17042	20180	37640	24954	11098
Benz(a)anthracene	23290	25431	45883	31535	72472
Chrysene/Triphenylene	41973	39947	67252	49724	15213
Benzofluoranthenes	94638	133412	149536	125862	28217
Benzo(e)pyrene	25966	34791	48172	36310	11181
Benzo(a)pyrene	26235	38979	46235	37150	10125
Perylene	644	9661	13562	7956	6626
9,10-diphenylanthracene	215	168	352	245	96
Dibenz(a,h)anthracene	9120	11169	12946	11078	1915
Benzo(g,h,i)perylene	19582	20327	28886	22932	5170
TOTAL DETECTABLE PAHs	469375	508975	726171	568174	138255

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #7:Los Angeles River Mouth At Queensway
COLLECTION DATE 27 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<283	<471	<375	<376	*
n-Propylbenzene	<162	<275	<225	<221	*
iso-Propylbenzene	<202	<353	<300	<285	*
Tetramethylbenzene	<202	<431	<300	<311	*
Naphthalene	2209	2517	1991	2239	264
C1-Naphthalenes(2)	2198	2213	2230	2214	16
C2-Naphthalenes(6)	10990	9643	7922	9518	1538
C3-Naphthalenes(2)	9602	8536	6499	8212	1577
Biphenyl	578	<211	427	405	184
Acenaphthylene	<116	<158	<142	<139	*
Acenaphthene	289	<369	380	346	50
Fluorene	2024	1317	1898	1746	377
Phenanthrene	23434	23975	21813	23074	1125
C1-Phenanthrenes(4)	22008	27348	25488	24948	2711
C2-Phenanthrenes(4)	25942	26188	25017	25716	617
C3-Phenanthrenes(2)	9237	15597	15312	13382	3593
Anthracene	1825	1686	1313	1608	265
Fluoranthene	31758	27295	26053	28369	3000
Pyrene	48081	41539	39339	42986	4547
2,3-benzofluorene	12114	6635	8192	8980	2823
Benz(a)anthracene	23853	16088	17312	19084	4175
Chrysene/Triphenylene	21223	20815	25427	22488	2553
Benzofluoranthenes	47976	42843	53421	48080	5290
Benzo(e)pyrene	13743	13167	14464	13791	650
Benzo(a)pyrene	12591	11857	13693	12714	924
Perylene	5102	5896	5336	5445	408
9,10-diphenylanthracene	658	131	193	327	288
Dibenz(a,h)anthracene	4855	4717	4950	4841	117
Benzo(g,h,i)perylene	15224	13692	16971	15296	1641
TOTAL DETECTABLE PAHs	347514	323695	335641	335617	11910

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #8:Upper Los Angeles River At Balboa Avenue
COLLECTION DATE 24 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<794	<485	<558	<612	*
n-Propylbenzene	<529	<388	<305	<407	*
iso-Propylbenzene	<635	<485	<457	<526	*
Tetramethylbenzene	<635	<485	<457	<526	*
Naphthalene	<520	<3773	1097	663	383
C1-Naphthalenes(2)	<290	<220	<223	<391	*
C2-Naphthalenes(6)	<436	<367	<371	<391	*
C3-Naphthalenes(2)	<436	<367	<371	<391	*
Biphenyl	<290	<220	<223	<244	*
Acenaphthylene	<218	<147	<148	<171	*
Acenaphthene	<436	<293	<371	<367	*
Fluorene	<290	<220	<223	<244	*
Phenanthrene	11950	12438	18367	14252	3572
C1-Phenanthrenes(4)	7059	4713	9875	7216	2585
C2-Phenanthrenes(4)	7782	4975	11916	8224	3492
C3-Phenanthrenes(2)	3224	2618	7307	4383	2550
Anthracene	834	589	1514	979	479
Fluoranthene	20899	16627	20803	19443	2439
Pyrene	24720	18070	24680	22490	3828
2,3-benzofluorene	6502	1629	2725	3619	2556
Benz(a)anthracene	12258	8295	11583	10712	2120
Chrysene/Triphenylene	15171	12960	15368	14500	1337
Benzofluoranthenes	46695	35497	39339	40510	5690
Benzo(e)pyrene	3384	9001	10189	7525	3635
Benzo(a)pyrene	13966	10671	11674	12104	1689
Perylene	4553	3920	4387	4287	328
9,10-diphenylanthracene	<123	<73	<71	<89	*
Dibenz(a,h)anthracene	4060	944	849	1951	1827
Benzo(g,h,i)perylene	10336	7187	8420	8648	1587
TOTAL DETECTABLE PAHs	193393	150134	200093	181207	27117

