Appendix C:

ESTIMATES OF MASS EMISSIONS TO THE NORTH AND CENTRAL COAST REGIONS

TABLE OF CONTENTS

INTRODUCTION

The North Coast Region

The North Coast Region, as described by Regional Water Quality Control Board (RWQCB) (1991 & 1993), is summarized in the following paragraphs. This region comprises all of Del Norte, Humboldt, Trinity, and Mendocino Counties, major portions of Siskiyou and Sonoma Counties, and small portions of Glenn, Lake, and Marin Counties. Total area encompassed by the North Coast Region is approximately 19,390 square miles, including 340 miles of scenic coastline and remote wilderness areas, as well as urbanized and agricultural areas, with a population of 460,000. Precipitation over the North Coast Region is greater than for any other part of California, and damaging floods are a fairly frequent hazard. This Region receives an average of 52 million acre-feet of precipitation. Along the coast, the mean annual precipitation ranges from 37 to 107 inches and in the inland areas it ranges from 11 to 77 inches.

The North Coast Region is divided into two natural drainage basins, the Klamath River Basin and the North Coastal Basin. The Klamath River Basin encompasses an area of approximately 10,883 square miles, and includes the area within California that is tributary to the Klamath, Smith, Applegate, Illinois and Winchuck Rivers, as well as the Lost River and Butte Valley hydrologic drainage areas. Most of the precipitation occurs in the rugged western portion of the Basin in the Klamath Mountains and Coast Range, ranging from 60 to 125 inches per year. The eastern portion of the Basin is characterized by broad valleys from 2,500 to 6,000 feet in elevation with mean annual precipitation ranging from 15 to 60 inches.

The North Coastal Basin covers approximately 8,570 square miles along the north-central California Coast. The basin includes the area tributary to all streams and rivers flowing to the Pacific Ocean from the Mad River in the north to Stemple Creek in northern Marin County. Most of the Basin consists of rugged, forested coastal mountains dissected by six major river systems: Eel, Russian, Mad, Navarro, Gualala, and Noyo rivers and numerous smaller river systems. Population centers in the North Coast Region are located around Humboldt Bay and the city of Santa Rosa. The city of Santa Rosa and neighboring communities comprise a population of over 200,000 people, the majority of whom receive domestic, irrigation, and industrial supply water from the Russian River. The cities of Arcata and Eureka comprise a population of over 41,000 around Humboldt Bay, and draw their domestic and industrial supply from the nearby Mad River. The North Coast Region also includes all enclosed bays and estuaries, and all coastal waters north from Estero de San Antonio in northern Marin to the Oregon border. Most of the Basin is rugged, mountainous and sparsely populated.

This study included 11 coastal hydrologic units within the North Coast hydrologic region: Winchuck River, Smith River, Klamath River, Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino, Mendocino Coast, and Russian River (Figure 1). The following paragraphs will provide a brief description of examples of these hydrologic units and main water bodies associated with these, as well as human activities of concern based on the Regional Monitoring Plan (RWQCB 1991) and the Regional Basins Plan (RWQCB 1993).

The Russian River hydrologic unit encompasses 1485 square miles in Mendocino and Sonoma counties, bounded by the Coast Ranges on both the east and the west. The main water body associated with this hydrologic unit is the Russian River Estuary. This estuary is the deep and broad terminus of the Russian River and encompasses approximately 150 acres. Flushing and tidal exchange occur only during and after periods of rainfall, otherwise natural sandbars obstruct the mouth for much of the year. While the Russian River Estuary is largely undeveloped, it is an area of potential concern for various reasons. There are municipal discharges, which enter into the Russian River Estuary from several communities, including those of the densely populated Santa Rosa Plain. In addition there are historic industrial discharges, urban runoff from Sonoma and Mendocino counties, and agricultural runoff. This river has been slated for total maximum daily load (TMDL) pollutants based on sedimentation or siltation. All of these factors have created a potential for sediment and pollutant deposition in this water body (CARA 1997).

Humboldt Bay is the most significant water body associated with the Eureka Plain hydrologic unit, and includes Arcata Bay and three segments of Humboldt Bay. The Bay encompasses approximately 15,000 acres and is considered a shipping port, industrial center, and northern California population hub. The northern and central portions of the Bay are encircled by two cities and several small, unincorporated communities. Along with these communities there are associated industrial activities, such as pulp mills, bulk petroleum plants, fossil fuel and nuclear power plants, lumber mills, boat repair facilities and fish processing plants. Small commercial and sport marinas have been constructed in the Bay and agricultural lands surround much of the Bay. Two large landfills are located adjacent to the Bay. Coal and oil gasification plants historically have been operated at various locations on the edge of the Bay. Municipal wastewater, industrial wastes and stormwater runoff have been discharged into the Bay throughout its 150 year history. Because there is a very narrow opening connecting Humboldt Bay to the Pacific Ocean, circulation and flushing are severely restricted, resulting in a high potential for sediment and pollutant deposition.

Previous studies indicated there might be areas of concern within Humboldt Bay. State Mussel Watch reports showed accumulation of heavy metals, pentachlorophenol, and tetrachlorophenol in tissues from transplanted mussels (Rasmussen, 1995). Also a draft report of a US Army Corps of Engineers (1991) study on sediments in the Eureka shipping channel described mortality of flatfish and oyster larvae in sediment bioassays. In an extensive study conducted by the Bay Protection and Toxic Cleanup Program (Jacobi et al. 1998), presence or absence of statistically significant toxicity effects in representative areas of the North Coast Region were determined. This study involved chemical analysis of sediments and tissues, benthic community analysis, and toxicity testing of sediments and sediment pore water. Chemicals that most often exceeded Effects Range-Median (ERM) or Probable Effects Level (PEL) guideline values were chromium, nickel, PAHs and lindane. Although copper, mercury, and zinc, did not exceed ERM or PEL guidelines values, these chemicals often exceeded Effects Range-Low (ERL) or Threshold Effects Level (TEL) sediment quality guideline values and may have a potential impact on the environment.

The Central Coast Region

The Central Coast Region, as described by the RWQCB (1994), includes 378 miles of coastline. It encompasses all of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties, as well as the southern one-third of Santa Clara County, and small portions of San Mateo, Kern, and Ventura Counties. The Region has urban areas, such as San Luis Obispo, Morro Bay, the Monterey Peninsula and the Santa Barbara coastal plain. Prime agricultural lands are located in the Salinas, Santa Maria, and Lompoc Valleys. Furthermore, this Region has National Forest lands, high precipitation areas, such as the Santa Cruz Mountains, and arid areas like the Carrizo Plain. Topographic features are dominated by a rugged seacoast and three parallel ranges of the Southern Coast Mountains. Between these ranges are the broad valleys of the San Benito and Salinas Rivers. Diverse topography within the long coastline gives rise to equally diverse habitats. These habitats are all influenced by human activities in inland, nearshore and marine areas.

The Central Coast Region has three times the volume of average annual precipitation (12,090,000 acre-feet) as the Los Angeles Region, but one-seventh the population (1.2 million versus 8 million). Northern areas receive a greater amount of rainfall and runoff than do southern areas. The mean annual precipitation ranges from 9 to 53 inches. The interaction of rainfall and runoff with urban, industrial and agricultural land uses creates a complex set of possible impacts on the bay and estuarine environments within the Region. Possible marine impacts include those related to boat traffic and maintenance, oil production, agriculture, waste and stormwater, and industry. In a recent report by BPTCP (Downing et al 1998), primary chemicals of concern for the Central Coast Region included chlordane, dieldrin, PAHs, chromium, nickel, and DDT and its metabolites.

This study included 10 coastal hydrologic units within the Central Coast hydrologic region: Big Basin, Pajaro River, Bolsa Nueva, Salinas, Carmel River, Santa Lucia, Santa Maria, San Antonio, Santa Ynez, and Estero Bay (Figure I-1). The following paragraphs will provide a brief description of some of the hydrologic units and associated water bodies, as reported by Downing et al (1998), and the Regional Basin Plan (RWQCB 1994),

The Big Basin hydrologic unit encompasses approximately 140 square miles within Santa Cruz County. The largest watershed within this hydrologic unit is the San Lorenzo Watershed, and its terrain is mountainous and densely forested, with a maximum elevation of approximately 3200 feet. The San Lorenzo River flows generally south-southeast in a narrow highly developed valley, through the towns of Boulder Creek, Ben Lomond, and Felton, continuing southerly through the city of Santa Cruz, before emptying into the Pacific Ocean. Major land uses in the San Lorenzo Watershed are forest, open land, urban, recreation, and agriculture (RWQCB 2000). The San Lorenzo

River has been slated for TMDL based on nutrients, pathogens, and sedimentation or siltation (CARA 1997).

The Bolsa Nueva hydrologic unit is small, encompassing an area of approximately 53 square miles, and is mainly composed of the areas around the fishing town of Moss Landing and Elkhorn Slough. Areas adjacent to the Slough and Moss Landing have been used for agricultural concerns, such as dairies and strawberry farms, however, they contain other sources of pollution, such as auto wrecking yards. Pesticides, including DDT, have been detected periodically in transplanted mussels in Moss Landing Harbor by California Mussel Watch Program (Rasmussen 1996). Other potential non-point source pollution is urban runoff from the cities of Salinas and Castroville.

The Salinas hydrologic unit encompasses approximately 3,054 square miles, covering most of the Central Coast Region. The Salinas Valley is the largest watershed in this hydrologic unit, encompassing an area of approximately 600 square miles, and the major water body associated with this hydrologic unit is Monterey Bay. The Salinas River and its surrounding watersheds have been heavily impacted by agricultural and urban development. Acres of natural wetlands have been filled and ditched, reducing water quality, flood protection, and the ground water recharge necessary to forestall saltwater intrusion; the most severe environmental problem in the Monterey Bay (Watershed Institute et al. 1997). Nonpoint source pollution also is a serious environmental problem in Monterey Bay (Stephenson et al. 1980). Agricultural lands, which use fertilizers and pesticides, are associated with high levels of nonpoint source pollution (Watkins et al. 1984, Ladd et al. 1984). Other sources of nonpoint source pollution include urban runoff, which is becoming a greater issue around the City of Salinas (Watershed Institute et al. 1997). Water bodies slated for TMDL in the Salinas hydrologic unit include the Salinas River, based on nutrients, pesticides, sedimentation or siltation; Monterey Bay based on metals and pesticides; and Tembladero Slough based on nutrients and pesticides (CARA 1997).

The goal of this report was to estimate mass emissions from a variety of sources to the coastal ocean of the North and Central Coast Regions. The objective was to compare which sources contribute the greatest proportion of potential pollutants. Sources examined included nonpoint source (NPS) pollution from stormwater runoff, small publicly owned treatment works (POTWs), industrial facilities, power generating stations (PGS), and dredged materials.

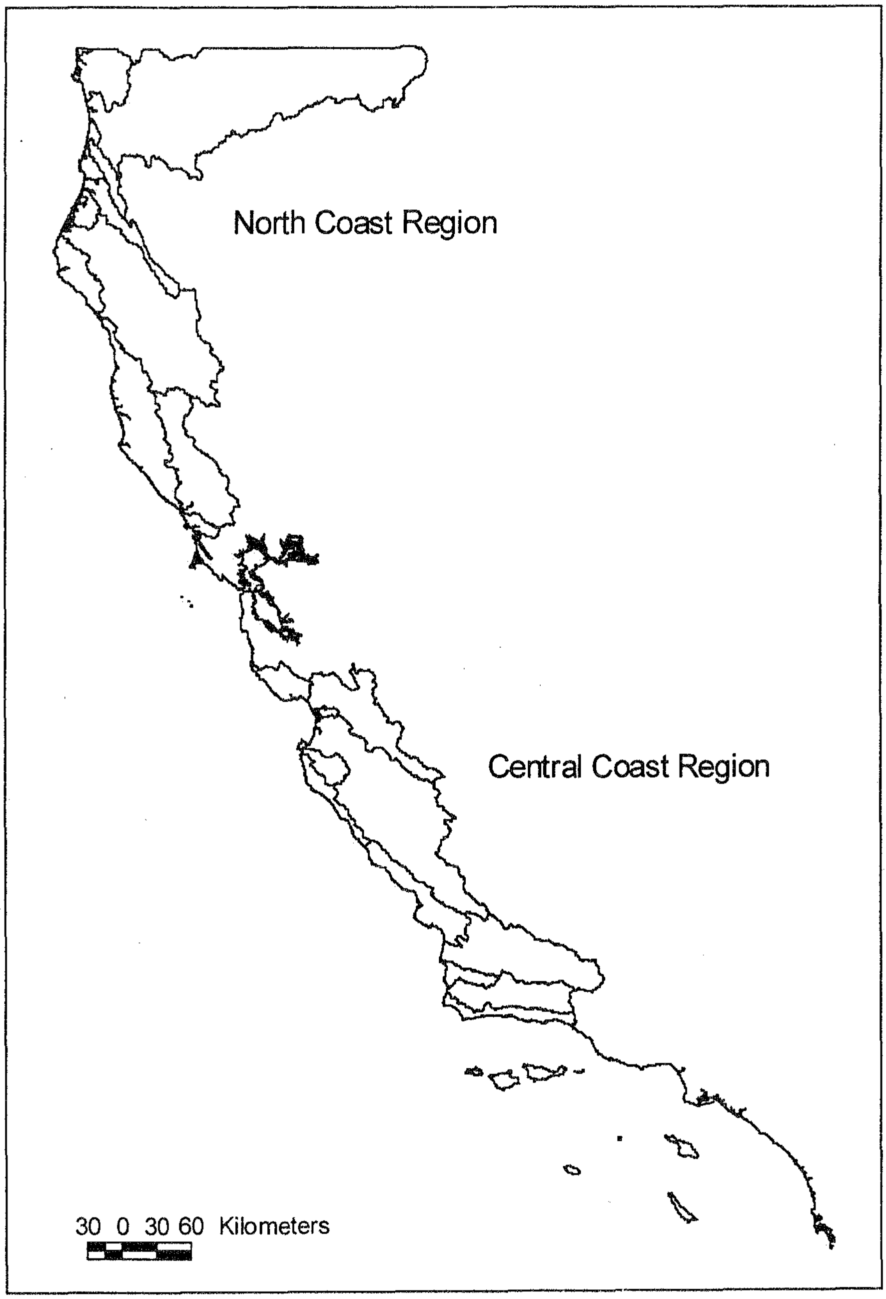


Figure I-1. The North and Central Coast Regions.

II. STORMWATER RUNOFF

Description of Source

Nonpoint source (NPS) pollution, also known as polluted runoff, is the major contributor of pollution to impacted streams, lakes, wetlands, estuaries, marine waters, and ground water basins in California (SWRCB 1998). Unlike point source pollution, such as pollution from wastewater treatment plants and industrial facilities, NPS pollution comes from different sources, such as rainfall, snowmelt, or irrigation water that moves over and through the ground. As the runoff moves, it transports natural and human-made pollutants, and deposits them into lakes, rivers, wetlands, and other inland and coastal waters (SWRCB/CCC 2000).

In the North and Central Coast Regions, monitoring of NPS pollution is not required. There are some groups that conduct volunteer monitoring, however these data are sparse. Because of the limited amount of empirical data, we used a simple, land use based model to estimate mass emissions due to stormwater runoff. A detailed explanation of the model is provided in the Southern California section, however, the following section will provide a brief summary of the model, modifications made for the North and Central Coast Regions, and data sources used.