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #9:Mid Los Angeles River Below Balboa Avenue
COLLECTION DATE 24 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1077	<1892	<1724	<1564	*
n-Propylbenzene	<769	<1351	<1379	<1166	*
iso-Propylbenzene	<769	<1892	<1379	<1347	*
Tetramethylbenzene	<769	<1892	<1379	<1347	*
Naphthalene	725	<1396	<1214	1112	347
C1-Naphthalenes(2)	<346	<901	<825	<691	*
C2-Naphthalenes(6)	<346	<1502	<1650	<1166	*
C3-Naphthalenes(2)	<346	<1502	<1650	<1166	*
Biphenyl	<346	<901	<825	<691	*
Acenaphthylene	<173	<601	<825	<533	*
Acenaphthene	<519	<1202	<1237	<986	*
Fluorene	<346	<901	<825	<691	*
Phenanthrene	2694	11919	28325	14313	12982
C1-Phenanthrenes(4)	11046	17879	5732	11552	6089
C2-Phenanthrenes(4)	23303	38737	5395	22478	16686
C3-Phenanthrenes(2)	18454	36841	6070	20455	15483
Anthracene	<135	<271	<337	<248	*
Fluoranthene	6870	19504	36081	20818	14650
Pyrene	12355	22612	37129	24032	12448
2,3-benzofluorene	3577	4059	2297	3311	911
Benz(a)anthracene	2439	12176	16842	10486	7349
Chrysene/Triphenylene	4389	25511	24880	18260	12017
Benzofluoranthenes	6097	63393	65276	44922	33637
Benzo(e)pyrene	2410	14121	15836	10789	7307
Benzo(a)pyrene	2269	16825	20857	13317	9778
Perylene	3261	12318	13905	9828	5742
9,10-diphenylanthracene	<142	<300	<386	<276	*
Dibenz(a,h)anthracene	851	5107	5407	3788	2548
Benzo(g,h,i)perylene	1560	9314	12746	7873	5730
TOTAL DETECTABLE PAHs	102300	310316	296778	236465	116387

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #10:Lower Los Angeles River At Willow Street
COLLECTION DATE 25 April 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<449	<4571	<1875	<2298	*
n-Propylbenzene	<286	<2286	<1125	<1232	*
iso-Propylbenzene	<286	<3429	<1375	<1697	*
Tetramethylbenzene	<367	<3429	<1625	<1807	*
Naphthalene	<267	<2232	<1105	<1201	*
C1-Naphthalenes(2)	<129	<844	<779	<584	*
C2-Naphthalenes(6)	<214	<1688	<1364	<1089	*
C3-Naphthalenes(2)	1543	<1688	<1364	1532	162
Biphenyl	<129	<844	<779	<584	*
Acenaphthylene	<86	<844	<585	<505	*
Acenaphthene	<171	<1688	<1364	<1074	*
Fluorene	<129	<1266	<974	<790	*
Phenanthrene	2678	7653	5112	5148	2488
C1-Phenanthrenes(4)	7311	9982	829	6041	4707
C2-Phenanthrenes(4)	5827	15970	2072	7956	7190
C3-Phenanthrenes(2)	9953	14307	<553	8271	7030
Anthracene	72	<333	<276	227	137
Fluoranthene	1665	8651	7046	5787	3659
Pyrene	1924	7751	6813	5496	3129
2,3-benzofluorene	616	2215	655	1162	912
Benz(a)anthracene	923	4429	3930	3094	1897
Chrysene/Triphenylene	2539	11073	6551	6721	4270
Benzofluoranthenes	2698	29206	19204	17036	13386
Benzo(e)pyrene	1714	7619	4697	4677	2953
Benzo(a)pyrene	1641	7936	6217	5265	3254
Perylene	2334	5397	2901	3544	1630
9,10-diphenylanthracene	<36	<317	<276	<210	*
Dibenz(a,h)anthracene	656	<317	<276	416	209
Benzo(g,h,i)perylene	1313	3492	3040	2615	1150
TOTAL DETECTABLE PAHs	45407	135681	69067	83385	46809

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #11:San Gabriel River
COLLECTION DATE 09 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<747	<1066	<840	<884	*
n-Propylbenzene	<456	<656	<534	<549	*
iso-Propylbenzene	<581	<820	<687	<696	*
Tetramethylbenzene	<664	<984	<802	<817	*
Naphthalene	<440	<660	<552	<551	*
C1-Naphthalenes(2)	<310	<490	<463	<421	*
C2-Naphthalenes(6)	<569	<858	<771	<733	*
C3-Naphthalenes(2)	<569	<858	<771	<733	*
Biphenyl	<310	<490	<463	<421	*
Acenaphthylene	<207	<368	<309	<295	*
Acenaphthene	<517	<796	<720	<678	*
Fluorene	<362	<551	<514	<476	*
Phenanthrene	8914	7730	5236	7293	1877
C1-Phenanthrenes(4)	4691	1747	6908	4449	2589
C2-Phenanthrenes(4)	5067	1429	1576	2691	2059
C3-Phenanthrenes(2)	3284	1218	<407	1636	1483
Anthracene	<141	<159	<203	<168	*
Fluoranthene	15154	15672	12760	14529	1553
Pyrene	16404	16975	14237	15872	1444
2,3-benzofluorene	2434	<525	<653	1204	1067
Benz(a)anthracene	9578	10325	9469	9791	466
Chrysene/Triphenylene	13546	13708	12147	13134	858
Benzofluoranthenes	40283	26640	19719	28881	10464
Benzo(e)pyrene	9439	9561	8417	9139	628
Benzo(a)pyrene	11293	10283	9712	10429	801
Perylene	3877	2947	2708	3177	618
9,10-diphenylanthracene	<169	<180	<235	<195	*
Dibenz(a,h)anthracene	281	1984	<294	853	979
Benzo(g,h,i)perylene	8484	8238	8358	8360	123
TOTAL DETECTABLE PAHs	152729	128457	111247	130811	20841

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #12:Orange County Outfall
COLLECTION DATE 06 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D
Indane	<412	<376	<151	<313	
n-Propylbenzene	<235	<226	<91	<184	
iso-Propylbenzene	<353	<301	<121	<258	
Tetramethylbenzene	<353	<301	<121	<258	
Naphthalene	3765	5414	<91	3090	2725
C1-Naphthalenes(2)	6353	5038	2628	4673	1889
C2-Naphthalenes(6)	6647	5639	3051	5112	1855
C3-Naphthalenes(2)	1000	<226	725	650	392
Biphenyl	2412	3233	1088	2244	1082
Acenaphthylene	<59	<150	<30	<80	*
Acenaphthene	1471	602	514	862	529
Fluorene	1353	1278	1027	1219	171
Phenanthrene	16000	13158	9819	12992	3094
C1-Phenanthrenes(4)	9059	5564	4592	6405	2349
C2-Phenanthrenes(4)	4529	3233	2779	3514	908
C3-Phenanthrenes(2)	2412	3609	1843	2621	901
Anthracene	2176	1805	1299	1760	440
Fluoranthene	21471	15865	12659	16665	4460
Pyrene	14941	18346	10937	14741	3709
2,3-benzofluorene	4235	6541	4804	5193	1201
Benz(a)anthracene	7294	15113	8369	10259	4238
Chrysene/Triphenylene	22176	11504	8882	14187	7042
Benzofluoranthenes	70059	27293	20665	39339	26810
Benzo(e)pyrene	14588	10301	7039	10643	3786
Benzo(a)pyrene	21647	13233	9728	14869	6126
Perylene	5706	4812	2810	4443	1483
9,10-diphenylanthracene	<59	<75	<30	<55	*
Dibenz(a,h)anthracene	3471	1128	2356	2318	1172
Benzo(g,h,i)perylene	2000	6617	4411	4343	2309
TOTAL DETECTABLE PAHs	244765	179326	122025	182039	61415

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #13:Anaheim Bay At Warner Avenue
COLLECTION DATE 31 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<320	<684	<489	<498	*
n-Propylbenzene	<160	<342	<217	<240	*
iso-Propylbenzene	<240	<513	<326	<360	*
Tetramethylbenzene	<240	<513	<326	<360	*
Naphthalene	<216	<332	811	453	315
C1-Naphthalenes(2)	<318	<220	<163	<234	*
C2-Naphthalenes(6)	<635	<441	<244	<440	*
C3-Naphthalenes(2)	<635	<441	<244	<440	*
Biphenyl	<318	<220	<163	<234	*
Acenaphthylene	<318	<220	<81	<206	*
Acenaphthene	<635	<330	<244	<403	*
Fluorene	<477	<330	<163	<323	*
Phenanthrene	2825	2956	7110	4297	2437
C1-Phenanthrenes(4)	582	<185	3416	1394	1762
C2-Phenanthrenes(4)	1163	<185	3067	1472	1466
C3-Phenanthrenes(2)	665	<185	2021	957	952
Anthracene	166	<92	488	249	211
Fluoranthene	4902	4712	12756	7457	4590
Pyrene	4669	7852	12431	8317	3902
2,3-benzofluorene	348	<386	1832	855	846
Benz(a)anthracene	1812	2703	3795	2770	993
Chrysene/Triphenylene	4181	4248	12235	6888	4631
Benzofluoranthenes	13444	12873	38738	21685	14771
Benzo(e)pyrene	3730	3897	10743	6123	4002
Benzo(a)pyrene	3497	3307	10037	5614	3832
Perylene	1554	1299	784	1212	392
9,10-diphenylanthracene	<78	<118	<78	<91	*
Dibenz(a,h)anthracene	855	827	2588	1423	1009
Benzo(g,h,i)perylene	3109	4133	10037	5760	3739
TOTAL DETECTABLE PAHs	47502	48807	132889	76399	48926