Methods

In order to estimate mass emissions by modeling, two major components are necessary: the volume of water flowing to the coast (stormwater runoff volume) and chemical concentrations in the stormwater runoff.

Runoff Volume

Stormwater runoff volume was estimated using a simple, land use based model, the Rational Method. Runoff volume was estimated using runoff coefficients, rainfall, and watershed (drainage) area.

The model can be written as follows:

$$Q = c * i * A$$

Where:

Q = runoff volume
c = runoff coefficient
i = rainfall
A = drainage area

Drainage Area (Watershed Delineation)

Determining the spatial extent of the watersheds contributing to mass emission was the first step required in the model development. Watershed delineation for California were obtained from a data set created by the Interagency California Watershed Mapping Committee and distributed by the California Department of Fish and Game (CDFG 1998). The California Watershed Map (CALWATER version 2.0) is a set of standardized watershed boundaries meeting standardized delineation criteria. The hierarchy of watershed designations consists of four levels of increasing specificity: Hydrologic Region (HR), Hydrologic Unit (HU), Hydrologic Area (HA), and Hydrologic Sub-Area (HSA).

ArcView® Geographic Information System (GIS) computer software program was used as the GIS platform for all spatial analyses for the North and Central Coast Regions. In defining the spatial extent, we used coastal Hydrologic Unit Code (HUC) areas. Coastal HUCs provided a spatial coverage of runoff that could reach the ocean (Figures II-1 & II-2). HUCs defined the spatial extent of the model domain, however, these areas were too broad. We defined subset areas of the HUCs as our watershed or drainage areas for this study. Watersheds were analyzed based on those subset areas (Figures II-3 & II-4).

Concerns arose that runoff upstream of a dammed area would have sufficient residence time to cause possible chemical transformation and water quality estimation would not be valid. Thus, the upstream, dammed areas were removed from the runoff model estimation. Dam information was obtained from the Department of Water Resources (DWR Bulletin 17 1993). Dams drainage areas ranged from 0.02 to 1350 mi^2 (Figures II-5 & II-6). Areas above dams with drainage area of 20 mi^2 or greater were removed from the model domain. When a dam was located downstream of a watershed, all watersheds upstream of the dam were removed from the model. If the dam was within a defined watershed, the drainage area of the dam was subtracted from the watershed area.

Land use Characteristics

Land use within each watershed was characterized to describe land use distribution within each watershed. Land use data were obtained from the California Gap Analysis Project (CA-GAP) land use GIS data layers. CA-GAP is conducted by the Biogeography Lab at the University of California, Santa Barbara and coordinated through the USGS-Biological Resources Division (CA-GAP 1998). Data were aggregated from its original GAP code categories into 3 model land use categories: Urban, Agricultural, and Open. The modeled land use categories were determined from land use categories compiled by the Central Coast Joint Data committee (CCJDC) in their Watershed Analysis Tool for Environmental Review (W.A.T.E.R.) web site (http://www.centralcoastdata.org/water.htm). W.A.T.E.R. is a set of GIS data layers, satellite images and scanned aerial photographs covering much of the Central Coast of California, including parts of Santa Cruz, Santa Clara, San Benito, Monterey and San

Luis Obispo Counties. The W.A.T.E.R. land use GIS layer was obtained from GAP as well, however, CCJDC defined land use categories to better fit the Central Coast Region. The original GAP code categories did not seem suitable when applied to the North and Central Coast Regions. Instead, we used the code categories defined in W.A.T.E.R. as the basis of the categories for this study.

Rainfall

The rainfall model, Parameter-elevation Regressions on Independent Slopes Model (PRISM) was used to estimate rainfall across the state. PRISM is an analytical model that used point data and a digital elevation model (DEM) to generate estimates of annual, monthly and event-based climatic parameters (Daly et al. 1997, Daly et al. 1994). This model used rainfall data from 1961 to 1990. Rainfall value at the centroid of each watershed was queried and assigned to that watershed.

An attempt was made to assess inter-annual rainfall variability. Rainfall data were used to bracket "typical" year values. Rainfall data from local gauges were obtained from the California Department of Water Resources/Department of Flood Management, and from Summary of the Day First-Order, an on-line dataset from the National Climatic Data Center (NCDC 1995). NCDC is part of the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS). Data from the same period as PRISM data were compiled and ranked. Tenth and 90th percentile were determined for all data to determine deviation from the mean. These numbers were applied to the rainfall value for each watershed centroid.

Runoff Model

Stream and rainfall data were used to calibrate the stormwater runoff model. Stream data were obtained from United States Geological Survey (USGS) gauge stations, and rainfall data were obtained from DWR and NCDC gauge stations. Data were collected from 1990 to 1997.

Stormwater runoff was differentiated from base flow by examining the cumulative probability plots for flow. Flow above the first inflection point was defined as associated with stormwater runoff. Rainfall data from nearby gauges were used to associate the event with stormwater runoff volume. Cumulative plots are presented in Appendix A.

The stormwater runoff model had one variable, runoff coefficient. The runoff coefficient is the fraction of rainfall that fall on an area that reaches a receiving water. Runoff coefficients can vary over an area from one event to another because of different physical, biological, and geological conditions.

Runoff coefficients were calculated from the collected data set and screened for outliers. For any given storm, its overall runoff coefficient can be calculated by dividing the measured runoff volume by the volume of rain that fell on that watershed. We first screened outliers by examining cases where more runoff occurred than rainfall, then we examined cases where little or no volume was discharged after significant rainfall. These events were removed from the calibration process.

Because the runoff coefficient is variable, the parameter was adjusted to achieve an optimal value for many events. The optimization technique entailed comparing the measured volumes to the modeled. Data from the North and Central Coast Regions were combined to calculate one set of runoff coefficients. Sum of the residual difference of the two was solved for and set to zero by changing the values of the runoff coefficients. Sum of residuals was set to zero to minimize the amount of bias in estimating stormwater runoff mass emissions. To equate the influence of the larger and smaller watersheds, the residuals were normalized with drainage area. To reduce the effects of the extreme events on the overall calibration, events were ranked, and the 10th and 90th percentile storms removed (events <0.43 and >2.73). Residual data and graphs are presented in Appendix A.

Runoff Volume Results

Sum of the normalized residuals was zero and produced the following empirically-derived runoff coefficients:

Urban 0.47
Agriculture 0.31
Open 0.11

For both Regions, the majority of the modeled area was open (Figures II-7 & II-8). In the Central Coast Region, the open area comprised 80% of the total area and contributed 60% of the total runoff volume. The Urban area, although it comprised approximately 5% of the total area, it contributed 16% of the total runoff volume (Figure II-9). In the North Coast Region, the open area comprised 96% of the total area and contributed 97% of the total runoff volume (Figure II-10).

Water Quality and Chemical Concentrations

We were unable to identify or obtain water quality and chemical concentration data related to specific land uses in the North and Central Coast Regions. Land use concentration data were obtained from the San Francisco Estuary Institute (SFEI) and from the Southern California Coastal Water Research Project (SCCWRP). These data were generated from surveys from San Francisco Bay and southern California. Table II-1 provides a list of the investigated constituents.

The urban category for the North and Central Coast Regions was composed of total urban regions. For the southern California and San Francisco Bay reports, the urban category was subdivided into residential, commercial, industrial, and other urban. The urban constituent concentrations for the North and Central Coast Regions used were an average of the averages from the 4 urban categories. Averaging averages may lead to biases.

However, considering the lack of land use constituent data in North and Central Coast Regions, we feel this bias is minimal compared to the biases generated through using non-regional data.

Results

Mass Emission Estimates

Mass emission estimates were calculated for each watershed using the following equation:

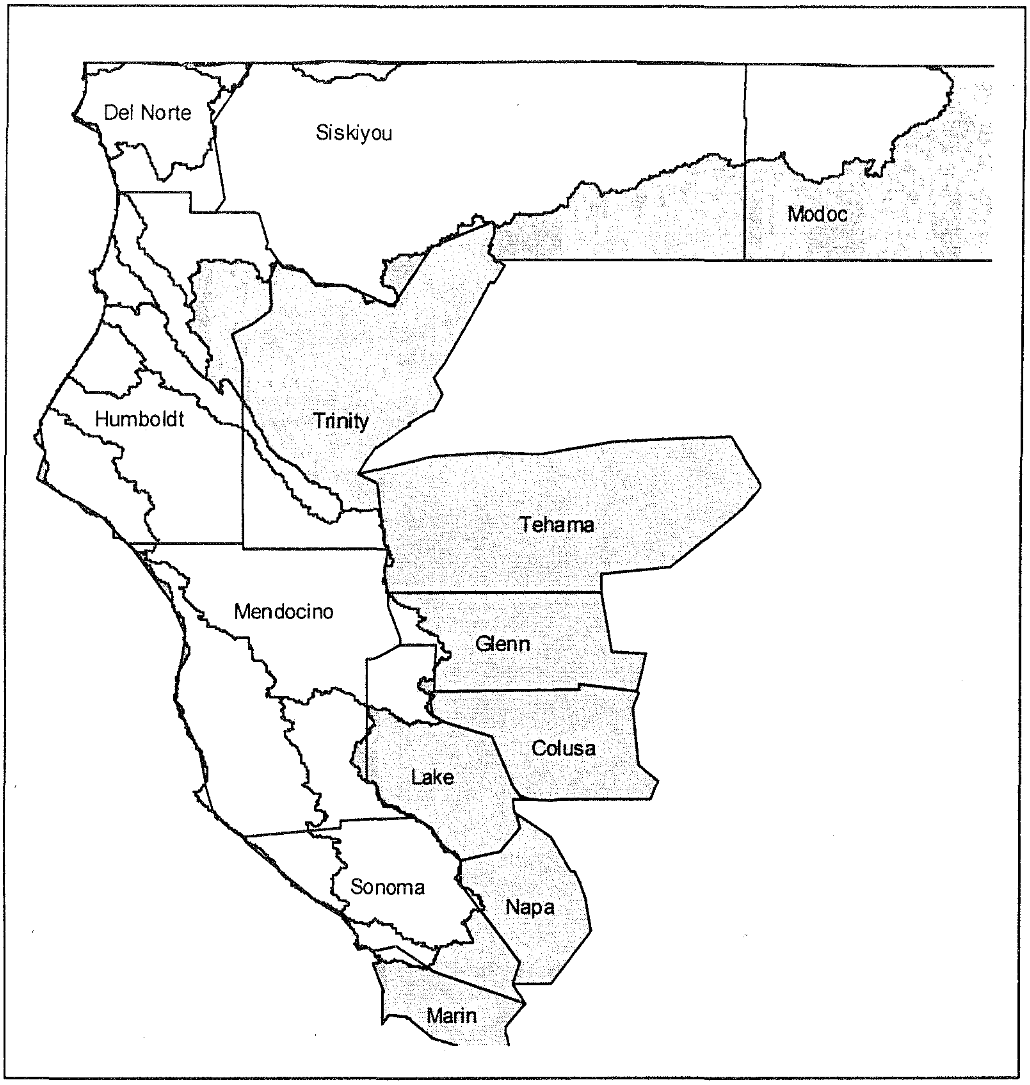
$$ME = \sum (Q * C)_{Urban} (Q * C)_{Agriculture} (Q * C)_{Open}$$

Where:

ME = mass emission
Q = estimated runoff volume
C = average land use concentration

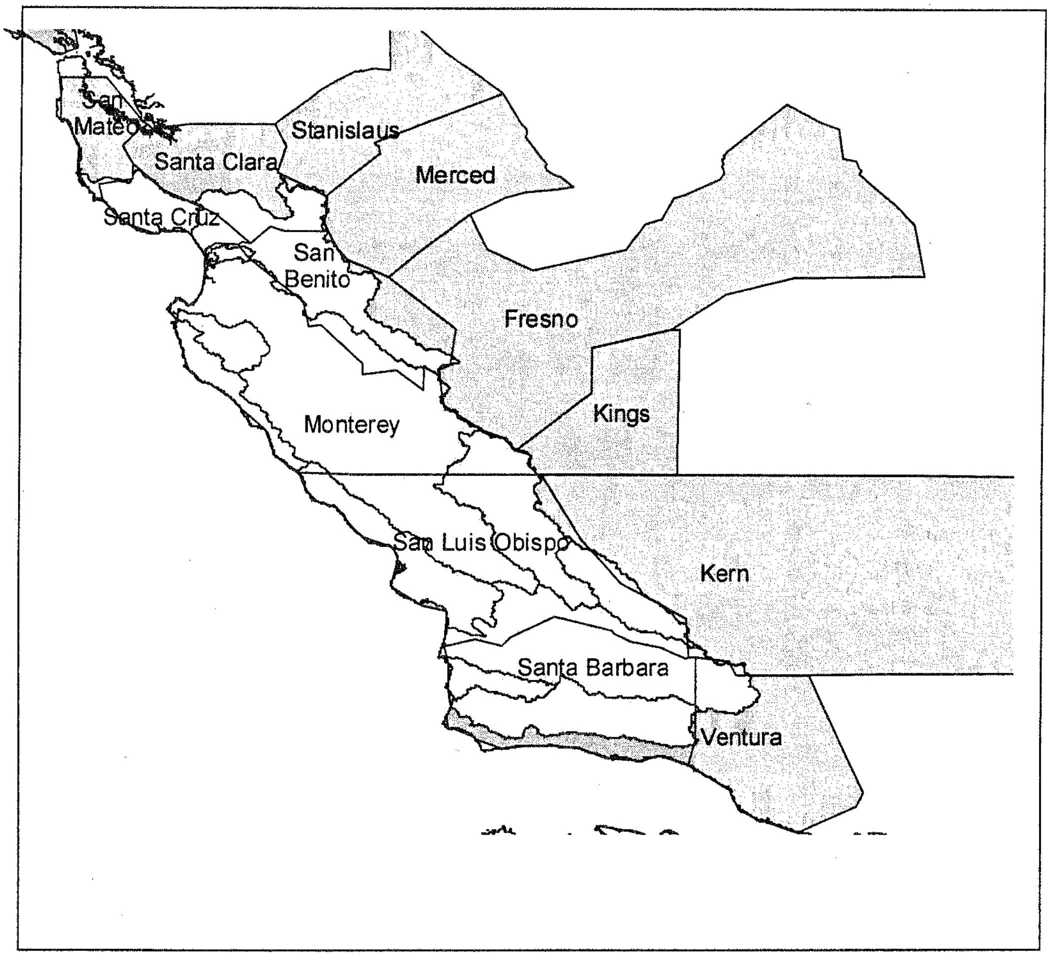
Table II-2 provides a list of land use concentration data used to drive the model.

A summary of the average estimated mass emissions (with 90th and 10th percentiles) are presented in tables II-3 & II-4. Estimates using 10th and 90th percentile rainfall values are indicative of estimated mass emissions during a dry and a wet year, respectively.