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'1'= SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #14:Anaheim Bay At The Pacific Coast Highway Bridge
COLLECTION DATE 31 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<431	<632	<467	<510	*
n-Propylbenzene	<259	<316	<280	<285	*
iso-Propylbenzene	<431	<421	<374	<409	*
Tetramethylbenzene	<431	<421	<374	<409	*
Naphthalene	<300	<301	<257	<286	*
C1-Naphthalenes(2)	<181	<301	<257	<246	*
C2-Naphthalenes(6)	<361	<601	<513	<492	*
C3-Naphthalenes(2)	<361	<601	<513	<492	*
Biphenyl	<181	<301	<257	<246	*
Acenaphthylene	<181	<301	<257	<246	*
Acenaphthene	<271	<601	<513	<462	*
Fluorene	<181	<451	<385	<339	*
Phenanthrene	1115	<301	592	669	412
C1-Phenanthrenes(4)	<171	<301	<395	<289	*
C2-Phenanthrenes(4)	<171	<301	<395	<289	*
C3-Phenanthrenes(2)	<171	<301	<395	<289	*
Anthracene	<86	<150	<197	<144	*
Fluoranthene	1629	902	3752	2094	1481
Pyrene	1827	1414	2017	1753	308
2,3-benzofluorene	<174	<530	<275	<326	*
Benz(a)anthracene	696	884	1008	863	157
Chrysene/Triphenylene	1479	1238	1833	1517	299
Benzofluoranthenes	5457	3495	5114	4689	1048
Benzo(e)pyrene	1364	1747	1103	1405	324
Benzo(a)pyrene	1182	1223	1303	1236	62
Perylene	637	349	401	462	153
9,10-diphenylanthracene	<91	<91	<100	<94	*
Dibenz(a,h)anthracene	<175	<175	<100	<150	*
Benzo(g,h,i)perylene	364	1048	1003	805	383
TOTAL DETECTABLE PAHs	15750	12300	18126	15392	2929

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #15:Rhine Channel-Crows Nest In Newport Beach
COLLECTION DATE 19 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<934	<1361	<673	<988	*
n-Propylbenzene	<659	<888	<433	<660	*
iso-Propylbenzene	<934	<888	<433	<752	*
Tetramethylbenzene	<934	<888	<673	<832	*
Naphthalene	<632	<900	677	<736	144
C1-Naphthalenes(2)	<320	<396	<238	<318	*
C2-Naphthalenes(6)	<639	<594	<358	<530	*
C3-Naphthalenes(2)	<639	<594	<358	<530	*
Biphenyl	<320	<396	<238	<318	*
Acenaphthylene	<320	<198	<119	<212	*
Acenaphthene	<480	<594	<358	<477	*
Fluorene	<480	<396	<238	<371	*
Phenanthrene	4346	1624	5240	3737	1883
C1-Phenanthrenes(4)	<193	<116	936	415	453
C2-Phenanthrenes(4)	<193	<116	281	197	83
C3-Phenanthrenes(2)	<193	<116	<187	<165	*
Anthracene	<290	<116	749	385	327
Fluoranthene	7340	3480	9076	6632	2864
Pyrene	11523	5000	13039	9854	4271
2,3-benzofluorene	6622	1061	4890	4191	2846
Benz(a)anthracene	8079	3333	9508	6973	3233
Chrysene/Triphenylene	10331	4849	12496	9225	3942
Benzofluoranthenes	46438	22130	54738	41102	16946
Benzo(e)pyrene	9933	4283	10948	8388	3591
Benzo(a)pyrene	11920	4997	14797	10571	5037
Perylene	3104	999	3970	2691	1528
9,10-diphenylanthracene	<124	<143	<120	<129	*
Dibenz(a,h)anthracene	3849	1285	4692	3275	1774
Benzo(g,h,i)perylene	8692	3998	10346	7679	3293
TOTAL DETECTABLE PAHs	132177	57039	156383	115200	51802

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #16:Newport Backbay
COLLECTION DATE 19 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1193	<3643	<614	<1817	*
n-Propylbenzene	<826	<1783	<351	<987	*
iso-Propylbenzene	<1193	<2713	<439	<1448	*
Tetramethylbenzene	<1193	<2713	<439	<1448	*
Naphthalene	<802	58112	26983	28632	28691
C1-Naphthalenes(2)	<488	<817	<255	<520	*
C2-Naphthalenes(6)	<976	<1634	<511	<1040	*
C3-Naphthalenes(2)	<976	<1634	<511	<1040	*
Biphenyl	<488	<817	<255	<520	*
Acenaphthylene	<488	<817	<255	<520	*
Acenaphthene	<732	<1634	<511	<959	*
Fluorene	<488	<1226	<383	<699	*
Phenanthrene	<301	<355	1094	583	443
C1-Phenanthrenes(4)	<301	<355	<243	<300	*
C2-Phenanthrenes(4)	<301	<355	<243	<300	*
C3-Phenanthrenes(2)	<301	<355	<243	<300	*
Anthracene	<150	<178	<122	<150	*
Fluoranthene	451	1599	2796	1615	1173
Pyrene	2507	1290	8519	4105	3870
2,3-benzofluorene	<367	<465	<877	570	*
Benz(a)anthracene	668	573	7344	2862	3882
Chrysene/Triphenylene	1170	1434	5581	2728	2474
Benzofluoranthenes	10529	7248	8695	8824	1644
Benzo(e)pyrene	1053	1990	2350	1798	670
Benzo(a)pyrene	2707	1990	4465	3054	1273
Perylene	602	<142	235	326	243
9,10-diphenylanthracene	<150	<142	940	411	458
Dibenz(a,h)anthracene	<150	<142	6580	2291	3715
Benzo(g,h,i)perylene	1654	2274	3055	2328	702
TOTAL DETECTABLE PAHs	21341	76510	78637	58829	32483

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #17: Santa Ana River
COLLECTION DATE 03 July 1986

RESULTS (nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1071	<2157	<984	<1404	*
n-Propylbenzene	<714	<1373	<656	<914	*
iso-Propylbenzene	<1071	<2157	<984	<1404	*
Tetramethylbenzene	<1071	<2157	<984	<1404	*
Naphthalene	<732	<1382	<636	<917	*
C1-Naphthalenes(2)	<467	<776	<442	<562	*
C2-Naphthalenes(6)	<700	<1164	<884	<916	*
C3-Naphthalenes(2)	<700	<1164	<884	<916	*
Biphenyl	<467	<776	<442	<562	*
Acenaphthylene	<233	<388	<442	<354	*
Acenaphthene	<700	<1164	<663	<842	*
Fluorene	<467	<776	<442	<562	*
Phenanthrene	3464	1181	2589	2411	1152
C1-Phenanthrenes(4)	<385	<590	<370	<448	*
C2-Phenanthrenes(4)	2501	<590	<370	<1154	1172
C3-Phenanthrenes(2)	962	<590	<370	641	299
Anthracene	<192	<295	<185	<224	*
Fluoranthene	5773	5313	4993	5360	392
Pyrene	7287	5361	5046	5898	1213
2,3-benzofluorene	<429	<511	<306	<415	*
Benz(a)anthracene	3000	2297	2141	2479	458
Chrysene/Triphenylene	4929	4084	4129	4381	475
Benzofluoranthenes	12978	14168	15039	14062	1035
Benzo(e)pyrene	3244	3334	3284	3287	45
Benzo(a)pyrene	3244	3334	5705	4094	1396
Perylene	2028	1945	2074	2016	65
9,10-diphenylanthracene	<203	<278	<173	<218	*
Dibenz(a,h)anthracene	608	<278	<173	353	227
Benzo(g,h,i)perylene	2839	2778	2766	2794	39
TOTAL DETECTABLE PAHs	52857	43795	47766	48139	4543