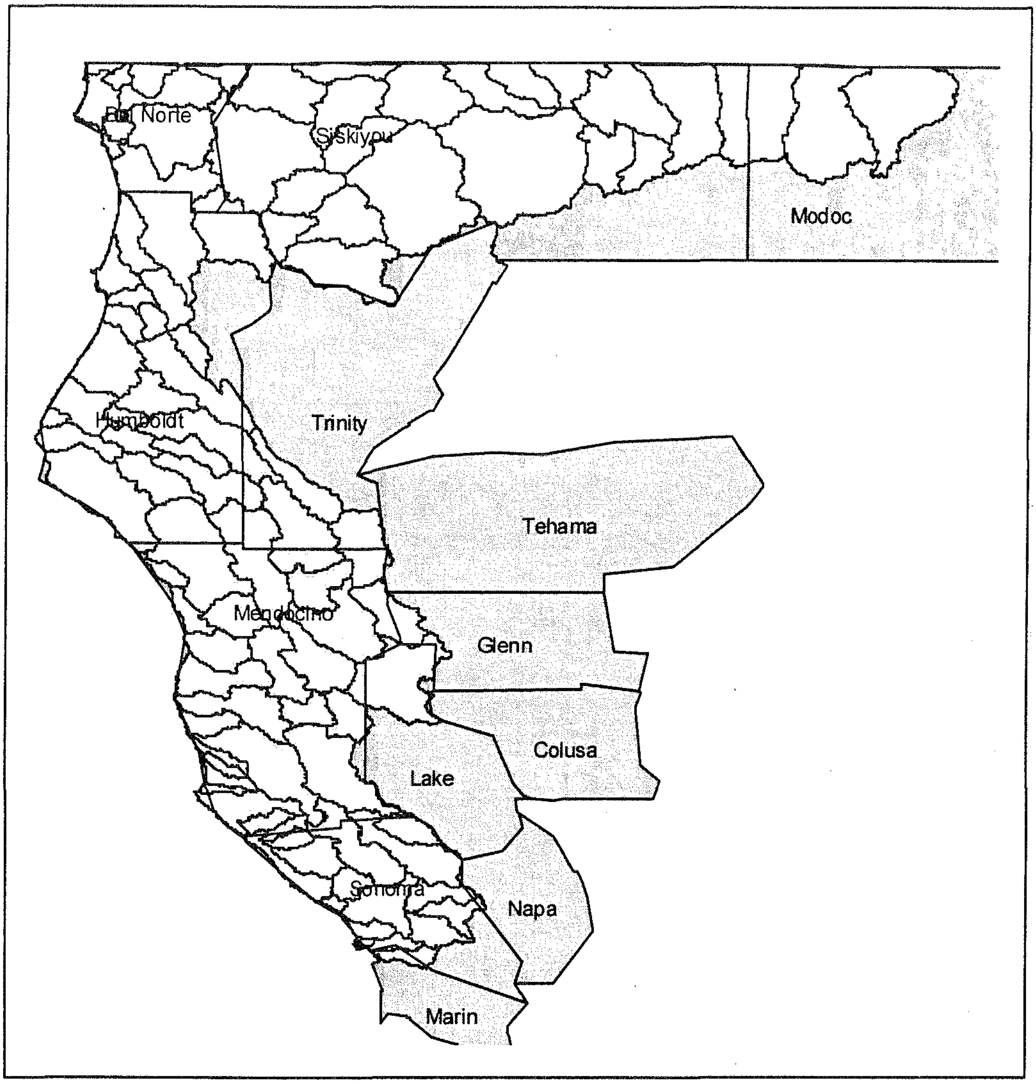
* Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-1. Initial Northern California study area, showing the HUCs and county regions.



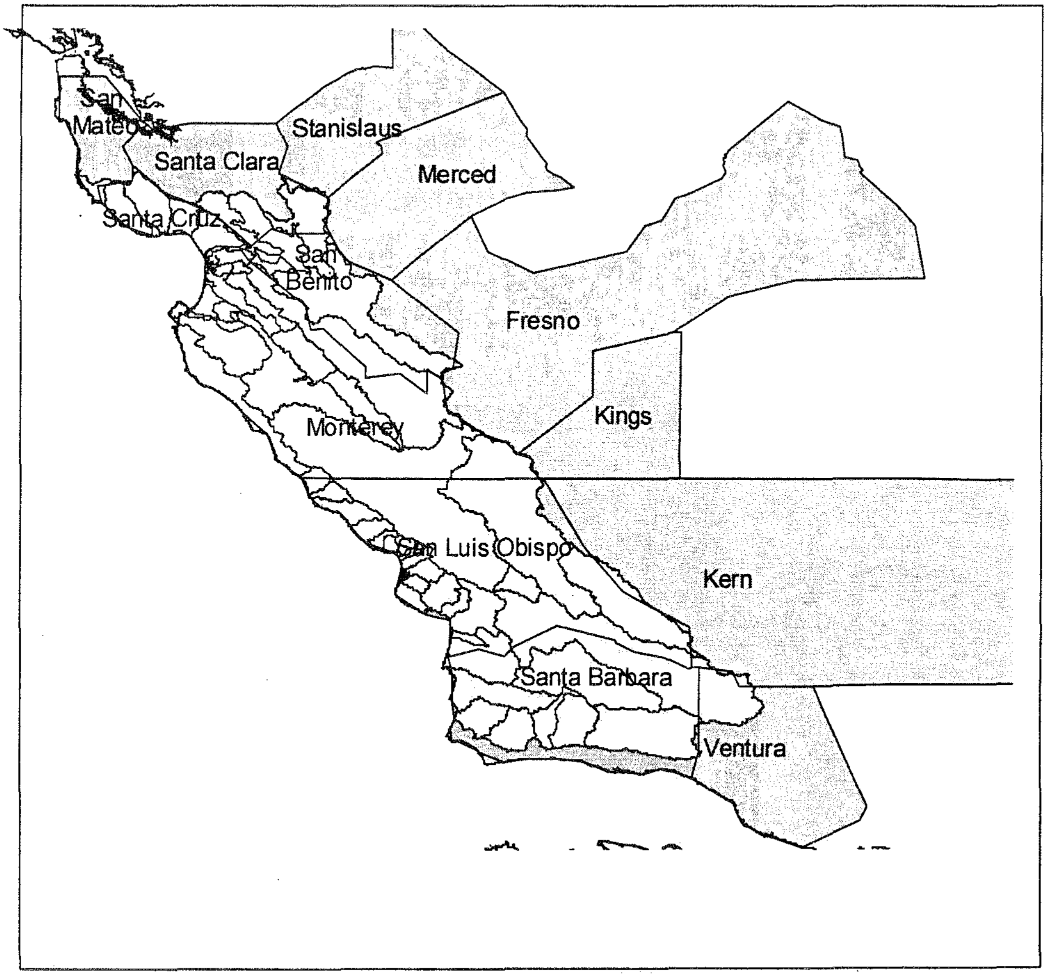
*Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-2. Initial Central California study area, showing the HUCs and county regions.



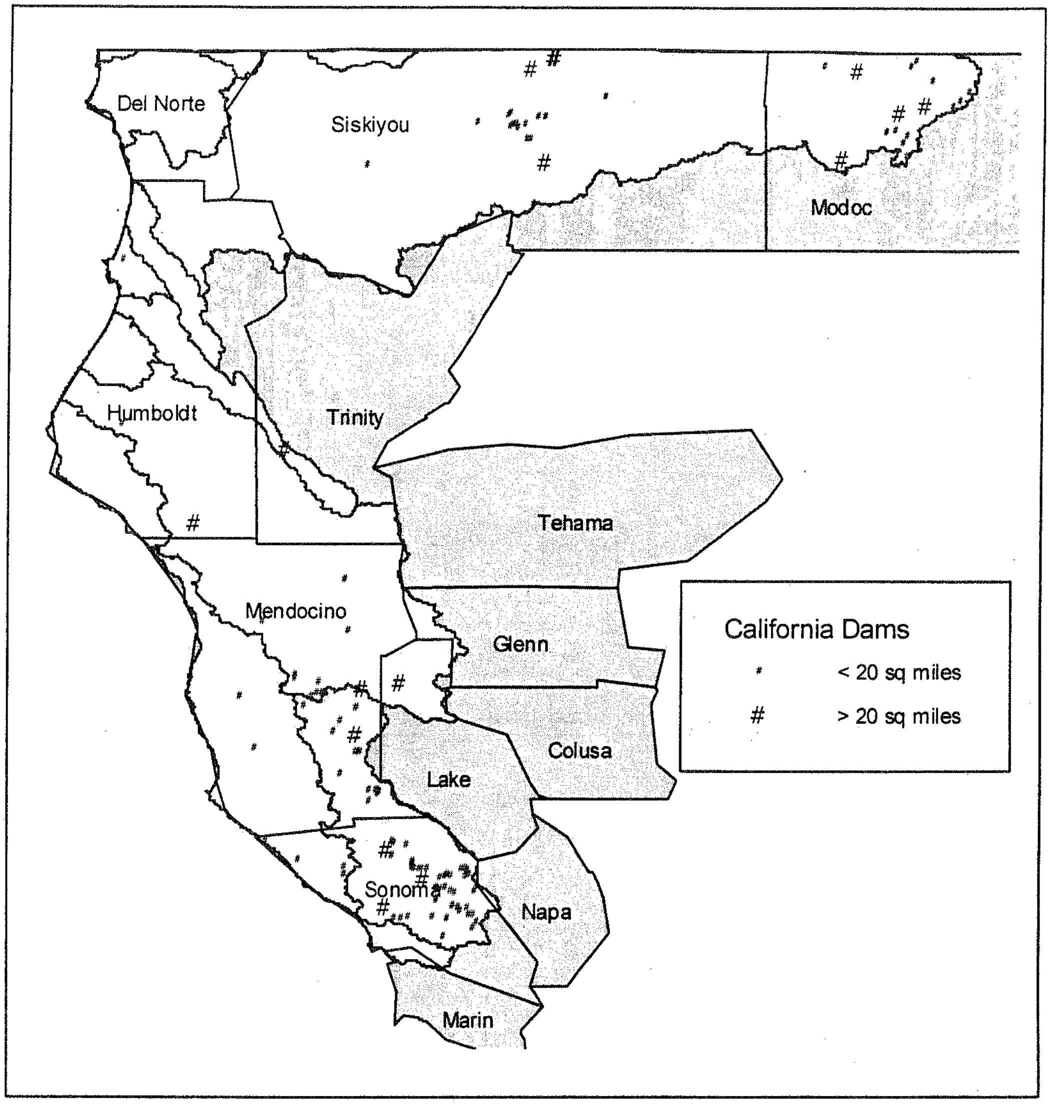
* Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-3. The North Coast Region watersheds within the HUCs.



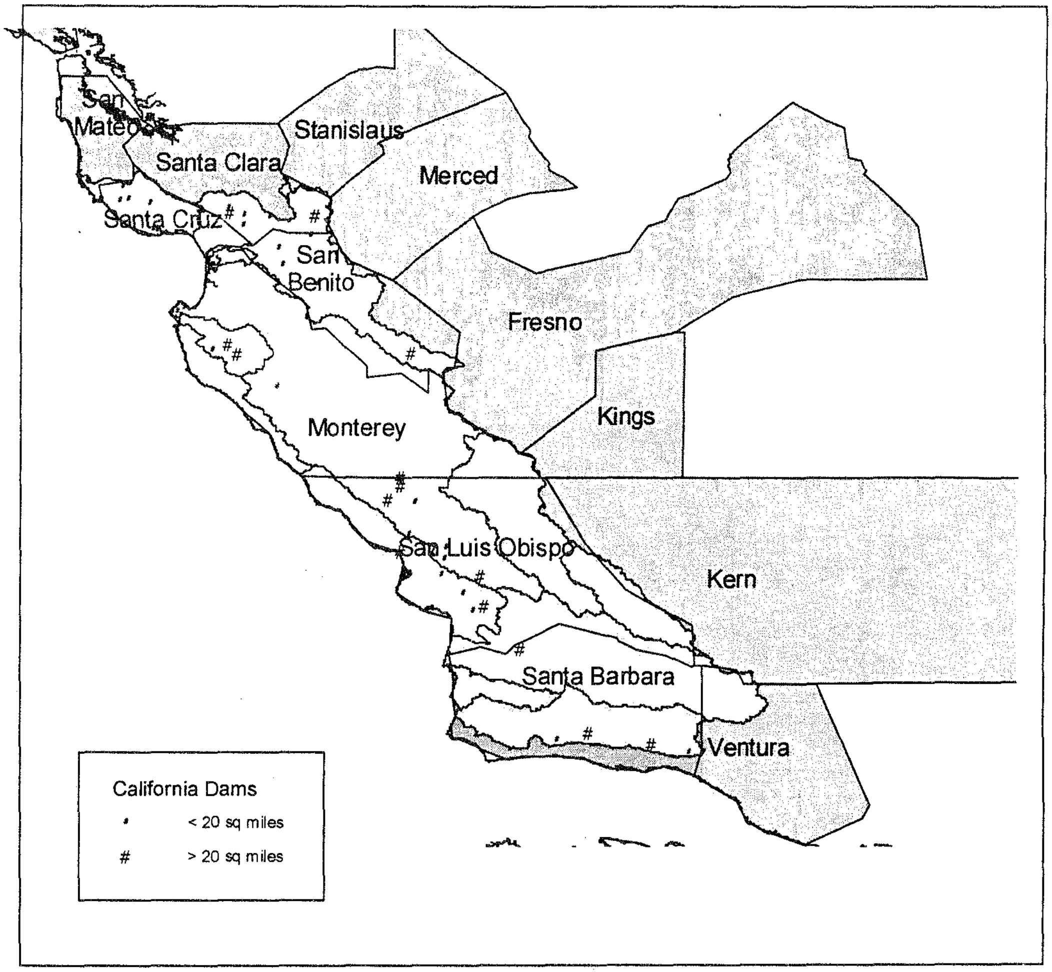
* Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-4. The Central Coast Region watersheds within the HUCs.



* Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-5. Location of all known dams in the North Coast study area.



* Areas presented in gray are portions of counties excluded in the delineation of watersheds used in the model.

Figure II-6. Location of all known dams in the Central Coast study area.

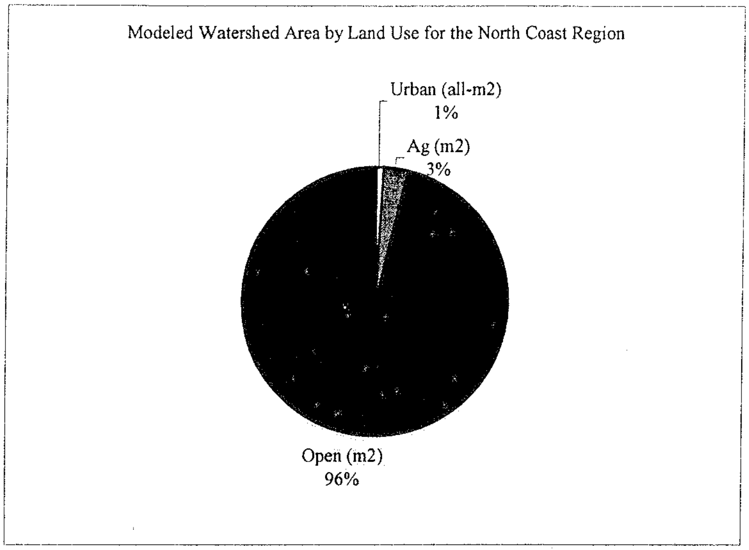


Figure II-7. Modeled area by land use for the North Coast Region.

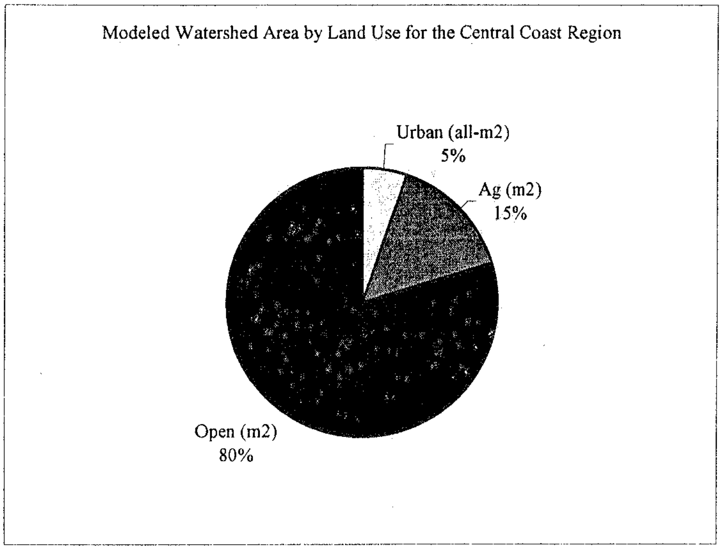


Figure II-8. Modeled area by land use for the Central Coast Region.

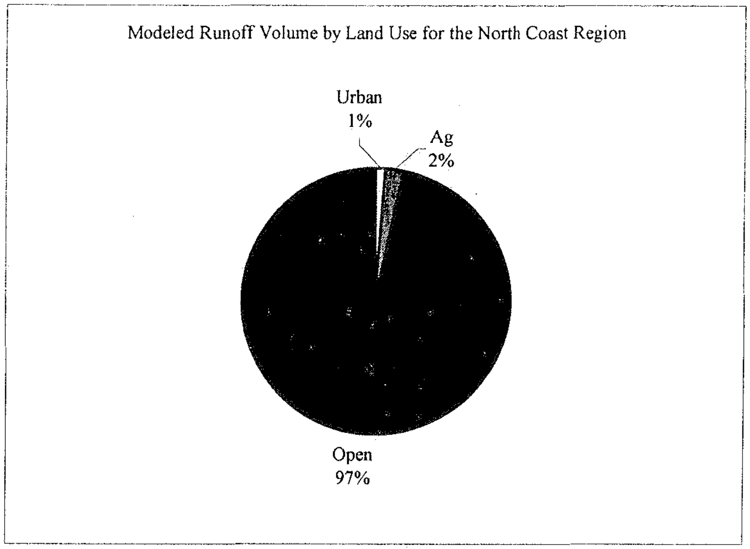


Figure II-9. Modeled runoff volume by land use for the North Coast Region.

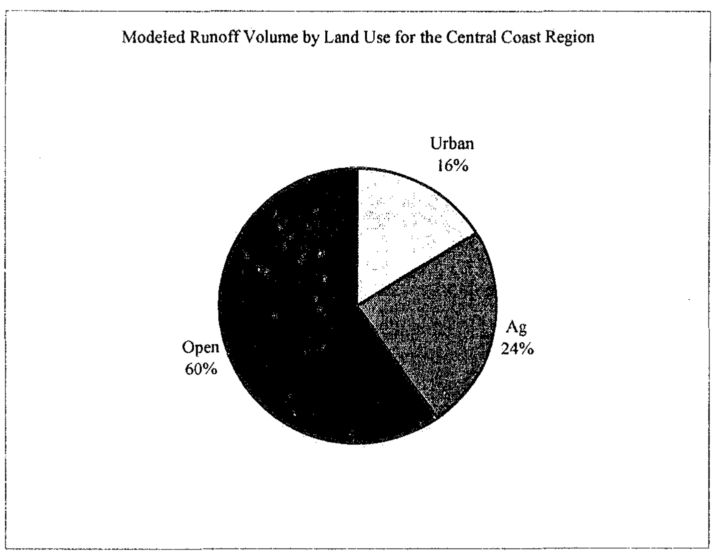


Figure II-10. Modeled runoff volume by land use for the Central Coast Region.

TABLE II-1. List of constituents identified to investigate.

Group	Constituent/Concentration
Flow/volume	
Metals	Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn
PCBs	Total
PAHs	Total
Pesticides	Dioxin (TCDD), diazinon, dursban (chloropyrifos), DDTs, chlordane, dieldrin
Sediment	Suspended solids
Nutrients	Nitrate, nitrite, ammonia, total phosphate
Pathogens	Total coliform, fecal coliform, enterococcus
BOD, CBOD	
MTBE	

Table II-2. Land use concentration data used.

Constituent	Units	Open	Agriculture	Urban
Ammonia	mg/L	0.12	2.27	0.58
BOD	mg/L	20.45	50.89	22.68
Cadmium	ug/L	0.6*	4.67	2*
Chlordane	ug/L	0.03	0.03	0.25
Chlorpyrifos	ug/L	0.03	0.86	3.84
Chromium	ug/L	12.6*	121	23*
Copper	ug/L	9*	122	51*
DDT	ug/L	19.09	121.57	37.82
Diazinon	ug/L	0.005	0.71	1.32
Dieldrin	ug/L	0.05	-	0.05
Fecal Coliform	MPN/100ml	-	109090.91	19468.17
Lead	ug/L	4*	39.47*	74*
Mercury	ug/L	2.97	0.18	2.2
Nickel	ug/L	18.4*	90.5	39*
Nitrate	mg/L	2.76	13.81	2.57
Nitrite	mg/L	0.05	-	0.18
PCB	ug/L	0.25	-	0.59
Phosphate	mg/L	-	0.64	0.53
Selenium	ug/L	2.78	1.45	3.69
Total Coliform	MPN/100ml	-	490909.09	93798.57
Total Suspended Solids	mg/L	85*	1144	115*
Zinc	ug/L	34*	257	319*

* data obtained from SFEI (rest of data from SCCWRP)
- indicate no data available

Note: Urban concentrations are an average of all urban categories used by SFEI and SCCWRP.

Table II-3. Estimated mass emissions from stormwater runoff from the North Coast Region using the 10th and 90th percentile of rainfall.

North Coast Region	Urban			Agriculture			Open			Total		
Loads (mt)	10th	Average	90th	10th	Average	90th	10th	Average	90th	10th	Average	90th
TSS	9.8E+03	1.6E+04	2.2E+04	1.8E+05	3.0E+05	4.0E+05	6.2E+05	1.0E+06	1.4E+06	8.1E+05	1.3E+06	1.8E+06
Cr	2.0	3.3	4.5	19	31	42	92	1.5E+02	2.0E+02	1.1E+02	1.9E+02	2.5E+02
Cd	0.18	0.30	0.41	0.73	1.21	1.62	4.4	7.3	10	5.3	8.8	12
Pb	6.4	11	14	6.2	10	14	29	48	65	42	69	93
Ni	3.3	5.6	7.5	14	23	31	1.3E+02	2.2E+02	3.0E+02	1.5E+02	2.5E+02	3.4E+02
Zn	27	45	61	40	66	89	2.5E+02	4.1E+02	5.5E+02	3.2E+02	5.2E+02	7.0E+02
Cu	3.2	5.4	7.2	19	31	42	1.4E+02	2.3E+02	3.1E+02	1.6E+02	2.7E+02	3.6E+02
Hg	0.19	0.31	0.42	0.03	0.05	0.06	22	36	48	22	36	49
Se	0.32	0.52	0.70	0.23	0.37	0.50	20	34	45	21	35	46
Ammonia	50	83	1.1E+02	3.5E+02	5.9E+02	7.9E+02	8.6E+02	1.4E+03	1.9E+03	1.3E+03	2.1E+03	2.8E+03
BOD	1.9E+03	3.2E+03	4.3E+03	7.9E+03	1.3E+04	1.8E+04	1.5E+05	2.5E+05	3.3E+05	1.6E+05	2.6E+05	3.5E+05
Nitrate	2.2E+02	3.6E+02	4.9E+02	2.2E+03	3.6E+03	4.8E+03	2.0E+04	3.3E+04	4.5E+04	2.3E+04	3.7E+04	5.0E+04
Chlordane	0.02	0.03	0.05	0.01	0.01	0.01	0.18	0.30	0.41	0.21	0.35	0.46
Chlorpyrifos	0.33	0.55	0.73	0.13	0.22	0.30	0.18	0.30	0.41	0.65	1.1	1.4
DDT	0.01	0.01	0.02	0.09	0.15	0.20	0.37	0.61	0.81	0.47	0.77	1.0
Diazinon	0.11	0.19	0.25	0.11	0.18	0.25	0.04	0.06	0.08	0.26	0.43	0.58
Dieldrin	0.00	0.01	0.01	-	-	-	0.37	0.61	0.81	0.37	0.61	0.82
Nitrite	15	25	34	-	-	-	4.0E+02	6.6E+02	8.9E+02	4.1E+02	6.9E+02	9.2E+02
PCB	0.05	0.08	0.11	-	-	-	1.8	3.0	4.1	1.9	3.1	4.2
Phosphate	46	76	1.0E+02	99	1.6E+02	2.2E+02	-	-	-	1.4E+02	2.4E+02	3.2E+02

\- indicate no data available

Table II-4. Estimated mass emissions from stormwater runoff from the Central Coast Region using the 10th and 90th percentile of rainfall.

Central Coast Region	Urban			Agriculture			Open			Total		
Loads (mt)	10th	Average	90th	10th	Average	90th	10th	Average	90th	10th	Average	90th
TSS	1.0E+04	2.5E+04	4.4E+04	1.5E+05	3.8E+05	6.5E+05	2.8E+04	6.9E+04	1.2E+05	1.9E+05	4.7E+05	8.1E+05
Cr	2.1	5.2	8.9	16	40	69	4.2	10	18	22	55	95
Cd	0.19	0.47	0.82	0.62	1.5	2.7	0.20	0.49	0.84	1.0	2.5	4.3
Pb	6.6	16	28	5.2	13	22	1.3	3.3	5.6	13	33	56
Ni	3.5	8.6	15	12	30	51	6.1	15	26	22	53	92
Zn	28	70	121	34	84	1.5E+02	11	28	48	74	1.8E+02	3.2E+02
Cu	3.4	8.3	14	16	40	69	6.3	16	27	26	64	1.1E+02
Hg	0.20	0.49	0.84	2.4E-02	6.0E-02	0.10	0.98	2.4	4.2	1.2	3.0	5.1
Se	0.33	0.81	1.4	0.19	0.47	0.82	0.92	2.3	3.9	1.4	3.5	6.1
Ammonia	52	1.3E+02	2.2E+02	3.0E+02	7.4E+02	1.3E+03	39	95	165	3.9E+02	9.7E+02	1.7E+03
BOD	2.0E+03	5.0E+03	8.6E+03	6.8E+03	1.7E+04	2.9E+04	6.7E+03	1.7E+04	2.9E+04	1.6E+04	3.8E+04	6.6E+04
Nitrate	2.3E+02	5.7E+02	9.8E+02	1.8E+03	4.5E+03	7.8E+03	9.1E+02	2.2E+03	3.9E+03	3.0E+03	7.3E+03	1.3E+04
Chlordane	2.2E-02	5.4E-02	9.4E-02	4.4E-03	1.1E-02	1.9E-02	8.2E-03	2.0E-02	3.5E-02	3.4E-02	8.5E-02	0.15
Chlorpyrifos	0.34	0.85	1.5	0.11	0.28	0.49	8.2E-03	2.0E-02	3.5E-02	0.46	1.1	2.0
DDT	9.1E-03	2.3E-02	3.9E-02	7.8E-02	0.19	0.33	1.6E-02	4.1E-02	7.0E-02	0.10	0.26	0.44
Diazinon	0.12	0.29	0.50	9.4E-02	0.23	0.40	1.6E-03	4.1E-03	7.0E-03	0.21	0.53	0.91
Dieldrin	4.1E-03	1.0E-02	1.8E-02	-	-	-	1.6E-02	4.1E-02	7.0E-02	2.1E-02	5.1E-02	8.8E-02
Nitrite	16	39	68	-	-	-	18	44	77	34	84	1.4E+02
PCB	5.2E-02	0.13	0.22	-	-	-	8.2E-02	0.20	0.35	0.13	0.33	0.58
Phosphate	47	1.2E+02	2.0E+02	84	2.1E+02	3.6E+02	-	-	-	1.3E+02	3.3E+02	5.6E+02

- indicate no data available

III. PUBLICLY OWNED TREATMENT WORKS

Description of Source

Publicly owned treatment works (POTWs) are facilities that receive and treat sanitary waste from the surrounding municipality. Sources of sanitary waste include inputs from domestic and industrial sewage systems.

Six POTWs in the North Coast Region and eleven in the Central Coast Region discharge directly into the coastal oceans (Figures III-1 & III-2, Table III-1). Each of these POTWs provides advanced primary and/or secondary treatment prior to discharge. All of these POTWs discharge their treated effluents through large effluent outfalls offshore.

Methods

Methods used were the same for both Regions. Effluents from POTWs have been routinely monitored for a large variety of general constituents, such as, nutrients, trace metals, and organics, in accordance with their National Pollutant Discharge Elimination System (NPDES) monitoring permits. These compliance monitoring data were used to estimate mass emissions. Effluent monitoring data were obtained from the most recent available discharger annual reports and/or their reports of waste discharge to the RWQCBs. Data years varied with facility (Table III-1). NPDES permits examined were obtained from the California Coastal Water Quality Monitoring Inventory (http://www.sfei.org/camp/index.html). The inventory does not include facilities above head of tide, therefore, permits above head of tide were not examined.

Mass emissions were calculated using the following equation:

$$ME = C * (Q * T)$$

Where:

ME = annual mass emissions
C = mean annual constituent concentration
Q = mean daily effluent flow
T = number of days in a year

One of the limitations to this approach is the occurrence of non-detectable quantities (ND) below the analytical laboratory reporting level. For ND constituents, we estimated mass emissions using the detection limit value for that constituent, 1/2 detection limit value, and zero. When detection values were not given for a ND, an average of detection limits for that constituent from all POTWs was used. For this section, mass emission using 1/2 detection limits for ND will be discussed; all other data are presented in Appendix B. Another limitation to this approach is the lack of common constituents. We estimated mass emissions for those constituents where we found any data, even if that constituent was not measured by all facilities.

Results

The majority of the data collected were from 1998. In 1998 four of the North Coast Region POWTs cumulatively discharged over 36 x 10^9 L of effluent, and seven of the Central Coast Region POWTs cumulatively discharged over 17 x 10^9 L of effluent. The total discharge for the North Coast Region was over 39 x 10^9 L of effluent, and for the Central Coast Region was over 60 x 10^9 L of effluent(Tables III-2 & III-3).

For the North Coast Region, a comparison of constituents among facilities was restricted because of the limited data set, because not a single constituent was measured in common among all facilities (13 constituents), and because of the large number of NDs (Table III-2). Biological oxygen demand (BOD) was measured by 5 of the 6 POTWs, and total suspended solids (TSS) were measured by 4 of the 6. Fort Bragg Wastewater Treatment Plant had the highest BOD concentration, and the Crescent City Seafood facility had the highest TSS concentration.