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #18:Dana Point Marina
COLLECTION DATE 08 May 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<2925	<4628	<1504	<3019	*
n-Propylbenzene	<1981	<3306	<885	<2057	*
iso-Propylbenzene	<2453	<4628	<1239	<2773	*
Tetramethylbenzene	<2453	<3967	<1239	<3553	*
Naphthalene	<1972	<3283	<921	<2059	*
C1-Naphthalenes(2)	<901	<1731	<481	<1038	*
C2-Naphthalenes(6)	<1351	<2770	<962	<1694	*
C3-Naphthalenes(2)	<1351	<2770	<962	<1694	*
Biphenyl	<901	<1731	<481	<1038	*
Acenaphthylene	<676	<1039	<321	<679	*
Acenaphthene	<1351	<2424	<802	<1526	*
Fluorene	<901	<1731	<642	<1091	*
Phenanthrene	2988	7720	<392	3700	3716
C1-Phenanthrenes(4)	6447	11065	<392	5968	5353
C2-Phenanthrenes(4)	7391	11065	<392	6283	5422
C3-Phenanthrenes(2)	5189	5147	<392	3576	2758
Anthracene	1101	<515	<131	582	488
Fluoranthene	3774	3345	1176	2765	1393
Pyrene	3713	8079	1339	4377	3419
2,3-benzofluorene	<646	<1443	<487	<859	*
Benz(a)anthracene	1130	1154	243	842	519
Chrysene/Triphenylene	2098	2885	1217	2067	834
Benzofluoranthenes	2691	9241	3108	5013	3667
Benzo(e)pyrene	1645	1960	907	1504	540
Benzo(a)pyrene	2093	1960	1166	1740	501
Perylene	2542	1960	1425	1976	559
9,10-diphenylanthracene	<299	<560	<130	<330	*
Dibenz(a,h)anthracene	1495	<840	<259	865	618
Benzo(g,h,i)perylene	1495	1680	1036	1404	332
TOTAL DETECTABLE PAHs	45792	67261	11617	41557	28063

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #19: San Mateo Pt.- Reference Survey Station R52-60
COLLECTION DATE 25 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<459	<849	<1262	<857	*
n-Propylbenzene	<367	<566	<874	<602	*
iso-Propylbenzene	<459	<849	<1262	<857	*
Tetramethylbenzene	<459	<849	<1262	<857	*
Naphthalene	<333	<542	<914	<596	*
C1-Naphthalenes(2)	<1188	<335	<445	<656	*
C2-Naphthalenes(6)	<2376	<670	<890	<1312	*
C3-Naphthalenes(2)	<2376	<670	<890	<1312	*
Biphenyl	<1188	<335	<445	<656	*
Acenaphthylene	<1188	<335	<445	<656	*
Acenaphthene	<1782	<503	<668	<984	*
Fluorene	<1188	<503	<668	<786	*
Phenanthrene	<287	1696	<292	758	812
C1-Phenanthrenes(4)	<287	3958	<292	1512	2118
C2-Phenanthrenes(4)	<287	7208	<292	2596	3994
C3-Phenanthrenes(2)	<287	3816	<292	1465	2036
Anthracene	<143	<141	<146	<143	*
Fluoranthene	717	1979	584	1093	770
Pyrene	362	4354	603	1773	2238
2,3-benzofluorene	<241	3338	<362	1314	1754
Benz(a)anthracene	<121	871	241	411	403
Chrysene/Triphenylene	<121	1742	723	862	819
Benzofluoranthenes	896	2662	1221	1593	940
Benzo(e)pyrene	256	420	<136	271	143
Benzo(a)pyrene	256	280	407	314	81
Perylene	512	560	678	583	85
9,10-diphenylanthracene	<128	<140	<136	<135	*
Dibenz(a,h)anthracene	<128	<140	<136	<135	*
Benzo(g,h,i)perylene	<128	140	<136	135	6
TOTAL DETECTABLE PAHs	2999	33024	4457	13493	16930

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #20:San Diego Outfall At Pt. Loma
COLLECTION DATE 30 June 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<685	<2388	<882	<1318	*
n-Propylbenzene	<411	<1493	<588	<831	*
iso-Propylbenzene	<685	<1493	<882	<1020	*
Tetramethylbenzene	<685	<1940	<882	<1169	*
Naphthalene	<429	<1443	<559	<810	*
C1-Naphthalenes(2)	<1864	<796	<328	<996	*
C2-Naphthalenes(6)	<3727	<1327	<655	<1903	*
C3-Naphthalenes(2)	<3727	<1327	<655	<1903	*
Biphenyl	<1864	<796	<328	<996	*
Acenaphthylene	<1864	<531	<328	<996	*
Acenaphthene	<2795	<1061	<491	<1449	*
Fluorene	<2795	<796	<328	<1796	*
Phenanthrene	992	<350	546	629	329
C1-Phenanthrenes(4)	<397	<175	<273	<282	*
C2-Phenanthrenes(4)	<397	<175	<273	<282	*
C3-Phenanthrenes(2)	<397	<175	<273	<282	*
Anthracene	<198	<175	273	215	51
Fluoranthene	1984	1399	1638	1674	294
Pyrene	2632	1421	1936	1996	608
2,3-benzofluorene	<564	<533	<298	<465	*
Benz(a)anthracene	1692	710	1191	1198	491
Chrysene/Triphenylene	2068	1243	1936	1749	443
Benzofluoranthenes	4671	3443	14198	7437	5887
Benzo(e)pyrene	3022	1418	3003	2481	921
Benzo(a)pyrene	3847	1620	3003	2823	1124
Perylene	550	405	1092	682	362
9,10-diphenylanthracene	<275	<203	<273	<250	*
Dibenz(a,h)anthracene	<275	<405	<273	<318	*
Benzo(g,h,i)perylene	2198	1013	1638	1616	593
TOTAL DETECTABLE PAHs	23656	12672	30454	22261	8973