For the Central Coast Region, only one of 24 constituents (TSS) was measured in common among all facilities. Eight of the constituents were measured in common in 9 of the facilities; these included BOD, and most of the trace elements examined (Table 3-3). The Highlands Sanitary Association Wastewater Treatment Plant had the highest TSS concentration of those reporting. There was also a large number of NDs for this Region; therefore it was difficult to determine if one facility had the highest concentration within the other 8 constituents.

Range in mass emission among POTWs in both Regions for BOD and TSS varied greatly (Tables III-2 & III-3). Mass emission for TSS ranged from 2 to 185 mt, and for BOD ranged from 4 to 161 mt. Mass emission for TSS for the Central Region ranged from 0.39 to 437 mt. Mass emission for BOD ranged from 0.3 to 1560 mt; the Santa Cruz Wastewater Treatment Plant having the largest BOD mass emission.

The reporting of constituents was not consistent throughout the POTWs. For example, most of the trace metals were only reported by 17% of the POTWs in the North Coast Region (Table III-2). In order to estimate total mass emission from all POTWs, constituent data that were reported by the POTWs were extrapolated to those facilities that did not report them. Missing data were assigned a value equal to the arithmetic mean of all POTWs for a particular constituent to estimate and compare total mass emission by all POTWs (Tables III-2 & III-3). When data were extrapolated to estimate total mass emission from all POTWs, mass emissions were approximately 27% higher in the North Coast Region, and 21% higher in the Central Coast Region.

Mass emission of fecal and total coliform, and enterococcus were not estimated. Instead arithmetic means densities were calculated and compared to water quality thresholds established by the State for AB411. These thresholds include total coliform (10,000 organisms/100 mL), fecal coliform (400 organisms/100 mL), and enterococcus (104 organisms/100 mL). None of the North Coast Region POTWs exceeded the threshold values. However, in the Central Coast Region mean annual densities of total coliform and enterococcus exceeded the water quality thresholds at the Santa Cruz and Scotts Valley Waste Water Treatment Plants. Mean annual densities of enterococcus exceeded water quality thresholds at Scotts Valley and Watsonville Waste Water Treatment Plants (Tables III-2 & III-3).

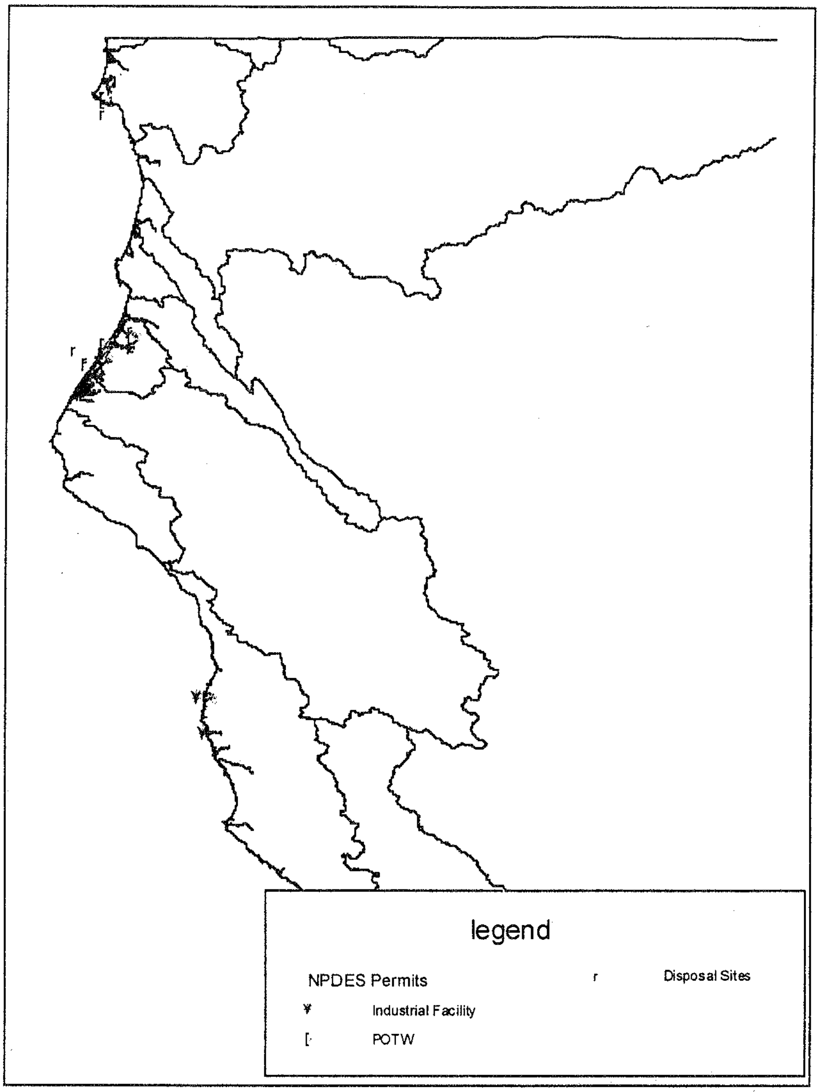


Figure III-1 POTWs, Industrial Facilities, and Ocean Disposal Sites in the North Coast Region.

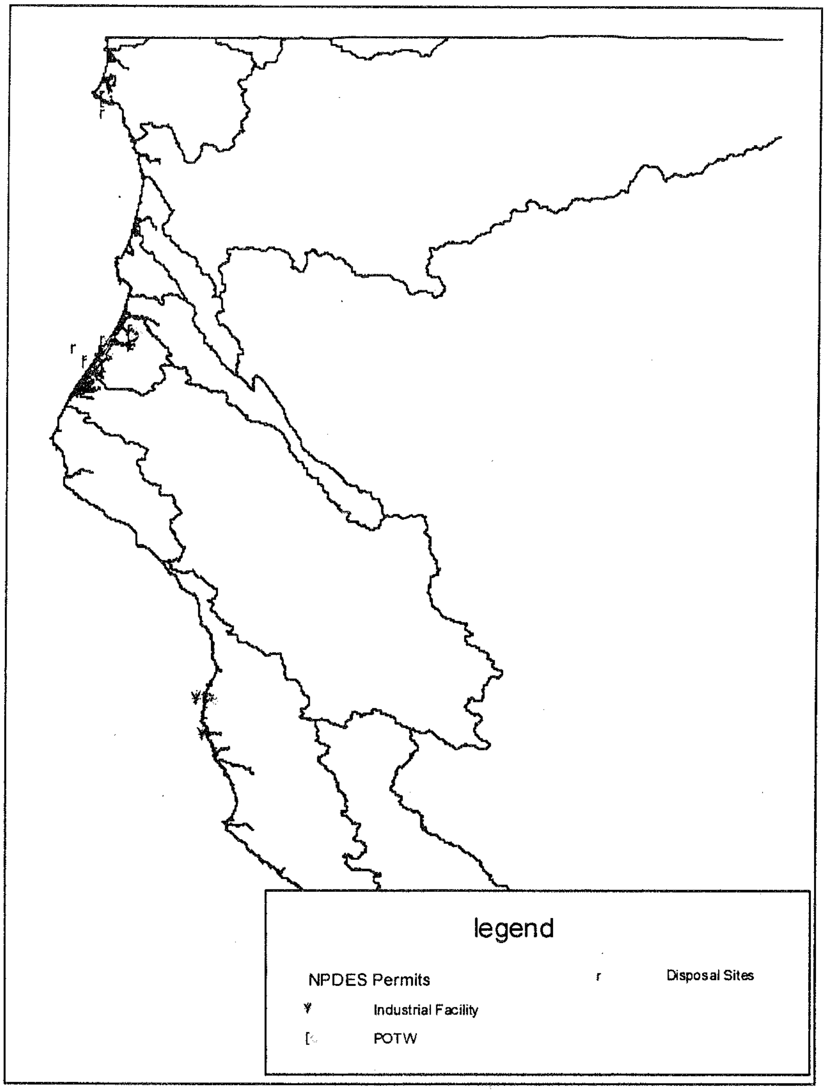


Figure III-2. POTWs, Industrial Facilities, PGS, and Ocean Disposal Sites in the Central Coast Region.

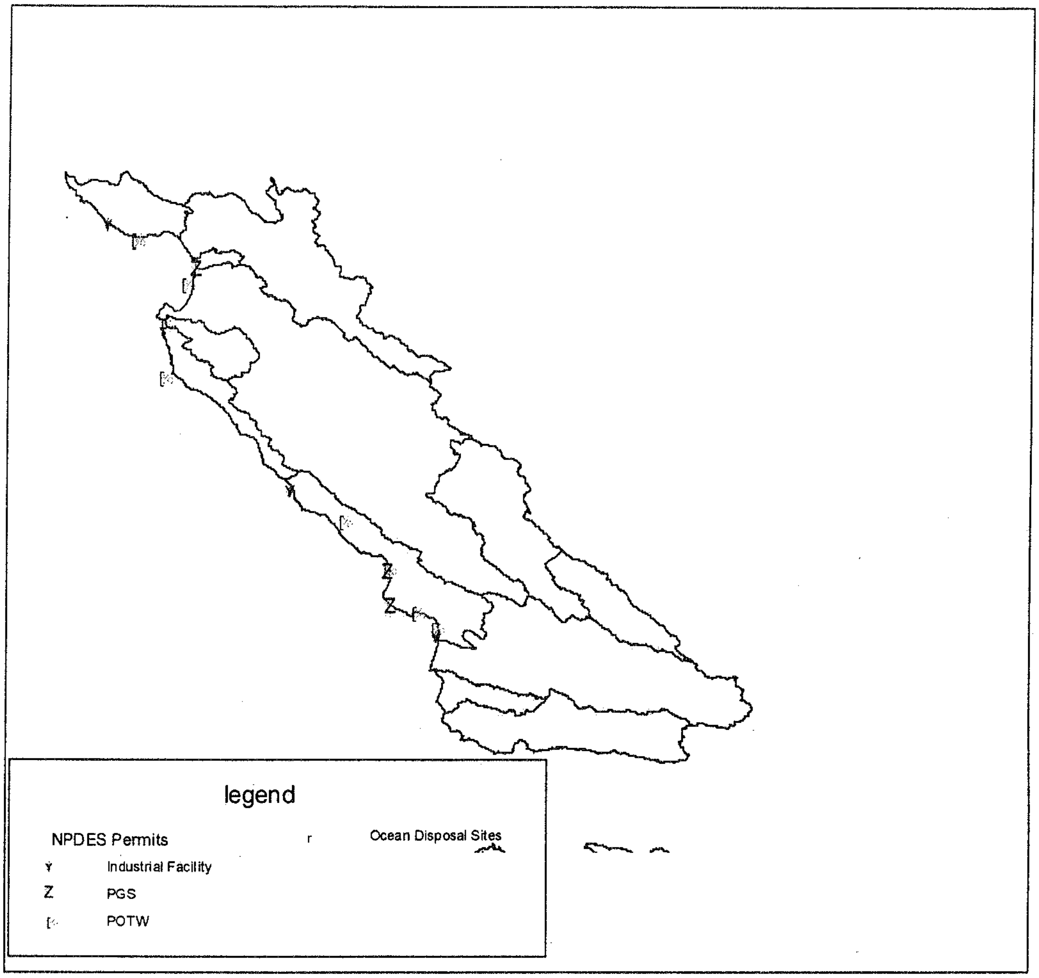


Figure III-3. POTWs, Industrial Facilities, PGS, and Ocean Disposal Sites in the Central Coast Region.

Table III-1. List of POTWs examined in the North and Central Coast Regions.

NORTH COAST REGION			
County	NPDES #	Project Name	Year of Data
Mendocino	CA0023078	Fort Bragg WW Treatment Plant-NPDES Self-Monitoring Program	1998
Del Norte	CA0022756	Crescent City POTW-NPDES Self-Monitoring Program	1997
Del Norte	CA0024473	Crescent City Seafood WW Syst.-NPDES Self-Monitoring Program	1997
Humboldt	CA0022713	Arcata City POTW-NPDES Self-Monitoring Program	1998
Humboldt	CA0024449	Eureka Elk River POTW-NPDES Self-Monitoring Program	1998
Humboldt	CA0005894	Louisiana Pacific Corporation Samoa Pulpmill-NPDES Self-Monitoring Program	1998

CENTRAL COAST REGION			
County	NPDES #	Project Name	Year of Data
Monterey	CA0047996	Carmel Area Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
Monterey	CA0049441	Highlands Inn Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
Monterey	CA0047872	Highlands Sanitary Association Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
Monterey	CA0048551	MRWPCA Reg Treatment & Outfall System-NPDES Self-Monitoring Program	1997
San Luis Obispo	CA0047830	Avila Waste Water Treatment Plant-NPDES Self-Monitoring Program	1997
San Luis Obispo	CA0047881	Morro Bay/Cayucos Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
San Luis Obispo	CA0048151	Pismo Beach Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
San Luis Obispo	CA0047961	San Simeon Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998
Santa Cruz	CA0048194	Santa Cruz Waste Water Treatment Plant-NPDES Self-Monitoring Program	1997
Santa Cruz	CA0048828	Scotts Valley Waste Water Treatment Plant-NPDES Self-Monitoring Program	1996
Santa Cruz	CA0048216	Watsonville Waste Water Treatment Plant-NPDES Self-Monitoring Program	1998

Table III-2. Summary of constituent concentrations and mass emissions for POTWs in the North Coast Region.

Project	% of POTWs Reporting	Arcata	Eureka	Crescent City	Crescent City Seafood
Flow (GD)		3.9E+06	7.7E+06	2.3E+06	6.6E+04
Flow (L)		5.4E+09	1.1E+10	3.2E+09	9.1E+07
TSS (mg/L)	67	34	-	10	2.0E+02
Load TSS (mt)		1.9E+02		32	18
Ammonia (mg/L-N)	33	-	-	-	-
Load Ammonia (mt)					
BOD (mg/L)	83	30	7	18	-
Load BOD (mt)		1.6E+02	77	58	
Cd (ug/L)	17	-	ND	-	-
Load Cd (mt)*					
Cr (ug/L)	17	-	ND	-	-
Load Cr (mt)*					
Cu (ug/L)	17	-	21	-	-
Load Cu (mt)			2.2E+02		
Hg (ug/L)	17	-	ND	-	-
Load Hg (mt)*					
Ni (ug/L)	17	-	ND	-	-
Load Ni (mt)*					
Pb (ug/L)	17	-	ND	-	-
Load Pb (mt)*					
Zn (ug/L)	17	-	30	-	-
Load Zn (mt)			3.2E+02		
Dioxin (TCDD) (ug/L)	17	-	-	-	-
Load TCDD (mt)*					
T Coliform (MPN/100mL)	33	ND	-	-	-
Fecal Coli (MPN/100mL)	33	ND	-	4	-

*Mass emission calculations where NDs were treated as 1/2 detection limits
**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting
-indicate no data available
Note: Load=Mass Emission

Table III-2 continued.

Project	Fort Bragg	Louisiana Pac (outfall 001)	TOTAL	Estimated Total with all POTWs Reporting**
Flow (GD)	9.2E+05	1.4E+07	2.9E+07	2.9E+07
Flow (L)	1.3E+09	1.9E+10	4.0E+10	4.0E+10
TSS (mg/L)	-	0.12		
Load TSS (mt)		2.1	2.4E+02	3.7E+02
Ammonia (mg/L-N)	18	2.6		
Load Ammonia (mt)	23	49	67	2.7E+02
BOD (mg/L)	38			
Load BOD (mt)	48	3.6	3.5E+02	3.5E+02
Cd (ug/L)	-	ND		
Load Cd (mt)*			1.5E+04	2.0E+04
Cr (ug/L)	-	ND		
Load Cr (mt)*			7.4E+04	8.6E+04
Cu (ug/L)	-	-		
Load Cu (mt)			2.2E+02	8.3E+02
Hg (ug/L)	-	ND		
Load Hg (mt)*			15	20
Ni (ug/L)	-	ND		
Load Ni (mt)*			1.5E+02	2.0E+02
Pb (ug/L)	-	ND		
Load Pb (mt)*			74	99
Zn (ug/L)	-	-		
Load Zn (mt)			3.2E+02	1.2E+03
Dioxin (TCDD) (ug/L)	-	ND		
Load TCDD (mt)*			3.3E-05	7.0E-05
T Coliform (MPN/100mL)	41.2	-	42	
Fecal Coli (MPN/100mL)	-	-	5.0	

*Mass emission calculations where NDs were treated as 1/2 detection limits
**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting
-indicate no data available
Note: Load=Mass Emission

Table III-3. Summary of constituent concentrations and mass emissions for POTWs in the Central Coast Region.

Project	% of POTWs Reporting	Avila	Highlands Sanitary	San Simeon	Carmel
Flow (GD)		5.6E+04	5.7E+03	6.1E+04	2.4E+06
Flow (L)		7.7E+07	7.9E+06	8.5E+07	3.3E+09
TSS (mg/L)	100	8.0	49	4.6	8.7
Load TSS (mt)		0.62	0.39	0.39	28
Nitrate (mg/L)	18	-	-	-	24
Load Nitrate (mt)*					79
Nitrite (mg/L)	9	-	-	-	3.0E-02
Load Nitrite (mt)					0.10
Ammonia (mg/L-N)	73	-	29	-	0.54
Load Ammonia (mt)			0.23		1.8
BOD (mg/L)	91	18	39	5.0	4.0
Load BOD (mt)		1.4	0.31	0.42	13
CBOD (mg/L)	18	-	-	-	-
Load CBOD (mt)					
Cd (ug/L)	82	-	ND	3.8	ND
Load Cd (mt)*				3.2E-04	
Cr (ug/L)	82	-	ND	7.7	39
Load Cr (mt)*				6.5E-04	0.13
Cu (ug/L)	82	-	44	16	23
Load Cu (mt)*			3.5E-04	1.3E-03	7.5E-02
Hg (ug/L)	82	-	ND	16	ND
Load Hg (mt)*				1.3E-03	
Ni (ug/L)	82	-	ND	78	66
Load Ni (mt)*				6.6E-03	0.21
Pb (ug/L)	82	-	2.1	7.7	ND
Load Pb (mt)*			1.7E-05	6.5E-04	
Se (ug/L)	73	-	ND	8.0	-
Load Se (mt)*				6.8E-04	
Zn (ug/L)	82	-	95	77	1.0E+02
Load Zn (mt)*			7.5E-04	6.6E-03	0.33
Total PCBs (ug/L)	45	-	-	-	ND
Load PCBs (mt)*					
Total PAHs ug/L	27	-	-	-	-
Load PAHs (mt)*					
Dioxin (TCDD) (ug/L)	36	-	-	-	-
Load TCDD (mt)*					
DDTs (ug/L)	55	-	-	-	ND
Load DDTs (mt)*					
Chlordane (ug/L)	55	-	-	-	ND
Load Chlordane (mt)*					
Dieldrin (ug/L)	55	-	-	-	ND
Load Dieldrin (mt)*					
T Phosphate (mg/L)	9	-	-	-	-
Load T Phosphate (mt)					
T Coliform (MPN/100mL)	73	33	4.6E+02	3.0	31
Fecal Coli (MPN/100mL)	45	-	-	-	-
Entero (MPN/100mL)	18	-	-	-	-

Table III-3 continued.

Project	Pismo Beach	Santa Cruz	Watsonville	Scotts Valley	Highlands Inn
Flow (GD)	1.2E+06	1.1E+07	7.4E+06	9.8E+05	2.1E+04
Flow (L)	1.7E+09	1.5E+10	1.0E+10	1.4E+09	2.9E+07
TSS (mg/L)	11	30	8.5	18	16
Load TSS (mt)	19	4.4E+02	86	24	0.47
Nitrate (mg/L)	-	ND	-	-	-
Load Nitrate (mt)*					
Nitrite (mg/L)	-	-	-	-	-
Load Nitrite (mt)					
Ammonia (mg/L-N)	7.5	41	11	16	0.77
Load Ammonia (mt)	13	6.0E+02	1.1E+02	22	2.2E-02
BOD (mg/L)	22	1.1E+02	19	21	17
Load BOD (mt)	38	1.6E+03	1.9E+02	28	0.50
CBOD (mg/L)	-	-	-	9.0	-
Load CBOD (mt)				12	
Cd (ug/L)	0.0	ND	ND	-	0.84
Load Cd (mt)*	0.0				2.4E-05
Cr (ug/L)	0.0	18	ND	-	42
Load Cr (mt)*	0.0	0.26			1.2E-03
Cu (ug/L)	5.0	77	ND	-	38
Load Cu (mt)*	8.6E-03	1.1			1.1E-03
Hg (ug/L)	0.0	ND	ND	-	8.4E+02
Load Hg (mt)*	0.0				2.4E-02
Ni (ug/L)	0.0	ND	30	-	24
Load Ni (mt)*	0.0		0.31		7.0E-04
Pb (ug/L)	0.0	ND	ND	-	3.0
Load Pb (mt)*	0.0				8.7E-05
Se (ug/L)	0.0	ND	ND	-	4.0
Load Se (mt)*	0.0				1.2E-04
Zn (ug/L)	1.7E+02	ND	20	-	39
Load Zn (mt)*	0.30		0.20		1.1E-03
Total PCBs (ug/L)	0.0	ND	-	-	-
Load PCBs (mt)*	0.0				
Total PAHs ug/L	0.0	ND	-	-	-
Load PAHs (mt)*	0.0				
Dioxin (TCDD) (ug/L)	0.0	2.0E-07	ND	-	-
Load TCDD (mt)*	0.0	2.9E-09			
DDTs (ug/L)	0.0	ND	ND	-	-
Load DDTs (mt)*	0.0				
Chlordane (ug/L)	0.0	ND	ND	-	-
Load Chlordane (mt)*	0.0				
Dieldrin (ug/L)	0.0	ND	ND	-	-
Load Dieldrin (mt)*	0.0				
T Phosphate (mg/L)	-	2.7	-	-	-
Load T Phosphate (mt)		39			
T Coliform (MPN/100mL)	-	4.7E+03	9.3E+03	1.8E+04	3.0
Fecal Coli (MPN/100mL)	20	3.0E+02	2.5E+04	2.6E+03	3.9
Entero (MPN/100mL)	-	9.6E+02	-	6.2E+03	-

Table III-3 continued.

Project	Morro Bay/Cayucos	MRWPCA	TOTAL	Estimated Total with all POTWs Reporting**
Flow (GD)	1.4E+06	2.0E+07	4.4E+07	4.4E+07
Flow (L)	2.0E+09	2.7E+10	6.0E+10	6.0E+10
TSS (mg/L)	39	13	2.1E+02	
Load TSS (mt)	78	3.6E+02	1.0E+03	1.0E+03
Nitrate (mg/L)	-	-		
Load Nitrate (mt)*			80	1.1E+03
Nitrite (mg/L)	-	-		
Load Nitrite (mt)			0.10	1.8
Ammonia (mg/L-N)	21	23		
Load Ammonia (mt)	41	6.2E+02	1.4E+03	1.4E+03
BOD (mg/L)	46	-		
Load BOD (mt)	91		1.9E+03	2.7E+03
CBOD (mg/L)	-	12		
Load CBOD (mt)		3.2E+02	3.4E+02	6.7E+02
Cd (ug/L)	ND	ND		
Load Cd (mt)*			0.18	0.19
Cr (ug/L)	1.4	ND		
Load Cr (mt)*	2.8E-03		0.51	0.54
Cu (ug/L)	ND	7.0		
Load Cu (mt)*		0.19	1.4	1.5
Hg (ug/L)	ND	ND		
Load Hg (mt)*			3.3E-02	0.44
Ni (ug/L)	ND	ND		
Load Ni (mt)*			1.4	1.4
Pb (ug/L)	ND	ND		
Load Pb (mt)*			0.41	0.42
Se (ug/L)	2.6	ND		
Load Se (mt)*	5.1E-03		0.36	0.38
Zn (ug/L)	ND	38		
Load Zn (mt)*		1.0	3.1	3.2
Total PCBs (ug/L)	ND	ND		
Load PCBs (mt)*			1.1E-02	1.4E-02
Total PAHs ug/L	-	ND		
Load PAHs (mt)*			0.10	0.15
Dioxin (TCDD) (ug/L)	-	1.4E-08		
Load TCDD (mt)*		3.8E-10	2.2E-08	2.2E-08
DDTs (ug/L)	ND	ND		
Load DDTs (mt)*			3.5E-03	3.6E-03
Chlordane (ug/L)	ND	ND		
Load Chlordane (mt)*			1.4E-02	1.5E-02
Dieldrin (ug/L)	ND	ND		
Load Dieldrin (mt)*			1.3E-03	1.3E-03
T Phosphate (mg/L)	-	-		
Load T Phosphate (mt)			39	1.6E+02
T Coliform (MPN/100mL)	-	-	32215.4	
Fecal Coli (MPN/100mL)	-	-	27737.6	
Entero (MPN/100mL)	-	-	7194.0	

*Mass emission calculations where NDs were treated as 1/2 detection limits
**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting
-indicate no data available
Note: Load=Mass Emission

IV. INDUSTRIAL DISCHARGERS

Description of Source

Industrial facilities discharge chemicals containing byproducts of the industrial and/or manufacturing process. Industrial facilities generate their own wastes, and many will provide some sort of waste treatment prior to discharge.

There were 3 industrial facilities that discharged directly into harbors, bays, and coastal oceans of the North Coast Region, and 3 in the Central Coast Region (Figures III-1& III-2, Table IV-1). These included the Georgia Pacific Corporation in the northern Region, a lumbermill which discharges a daily average of 150,000 gallons of hydraulic debarker water, 7200 gallons of boiler blowdown, 7200 gallons of cooling tower blowdown, and 100,000 gallons of boiler wet scrubber water. In the Central Region, the industrial facilities included TOSCO Refining Company, which operates a wastewater collection, treatment and disposal system to provide treatment of production wastewater and contaminated storm runoff at the Santa Maria Refinery.

Methods

Methods used were the same for both Regions. We did not calculate mass emissions for facilities that discharge directly to storm drains above the tidal prism, or that discharge solid wastes, groundwater dewatering, or on-site stormwater runoff because those data are not available.

Compliance monitoring data from NPDES monitoring permits were used to estimate mass emissions. We obtained effluent monitoring data from the most recent available discharger annual reports and/or their reports of waste discharge to the RWQCBs. Data years varied with facility (Table IV-1). NPDES permits examined were obtained from the California Coastal Water Quality Monitoring Inventory (http://www.sfei.org/camp/index.html). The inventory does not include facilities above head of tide, therefore, permits above head of tide were not examined.

Mass emissions were calculated using the following equation:

$$ME = C * (Q * T)$$

Where:

ME = annual mass emissions
C = annual mean constituent concentration
Q = mean daily effluent flow
T = number of days in a year

Non-detectable quantities (ND) below the analytical laboratory reporting level were treated in the same manner as for the POTWs. For this section, mass emission using 1/2 detection limits for ND will be discussed; all other data are presented in Appendix C.

Results

The majority of the data we collected were from 1998 for the North Coast Region and 1999 for the Central Coast Region. In 1998 two of the North Coast Region industrial facilities cumulatively discharged over 2 x 10^8 L of effluent, and 2 of the Central Coast Region industrial facilities cumulatively discharged over 5 x 10^8 L of effluent. The total discharge for the North Coast Region was over 3 x 10^8 L of effluent, and for the Central Coast Region was over 6 x 10^8 L of effluent (Tables IV.2 & IV.3).

For the North Coast Region, a comparison of constituents among facilities was limited because not a single constituent was measured in common among all facilities (13 constituents), and because of the large number of NDs (Table IV-2). Biological oxygen demand (BOD), ammonia, and total coliform were measured by 2 of the 3 industrial facilities. College of the Redwoods had the highest total coliform concentration

For the Central Coast Region, one of 24 constituents (TSS) was measured in common among all facilities. Four of the constituents were measured in common in 2 of the facilities, and these included BOD, ammonia, chromium, and zinc (Table IV-3). TOSCO Refining Company had the highest TSS concentration, and Ragged Point Inn had the highest BOD and ammonia concentrations.

The range in mass emission among industrial facilities in the Northern Region for BOD and ammonia did not vary greatly (Table IV-2). Mass emission for BOD ranged from 0.3 to 0.6 mt, and for ammonia ranged from 0.04 to 0.09 mt. For the Central Region, mass emission for TSS varied ranging from 0.1 to 14 mt (Table IV-3). Mass emission for BOD varied more in the Central Region than in the Northern Region, ranging from 0.5 to 8 mt; the TOSCO Refining Company having the largest mass emission. Mass emission for ammonia also varied more and was higher in the Central Region than in the Northern Region, ranging from 0.4 to 4 mt.

The reporting of constituents was not consistent throughout the industrial facilities. For example, most of the trace metals were only reported by 33% of the facilities in the North Coast Region (Table IV -2). In order to estimate total mass emission from all the industrial facilities, constituent data that were reported by the facilities were extrapolated to those facilities where data were missing. Missing data were assigned a value equal to the arithmetic mean of all industrial facilities for a particular constituent to estimate and compare total mass emission by all industrial facilities (Tables IV -2 & IV -3). When data were extrapolated to estimate total mass emission from all industrial facilities, mass emissions were approximately 65% higher in the North Coast Region and 52% higher in the Central Coast Region.

Mass emission of total coliform was not estimated. Instead arithmetic means densities were calculated and compared to water quality thresholds established by the State for AB411. These thresholds include total coliform (10,000 organisms/100 mL). None of the industrial facilities in Central Coast Region reported total coliform values. In the North Coast Region Mendocino City and College of the Redwoods reported total coliform values, however, neither exceeded the threshold values (Tables IV -2 & IV -3).

Table IV-1. List of Industrial Facilities in the North and Central Coast Regions.

NORTH COAST REGION			
County	NPDES #	Project Name	Year of Data
Mendocino	CA0005304	Georgia Pacific Corporation, Fort Bragg-NPDES Self-Monitoring Program	1998
Mendocino	CA0022870	Mendocino City Community Services District-NPDES Self-Monitoring Program	1998
Humboldt	CA0006700	College of the Redwoods, POTW-NPDES Self-Monitoring Program	1999

CENTRAL COAST REGION			
County	NPDES #	Project Name	Year of Data
San Luis Obispo	CA0049417	Ragged Point Inn Motel-NPDES Self-Monitoring Program	1999
San Luis Obispo	CA0000051	TOSCO Refining Company, Santa Maria-NPDES Self-Monitoring Program	1999
Santa Cruz	CA0048682	RMC Lonestar Santa Cruz Cement-NPDES Self-Monitoring Program	1997

Table IV -2. Summary of constituent concentrations and mass emissions for industrial facilities in the North Coast Region.