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #21:North San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1212	<21273	<2273	<8253	*
n-Propylbenzene	<606	<14182	<1515	<5434	*
iso-Propylbenzene	<909	<21273	<2273	<8152	*
Tetramethylbenzene	<909	<21273	<2273	<8152	*
Naphthalene	<575	<569	<1479	<874	*
C1-Naphthalenes(2)	<348	<779	<557	<561	*
C2-Naphthalenes(6)	<697	<1558	<835	<1030	*
C3-Naphthalenes(2)	<697	<1558	<835	<1030	*
Biphenyl	<348	<779	<557	<561	*
Acenaphthylene	<348	<779	<278	<468	*
Acenaphthene	<697	<1168	<835	<900	*
Fluorene	<523	<1168	<557	<2749	*
Phenanthrene	7385	9324	4269	6993	2550
C1-Phenanthrenes(4)	8057	6368	<356	4927	4048
C2-Phenanthrenes(4)	10071	10461	712	7081	5519
C3-Phenanthrenes(2)	4868	8187	<356	4470	3931
Anthracene	1175	1137	356	889	462
Fluoranthene	11749	16146	8361	12085	3903
Pyrene	18359	18951	8313	15208	5978
2,3-benzofluorene	4822	5054	959	3612	2300
Benz(a)anthracene	10570	9265	2398	7411	4390
Chrysene/Triphenylene	22439	27585	9752	19925	9178
Benzofluoranthenes	68803	86953	40534	65430	23393
Benzo(e)pyrene	17520	22216	8524	16087	6958
Benzo(a)pyrene	17520	23410	9742	16891	6856
Perylene	5475	6211	2088	4591	2199
9,10-diphenylanthracene	<183	<239	<174	<199	*
Dibenz(a,h)anthracene	4380	<239	1218	1946	2164
Benzo(g,h,i)perylene	10585	13855	5741	10060	4082
TOTAL DETECTABLE PAHs	223778	265123	102967	197289	84261

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #22:NASSCO-San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<1016	<6550	<5140	<4235	*
n-Propylbenzene	<749	<4350	<2905	<2668	*
iso-Propylbenzene	<1016	<5450	<4413	<3626	*
Tetramethylbenzene	<909	<5450	<3687	<3349	*
Naphthalene	1927	<4366	<2929	3074	1226
C1-Naphthalenes(2)	<524	<924	<824	<757	*
C2-Naphthalenes(6)	<838	<1386	<1441	<1222	*
C3-Naphthalenes(2)	<838	<1386	<1441	<1222	*
Biphenyl	<524	<924	<824	<757	*
Acenaphthylene	<314	1616	<618	849	681
Acenaphthene	<733	<1386	<1441	<1187	*
Fluorene	<524	<924	<1030	<826	*
Phenanthrene	6414	32245	6362	15007	14929
C1-Phenanthrenes(4)	5064	7960	2121	5048	2920
C2-Phenanthrenes(4)	3292	2968	3333	3198	200
C3-Phenanthrenes(2)	5570	1349	2121	3013	2248
Anthracene	2363	5936	2727	3675	1966
Fluoranthene	20931	48166	15300	28132	17577
Pyrene	48428	57100	102263	69264	28905
2,3-benzofluorene	9536	16990	10009	12178	4174
Benz(a)anthracene	12995	22993	13012	16333	5767
Chrysene/Triphenylene	24494	34618	25858	28323	5494
Benzofluoranthenes	70041	134975	97370	100795	32602
Benzo(e)pyrene	26828	32910	43258	34332	8307
Benzo(a)pyrene	33580	43583	56592	36583	5791
Perylene	9543	556	12869	7656	6370
9,10-diphenylanthracene	<180	<222	<310	<237	*
Dibenz(a,h)anthracene	6752	2224	2481	3819	2543
Benzo(g,h,i)perylene	18546	23682	31009	24412	6264
TOTAL DETECTABLE PAHs	306304	469871	426685	400937	84745