Project	% of Facilities Reporting	Mendocino City	Georgia Pac	College of the Redwoods	TOTAL	Estimated Total with all Facilities Reporting**
Flow (GD)		1.2E+05	9.2E+04	4.2E+04	2.6E+05	3.9E+05
Flow (L)		1.7E+08	1.3E+08	5.8E+07	3.6E+08	3.6E+08
Ammonia (mg/L-N)	67	0.53	0.28	-		
Load Ammonia (mt)		0.09	0.04		0.13	1.2
BOD (mg/L)	67	4	-	5		
Load BOD (mt)		0.69		0.27	0.96	13
Cd (ug/L)	33	-	ND	-		
Load Cd (mt)*					6.4E-02	0.18
Cr (ug/L)	33	-	4.5	-		
Load Cr (mt)			0.57		0.57	14
Cu (ug/L)	33	-	6	-		
Load Cu (mt)			0.73		0.73	17
Hg (ug/L)	33	-	ND	-		
Load Hg (mt)*					0.01	0.04
Ni (ug/L)	33	-	5	-		
Load Ni (mt)			0.60		0.60	0.60
Pb (ug/L)	33	-	ND	-		
Load Pb (mt)*					0.32	0.89
Zn (ug/L)	33	-	25	-		
Load Zn (mt)			3		3	75
T Coliform (MPN/100mL)	67	5	-	36	41	

*Mass emission calculations where NDs were treated as 1/2 detection limits

**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting

-indicate no data available

Note: Load=Mass Emission

Table IV-3. Summary of constituent concentrations and mass emissions for industrial facilities in the Central Coast Region.

Project	% of Facilities Reporting	RMC	TOSCO	Ragged Point Inn	TOTAL	Estimated Total with all Facilities Reporting**
Flow (GD)		6.0E+04	4.1E+05	6.5E+03	4.8E+05	4.8E+05
Flow (L) per year		8.2E+07	5.7E+08	9.0E+06	6.6E+08	6.6E+08
TSS (mg/L)	100	12	24	12		
Load TSS (mt)		0.99	14	0.11	15	15
Ammonia (mg/L-N)	67	-	7	48		
Load Ammonia (mt)			4	0.43	4	4.4
BOD (mg/L)	67	-	13	54		
Load BOD (mt)			7	0.48	8	11
CBOD (mg/L)	33	-	10	-		
Load CBOD (mt)			6		6	6.6
Cd (ug/L)	33	-	-	ND		
Load Cd (mt)*					0	1.6E-03
Cr (ug/L)	67	-	8	ND		
Load Cr (mt)*			4.54E-03		4.59E-03	5.2E-03
Cu (ug/L)	33	-	-	ND		
Load Cu (mt)*					2.25E-05	1.6E-03
Hg (ug/L)	33	-	-	ND		
Load Hg (mt)*					2.25E-06	1.6E-04
Ni (ug/L)	33	-	-	ND		
Load Ni (mt)*					4.49E-05	3.3E-03

*Mass emission calculations where NDs were treated as 1/2 detection limits
**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting
-indicate no data available
Note: Load=Mass Emission

V. POWER GENERATING STATIONS

Description of Source

Power Generation Stations (PGS) are facilities that generate electricity for utility companies. There were 2 PGS in the North Coast Region: the Fairhaven Power Plant and the Humboldt Bay Power Plant. However, the Fairhaven Power Plant did not monitor the constituents we were examining, and the Humboldt Bay Power Plant was not required to monitor the low volume waste discharge or in-plant waste streams we were examining. Therefore, these 2 PGS were not included in this study. There were 3 PGS in the Central Coast Region: the Duke Energy Power Services, Diablo Canyon Power Plant, and Morro Bay Power Plant (Figure III-2).

Methods

Only in-plant waste streams were examined for mass emission estimates from PGS. Compliance NPDES monitoring data during 1998 were used to estimate mass emissions for Duke and for Diablo Canyon. Data during 1997 were used for Morro Bay. We obtained effluent monitoring data from the most recent available discharger annual reports and/or their reports of waste discharge to the RWQCBs. NPDES permits examined were obtained from the California Coastal Water Quality Monitoring Inventory (http://www.sfei.org/camp/index.html). The inventory does not include facilities above head of tide, therefore, permits above head of tide were not examined.

Mass emissions for each in-plant waste stream characterized were calculated according to equation 1, and then summed for total mass emissions:

$$ME = C * (Q * T) \qquad \text{Equation (1)}$$

Where:

ME = annual mass emissions
C = annual mean constituent concentration
Q = mean daily effluent flow
T = number of days in a year

Non-detectable quantities (ND) below the analytical laboratory reporting level were treated in the same manner as for the POTWs. For this section, mass emission using 1/2 detection limits for ND will be discussed; all other data are presented in Appendix D.

Results

Total in-plant waste flow during 1998 was over 5 x 10^7 L, and during 1997 was over 1 x 10^8 L. During 1997, the flow was all attributed to Duke Energy Power Services (Table V-1).

A comparison of constituents among facilities was limited because not a single constituent was measured in common among all facilities (24 constituents) (Table V-1). Two constituents (TSS and copper) were measured by 2 of the PGS. Duke had the highest concentration of TSS. Copper was measured but not detected in Diablo Canyon, and for Duke it was reported as zero. Duke measured 7 of the trace elements, however, only two (copper and zinc) were measured in detectable concentrations. The range in mass emission of TSS varied among Duke and Morro Bay, ranging from 0.4 to 5 mt.

The reporting of constituents was not consistent throughout the PGS. For example, most trace metals were reported by 33% of all PGS in the Central Coast Region (Table V-1). In order to estimate total mass emission from all PGS, constituent data that were reported by the PGS were extrapolated to those PGS that were missing data. Missing data were assigned a value equal to the arithmetic mean of all PGS for a particular constituent to estimate and compare total mass emission by all PGS (Table 5-1). When data were extrapolated to estimate total mass emission from all PGS, mass emissions were approximately 91% higher in the Central Coast Region.

Fecal indicator bacteria (total coliform, fecal coliform, and enterococcus) were not reported by any of the PGS.

Table V-1. Summary of constituent concentrations and mass emissions for PGS in the Central Coast Region.

Project	% of PGS Reporting	Morro Bay	Diablo Canyon	Duke	TOTAL	Estimated Total with all PGS Reporting**
Flow (GPD)		3.7E+04		9.6E+04	1.3E+05	
Flow (L) per year		5.1E+07	9.3E+02	1.3E+08	1.8E+08	1.8E+08
TSS (mg/L)	67	12		80		
Load TSS (mt)		0.40		5.0	5.4	5.4
Nitrate (mg/L)	33	-	ND	-		
Load Nitrate (mt)*					4.7E-08	9.2E-03
Ammonia (mg/L-N)	33	-	53	-		
Load Ammonia (mt)			4.9E-05		4.9E-05	9.7
T Phosphate (mg/L)	33	-	1.9E+02	-		
Load T Phosphate (mt)			1.8E-04		1.8E-04	35
Cd (ug/L)	33	-	ND	-		
Load Cd (mt)*					2.3E-08	4.6E-03
Cr (ug/L)	67	-	ND	-		
Load Cr (mt)*					4.7E-08	9.2E-03
Cu (ug/L)	33	-	3.9E+03	-		
Load Cu (mt)			3.6E-06		3.6E-06	0.70
Hg (ug/L)	33	-	ND	-		
Load Hg (mt)*					2.3E-09	4.6E-04
Ni (ug/L)	33	-	ND	-		
Load Ni (mt)*					4.7E-08	9.2E-03
Pb (ug/L)	33	-	ND	-		
Load Pb (mt)*					9.3E-08	0.02
Zn (ug/L)	33	-	7.5E+03	-		
Load Zn (mt)			7.0E-06		7.0E-06	1.3

*Mass emission calculations where NDs were treated as 1/2 detection limits
**Extrapolated data were used to provide an estimate of mass emission when all facilities were reporting
-indicate no data available
Note: Load=Mass Emission

VI. DREDGE MATERIAL

Description of Source

Dredge material, as defined by the Environmental Protection Agency (EPA) and United States Army Corps of Engineers (USACE), is material that is excavated or dredged from waters of the United States (USACE/EPA, 1998). Effects from the ocean disposal of dredged material in the marine environment can range from unmeasurable to significant. These effects may vary depending on factors, such as, the composition of the proposed dredged material (e.g., the presence of contaminants and sediment grain size) and disposal site location.

In 1991 the EPA and USACE released a national guidance for the evaluation of dredged material entitled the "Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual" (USACE/EPA, 1991). This manual, more commonly known as the "1991 Green Book", includes a description of the tiered approach to sediment testing. Included in the manual are methods and procedures for sediment sampling and testing, general guidance on bioassay and bioaccumulation testing, as well as an overview of data analyses and quality assurance procedures.

There are currently 5 dredged material disposal sites in the North Coast Region, and 1 in the Central Coast Region (Figures III-1 & III-2). Humboldt Bay Harbor, Hoods, and Nearshore disposal site typically serve the Humboldt area. The Farallon's disposal typically serves the San Francisco Bay area. The Crescent City Harbor (SF-1) disposal site typically serves the Crescent City area, and the Moss Landing dump site serves the Moss Landing Harbor.

Methods

Dredged materials disposed at the six offshore disposal sites between 1991 and 1997 were targeted for mass emission calculations. This period was chosen due to increased consistency and quality assurance of dredged material evaluations after the release of the "1991 Greenbook".

Projects disposing at offshore disposal sites are required to conduct sediment chemistry analysis on dredged material. These data are catalogued in the USACE's Ocean Disposal Database (ODD) (USACE 1999). We used these data to estimate mass emission for dredged material.

Dredged material mass emissions were calculated on a project-by-project basis. Sediment data for the North Coast and Central Coast Regions (San Francisco) were available only for 1995, and for only three projects. These three projects disposed dredged material at the Hoods disposal site.

Mass emissions were calculated using the following equation:

$$ME = \sum_{i=1}^{n} (C_i * V_i * d)$$

Where:

ME = annual mass emission
C = constituent concentration for the *i*th project
V = total volume disposed for the *i*th project
d = density conversion factor

The main assumption to this approach is the density factor (d). Densities of dredged materials rarely are reported to the USACE as part of the permitting process. Density conversion factor used in this report is the mean densities of previous studies by Schiff et al (1992), 1.087 g/cm^3.

Results

Total volume of dredged materials disposed into the North Coast Region between 1991 and 1997 was 4,151,161 m^3 (4,512,312 mt), and 4,309 m^3 (4,684 mt) into the Central Coast Region (Table VI-1).

Project sediment chemistry data were only available for 1995, and only one project reported data for the constituents we were examining (Table VI-2).

Table VI-1. List of disposal sites in the San Francisco Region (SPN) and volume disposed between 1991 to 1997.

Disposal Site Year Dispose	Crescent mt	Farallon's mt	Hoods mt	Humboldt mt	Moss Landing mt	Nearshore mt
1991	0		592007	0	0	0
1992	0		128990	0	0	0
1993	31168	820315	0	695897	0	0
1994	0		604308	0	0	0
1995	0		644866	0	0	0
1996	0		132730	394782	4684	0
1997	0		467248	0	0	0
Total Mass	31168	820315	2570150	1090679	4684	0
Grand Mass (7 yrs)	8987140					
AVERAGE ANNUAL MASS (mt)	1283877					

Table VI-2. Mass emission from available sediment chemistry data for 1995.

Proj Name & Disposal Site	Eureka (Hoods)
Amount Disposed 1995 (m3)	593253
Constintuents (mg/kg)	Load (mt)
Mercury	0.07
Cadmium	0.09
Lead	7
Chromium	76
Copper	14
Nickle	72
Zinc	43
Selenium	0.11
Silver	0.85
Dieldrin	0
DDD	0
DDE	0
DDT	0
Total PAH	0.41
Total Suspended Solids	42

VII. DISCUSSION

Attempts to estimate total mass emissions to ocean waters in northern and central California are made in this study with varying degrees of success. This is due to the fact that monitoring of coastal waters and watersheds is extremely limited in the best circumstances and non-existent in the majority. Two critical pieces of information must be known for accurate calculation of mass loading: the volume of water entering ocean waters and the concentration of chemicals in those waters. The volume of water and a limited number of chemicals have been measured at most point source discharges, but water volume and chemical concentrations are rarely known for rivers and nonpoint sources. Even with this paucity of empirical data, however, it is possible to draw some significant conclusions using estimates of point source loads and nonpoint source modeling. These exercises have helped us identify limitations that hinder accurate determination of mass emissions in northern and central California and help provide a clear avenue for improving emission estimates.

1) *Water flow to the ocean is dominated by stormwater runoff in the North and Central Coast Regions*

Total flow of water to the ocean is estimated by combining all point and nonpoint sources. Point source flow is empirically derived from reported monitoring, so confidence in these estimates is high. Flow of nonpoint source stormwater is poorly measured, so for purposes of this study has been modeled, using rainfall, land use and watershed information. Comparison of modeled flow to empirical flow data, for the few rivers where data have been gathered, indicates that actual measured flows are usually less than the range predicted by the model (Tables VII-1, VII-2). It therefore seems probable that the model has overestimated the amount of stormwater runoff that reaches ocean waters. The most likely source of error in the model are the calculated runoff coefficients for particular land uses, but limited measurements of river flow throughout the North and Central Coast Regions make refined calibration of runoff coefficients impossible. Although error sources limit the absolute accuracy of the modeled flow, comparisons to empirical data indicate the model generally predicts stormwater flow within an order of magnitude of measured flow. For the purposes of this study, this accuracy is adequate for estimates of non-point source mass emissions and for generalized comparisons to point source mass emissions.

As would be expected from rainfall information, modeled flow from north coast rivers is significantly greater (approx. 5 times) than runoff from the central coast. Flow originating from runoff for areas of non-urban open lands is 97% of the total for the north coast and 60% of the total for the central coast (Tables VII-3, VII-4). Large rivers dominate the majority of this non-urban runoff volume. In the North Coast Region, the Eel, Klamath, and Smith Rivers generate approximately 69% of the total runoff volume (Appendix A). In the Central Coast Region, the Pajaro and Salinas Rivers generate approximately 51% of the total runoff volume (Appendix A).

Point source water flow is well characterized and contributes less than 1% of the total water flow to ocean waters north of Point Conception. Small POTWs are the major point source of water flow, with industrial facilities and power plants a distant second and third. Point source flow along the central coast is approximately twice that of inputs along the north coast.

2) *Constituent data for most pathways and sources of contamination are unavailable in the North and Central Coast Regions. When data are available, they are extremely limited, and method detection limits for these measured constituents are variable.*

Most chemical constituents are poorly monitored in waters flowing to the ocean in the northern and central California. Point source discharges are monitored but inconsistencies in analyte lists and detection limits among different dischargers severely limit the ability to contrast and compare mass emissions. In general, point source discharges in the Central Coast Region are better monitored, in terms of constituents and consistency, than are those of the North Coast Region. The most consistently monitored point source constituents are from POTWs, and in order of consistency are: total suspended solids, BOD, ammonia, total coliform bacteria and to a lessor extent, trace metals. Most synthetic organic constituents are unmeasured or inconsistently measured.