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #23:Chollas Creek-San Diego Bay
COLLECTION DATE 01 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<941	<1333	<974	<1083	*
n-Propylbenzene	<588	<848	<584	<673	*
iso-Propylbenzene	<941	<1091	<974	<1002	*
Tetramethylbenzene	<765	<1091	<779	<878	*
Naphthalene	1307	1304	<575	1062	422
C1-Naphthalenes(2)	<228	<335	<347	<303	*
C2-Naphthalenes(6)	<455	<670	<694	<606	*
C3-Naphthalenes(2)	<455	<670	<694	<606	*
Biphenyl	<228	<447	<347	<341	*
Acenaphthylene	<152	670	<231	351	279
Acenaphthene	<379	<670	<578	<542	*
Fluorene	<304	<447	<463	<405	*
Phenanthrene	9483	12073	9982	10513	1374
C1-Phenanthrenes(4)	3556	5887	5367	4937	1224
C2-Phenanthrenes(4)	3100	5388	6011	4833	1533
C3-Phenanthrenes(2)	1368	4989	3542	3300	1823
Anthracene	2371	2993	2791	2718	317
Fluoranthene	12218	20853	19212	17428	4586
Pyrene	21091	54036	49268	41465	17805
2,3-benzofluorene	3361	12172	11274	8936	4849
Benz(a)anthracene	4693	16381	15784	12286	6583
Chrysene/Triphenylene	23814	32535	35739	30696	6172
Benzofluoranthenes	117067	88526	105611	103735	14363
Benzo(e)pyrene	26517	33087	36121	31908	4908
Benzo(a)pyrene	30137	38066	41396	36553	5784
Perylene	1114	775	9862	3917	5151
9,10-diphenylanthracene	<70	221	<115	135	78
Dibenz(a,h)anthracene	<139	2434	8944	3839	4568
Benzo(g,h,i)perylene	12110	21136	22017	18421	5483
TOTAL DETECTABLE PAHs	273307	353526	382921	336586	56737

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SWRCB POLYNUCLEAR AROMATIC HYDROCARBONS SURVEY

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STATION #24:San Diego Harbor At 7th Street
COLLECTION DATE 01 July 1986

RESULTS(nG/G TOC)	Rep #1	Rep #2	Rep #3	Mean	1 S.D.
Indane	<446	<2489	<1460	<1465	*
n-Propylbenzene	<223	<1502	<796	<840	*
iso-Propylbenzene	<357	<1803	<1106	<1089	*
Tetramethylbenzene	<357	<1974	<1106	<1146	*
Naphthalene	1230	<1482	<805	1172	342
C1-Naphthalenes(2)	<132	<622	<483	<412	*
C2-Naphthalenes(6)	1185	<1089	<869	1048	162
C3-Naphthalenes(2)	2172	<1089	<869	1377	698
Biphenyl	<132	<700	<483	<438	*
Acenaphthylene	724	<467	<386	526	176
Acenaphthene	<197	<1089	<773	<686	*
Fluorene	<132	<778	<580	<497	*
Phenanthrene	4628	7647	7222	6499	1634
C1-Phenanthrenes(4)	792	8562	7760	5705	4273
C2-Phenanthrenes(4)	4324	12332	3534	9730	4868
C3-Phenanthrenes(2)	8891	14055	5762	9569	4188
Anthracene	2314	3016	2920	2750	381
Fluoranthene	7795	14916	11140	11284	3563
Pyrene	169522	102277	83073	121624	41735
2,3-benzofluorene	42228	47411	34834	41491	6321
Benz(a)anthracene	28662	15804	9701	18056	9679
Chrysene/Triphenylene	22746	28352	12434	21177	8074
Benzofluoranthenes	235566	192912	133794	187421	51107
Benzo(e)pyrene	52586	38736	29598	40307	11574
Benzo(a)pyrene	57037	49418	32528	46328	12543
Perylene	16567	13431	7437	12478	4639
9,10-diphenylanthracene	82	<2070	150	146	63
Dibenz(a,h)anthracene	6347	10993	8339	8560	2331
Benzo(g,h,i)perylene	31156	21468	19457	24027	6255
TOTAL DETECTABLE PAHs	696554	581330	409683	562522	144357

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