Method detection limits (MDLs) for measured chemicals are variable among facilities and monitoring programs. Examples of the wide range of method detection limits encountered include the trace metals: cadmium (1-1000 μg/L), chromium (5-5000 μg/L), and mercury (0.2 – 5 μg/L). Detection limits are more consistent for measurement of organic compounds, however, most are measured infrequently among programs. Inconsistencies in method detection limits create major difficulties for estimation of mass emissions because of the inability to treat non-detects equitably among monitoring programs. The options used for handling chemical concentrations that were below laboratory detection limits (ND) were selected as ND=0, ND = ½ the reported detection limit or ND = the reported detection limit. Mass emissions in northern and central California were calculated using all three options to give the range of emission estimates that are dependent on the treatment of non-detects (Tables VII-5 & VII-6). When replacing non-detects with zero during emission calculations, underestimates are likely, while replacing non-detects with reported MDLs, particularly for those facilities or programs accepting relatively high MDLs from analytical laboratories, will likely lead to an overestimate of emissions. The large range in emission estimates demonstrates the significance of this problem. Summary mass emission tables reported here (Tables VII-3 & VII-4) were calculated by replacing non-detects with ½ the reported detection limits. Although acknowledged as an artificial quantification, this is assumed in this report to provide a more central tendency for estimating low chemical concentrations, at or below the analytical capabilities of varying laboratories.

Measurement of chemical constituents in non-point source waters is extremely limited. In the north coast region, only the Eel and Russian Rivers have been monitored regularly over the past ten years and only for total suspended solids, nutrients and a few metals and pesticides. In the central coast region, only the Pajaro, Salinas and San Lorenzo Rivers, and Elkhorn Slough have recent measures, although only for a limited number of constituents. Often synoptic flow measurements and land use information are not collected with water samples so modeled mass emissions cannot be calculated. Due to this limited availability of data for chemical constituents in rivers and stormwater in northern and central California, mass emissions were not determined using local data. Instead, chemical concentration data collected from defined land uses in San Francisco Bay and southern California were used during calculation of non-point source mass emissions. Extrapolated use of data from outside the study area is obviously unadvisable, but has been unavoidable based on our review of data sources. A major, yet clearly indefensible, assumption has been made that chemical concentrations, in waters originating from defined land uses, are similar among all regions of the state.

3) *Confidence among mass emission estimates varies with constituent. Reasonable confidence can be placed only in total suspended solids, biological oxygen demand, and limited trace metals.*

Calculation of total mass emissions requires quantification and subsequent summation of all individual point and non-point emissions. In northern and central California, chemical constituent data are so limited that rarely can emissions be estimated from all point and non-point sources. This is demonstrated in Summary Tables VII-3 & VII-4, where point source emission estimates are not made for many chemicals, due to their absence in many monitoring programs. As a result, for many chemical constituents in northern California, mass emission estimates can only be based on stormwater runoff, using chemical concentration data collected in southern California (eg-nitrates, PCBs, chlorpyrifos). This is clearly a significant concern for the accuracy of emission estimates. Compounding this problem is the fact that chemical concentrations are missing even within stormwater runoff for some land uses (Table II-2). This means that within many watersheds there are large areas of land for which runoff emissions estimates are missing, making the emission estimate for total runoff incomplete. An example is stormwater pesticide data are often unavailable for agricultural land uses so runoff emissions of pesticides are calculated without including inputs from agricultural areas. It is therefore probable that total mass emissions are significantly underestimated for many constituents in stormwater runoff. Confidence in these total mass emission estimates should be recognized as very low. Similarly, some estimates of total mass emissions are based entirely on single point source emission estimates because chemicals are unmeasured in other point source discharges or stormwater runoff (eg- dioxins, PAHs). Again it must be noted that confidence in these estimates are very low.

Reasonable confidence can be expressed for estimates of total mass emissions from northern and central California for total suspended solids, BOD, and limited trace metals. This is because these parameters are directly measured in the major point source monitoring programs and can be estimated for stormwater runoff, based on chemical and land use data collected in southern California or San Francisco Bay. In northern and central California, approximately 1.8 million metric tons of total suspended solids enters ocean waters, with > 99% of this total from stormwater runoff. Similarly, >95% of BOD entering ocean waters is found in stormwater runoff. For trace metals, point sources appear to play a significant role in contributing to mass emissions in northern California while in central California stormwater dominates trace metal emissions. Investigation of this apparent difference reveals trace metals are rarely detected in point source discharges from the North Coast Region, but detection limits for these metals are usually higher than those of dischargers from the Central Coast. This has created an unresolvable artifact in the metals mass emission calculation because replacing non-detects with a value of ½ MDL, when MDLs were relatively high, has lead to apparent overestimation of metal mass emissions. The alternative of treating non-detects as zero would lead to the equally disturbing conclusion that no trace metals enter ocean waters through point sources (Tables VII-5 & VII-6). Method detection limit artifacts such as these can only be eliminated through improved laboratory analytical capabilities. Indications are that stormwater is the primary source of trace metal emissions in the Central Coast Region, but results are inconclusive regarding the North Coast region.

Mass emissions estimates expressed for the remaining constituents reported here are given with reduced, yet varying, degrees of confidence. Reduced confidence is primarily due to estimates being made with limited or missing data. Nutrients tend to be better monitored yielding more defensible emission estimates while organic compounds and pathogen counts are generally poorly monitored and less defensible. Tables III-2, III-3, IV-2, IV-3, and V-1 report the percentage of point source discharges that monitor particular chemical constituents, further highlighting the inconsistent availability of useable data.

Because stormwater mass emissions appear to dominate the vast majority of total mass emissions, it is useful to consider how stormwater originating from various land uses contribute to estimates of the stormwater totals. In the North Coast Region mass emission are primarily originating from large areas of open land (Table VII-7). As demonstrated in the results, large volumes of water, with even trace quantities of chemicals, can significantly impact mass emission calculations. Accurate determination of low concentration of chemicals is critical to emission estimates from open areas, however, relatively high detection limits and lack of quality assurance information make evaluation of accuracy impossible with the current data. The implication of large contributions to mass emissions from open areas is that atmospheric deposition may play a significant, yet unquantified, role. Agricultural land is the second largest contributor to mass emissions in northern California, while urban areas only play a dominant role with residential use pesticides. In stormwater from the Central Coast Region, agricultural lands are the largest contributors to mass emissions. Urban areas again appear to contribute the majority of residential use pesticides while open areas only appear to provide significant inputs of mercury and selenium.

The reported total suspended solid emission (Tables VII-3 & VII-4) is significant and worthy of discussion because of the likelihood that chemical contaminants are associated with suspended particles during storm events. Concentration data for particle associated chemicals are not available from northern or central California, therefore mass emissions reported in this study primarily estimate the dissolved fraction of chemical constituents entering ocean waters. Only that portion attributable to ocean dumping, via dredging operations (<0.1%), represents the particle bound fraction of the total mass emission estimate. Chemicals in the suspended load are presumed to represent a significant contribution to total mass emission of chemicals to ocean waters, however this study was unable to quantify that contribution due to absence of data.

The significance of chemical loads bound to particles should not be ignored, however, and can be demonstrated by the following. Using data from the Bay Protection and Toxic Cleanup Program the mean concentration of copper can be calculated as 45 μg/g, from 55 sediment samples collected in bays, estuaries and harbors of northern and central California. If the assumption is made that sediment in bays, estuaries and harbors primarily originates from stormwater runoff, the copper concentration in sediments can roughly be used to estimate the copper concentration in the suspended sediment load. With an estimated average concentration of copper at 45 μg/g in suspended sediments, the mass emission of copper associated with suspended solids can be estimated as 81 metric tons of copper entering ocean waters. When this value is compared to the estimated dissolved copper emissions in stormwater runoff for northern and central California (334 metric tons) it is clear that the particle associated copper load is very significant and that stormwater emissions are likely underestimated without this consideration.

Table VII-1. Comparison of estimated runoff volume to empirical runoff volume for the North Coast Region.

North Coast Region		Modeled Total Runoff Volume (m3)/yr			Empirical
HUC	Area	10th	Average	90th	Total Runoff Volume (m3)/yr
CAPE MENDOCINO	Mattole River	3.7E+08	6.2E+08	8.3E+08	9.5E+07
EEL RIVER	Lower Eel River	4.8E+07	7.9E+07	1.1E+08	5.7E+08
EUREKA PLAIN		1.1E+08	1.9E+08	2.5E+08	1.0E+08
KLAMATH RIVER	Lower Klamath River	5.1E+08	8.4E+08	1.1E+09	1.3E+09
KLAMATH RIVER	Lower Klamath River	2.1E+08	3.4E+08	4.6E+08	6.5E+08
MAD RIVER	Blue Lake	4.0E+07	6.6E+07	8.9E+07	1.2E+07
MENDOCINO COAST	Gualala River	5.2E+07	8.7E+07	1.2E+08	1.2E+07
MENDOCINO COAST	Navarro River	1.4E+08	2.4E+08	3.2E+08	3.6E+07
MENDOCINO COAST	Noyo River	1.1E+08	1.7E+08	2.3E+08	1.5E+07
REDWOOD CREEK	Orick	1.0E+08	1.7E+08	2.3E+08	7.5E+07
RUSSIAN RIVER	Lower Russian River	2.9E+07	4.8E+07	6.5E+07	1.7E+08
RUSSIAN RIVER	Upper Russian River	1.4E+08	2.4E+08	3.2E+08	2.5E+07
TRINIDAD	Little River	3.6E+07	5.9E+07	7.9E+07	1.0E+07

Table VII-2. Comparison of estimated runoff volume to empirical runoff volume for the Central Coast Region.

Central Coast Region			Modeled Total Runoff Voulume (m3)/yr			Empirical
HUC	Area	Subarea	10 th	Average	90 th	Total Runoff volume (m3)/yr
CARMEL RIVER			9.0E+06	2.2E+07	3.8E+07	7.1E+06
ESTERO BAY	Arroyo Grande	Nipomo Mesa	3.2E+06	7.8E+06	1.3E+07	7.7E+05
SALINAS	Paso Robles	Atascadero	6.0E+07	1.5E+08	2.6E+08	7.9E+06
SALINAS	Salinas Valley	Chualar	9.9E+06	2.5E+07	4.2E+07	2.3E+07
SALINAS	Salinas Valley	Soledad	1.1E+07	2.6E+07	4.6E+07	2.7E+07

Table VII-3. Comparison of annual mass emissions among sources to the coastal oceans of northern California.

North Coast Region			Percent Contribution			
Constituent	Units	Total	Runoff	POTWs***	Ocean Dumping	Industrial Facilities***
Year			Average	1997/1998	1995	1997/1998
Area	km2	3.0E+04	-	-	-	-
Flow	L x 10^9	1.3E+04	100	0.02	-	<0.1
Suspended solids**	mt	1.3E+06	100	0.47	<0.1	<0.1
BOD*	mt	2.6E+05	100	0.13	<0.1	<0.1
CBOD*	mt	-	-	-	-	-
Oil and grease	mt	-	-	-	-	-
Nitrate-N*	mt	3.7E+04	100	-	-	-
Nitrite-N*	mt	6.9E+02	100	-	-	-
Ammonia-N*	mt	2.2E+03	97	3.1	-	<0.1
Organic N	mt	-	-	-	-	-
Phosphate*	mt	2.4E+02	100	-	-	-
Total phosphorus	mt	-	-	-	-	-
Cyanide	mt	-	-	-	-	-
Arsenic	mt	-	-	-	-	-
Cadmium**	mt	1.5E+04	0.06	100	<0.1	<0.1
Chromium**	mt	7.5E+04	0.25	100	0.12	<0.1
Copper*	mt	5.1E+02	53	44	3.0	0.14
Lead**	mt	1.5E+02	46	49	5.1	0.10
Mercury*	mt	51	71	29	0.16	<0.1
Nickel**	mt	4.8E+02	52	31	17	0.13
Selenium*	mt	35	100	-	0.32	-
Silver*	mt	-	-	-	-	-
Zinc**	mt	9.0E+02	58	36	5.7	0.35
Phenols	mt	-	-	-	-	-
Chlorinated	mt	-	-	-	-	-
Nonchlorinated	mt	-	-	-	-	-
Total DDT*	mt	0.77	100	-	<0.1	-
Total PCB*	mt	3.11	100	-	-	-
Total PAH*	mt	0.41	-	-	100	-
Chlordane*	mt	0.35	100	-	<0.1	-
Dieldrin*	mt	0.61	100	-	<0.1	-
Dioxin (TCDD)*	mt	3.3E-05	-	100	-	-
Chlorpyrifos*	mt	1.1	100	-	-	-
Diazinon*	mt	0.43	100	-	-	-

-Indicate no estimate
* indicate constituent concentrations for runoff came from SCCWRP
** indicate constituent concentrations for runoff came from SFEI
***1/2 detection limits were used for ND for calculating mass emissions

Table VII-4. Comparison of annual mass emissions among sources to the coastal oceans of central California.

Central Coast Region			Percent Contribution			
Constituent	Units	Total	Runoff	POTWs***	Industrial Facilities***	Power Plants
Year			Average	1997/1998	1997/1998	1998
Area	km2	1.8E+04				
Flow	L x 10^9	1.4E+03	96	4.3	<0.1	<0.1
Suspended solids**	mt	4.7E+05	100	<0.1	<0.1	<0.1
BOD*	mt	4.0E+04	95	4.8	<0.1	-
CBOD*	mt	3.4E+02	-	98	2	-
Oil and grease	mt	-	-	-	-	-
Nitrate-N*	mt	7.4E+03	99	1.1	-	<0.1
Nitrite-N*	mt	84	100	0.12	-	-
Ammonia-N*	mt	2.4E+03	41	59	<0.1	<0.1
Organic N	mt	-	-	-	-	-
Phosphate*	mt	3.6E+02	89	11	-	<0.1
Total phosphorus	mt	-	-	-	-	-
Cyanide	mt	-	-	-	-	-
Arsenic	mt	-	-	-	-	-
Cadmium**	mt	2.7	93	6.8	<0.1	<0.1
Chromium**	mt	56	99	0.92	<0.1	<0.1
Copper*	mt	65	98	2.2	<0.1	<0.1
Lead**	mt	33	99	1.2	<0.1	<0.1
Mercury*	mt	3.0	99	1.1	<0.1	<0.1
Nickel**	mt	55	98	2.5	<0.1	<0.1
Selenium*	mt	3.9	91	9.3	<0.1	-
Silver*	mt	-	-	-	-	-
Zinc**	mt	1.9E+02	98	1.7	<0.1	<0.1
Phenols	mt	-	-	-	-	-
Chlorinated	mt	-	-	-	-	-
Nonchlorinated	mt	-	-	-	-	-
Total DDT*	mt	0.26	99	1.4	-	-
Total PCB*	mt	0.34	97	3.3	-	-
Total PAH*	mt	0.10	-	100	-	-
Chlordane*	mt	0.10	86	14	-	-
Dieldrin*	mt	0.05	97	2.5	-	-
Dioxin (TCDD)*	mt	2.2E-08	-	100	-	-
Chlorpyrifos*	mt	1.1	100	<0.1	-	-
Diazinon*	mt	0.53	100	<0.1	-	-

-indicate no estimate
* indicate constituent concentrations for runoff came from SCCWRP
** indicate constituent concentrations for runoff came from SFEI
*** 1/2 detection limits were used for ND for calculating mass emissions

Table VII-5. Total mass emissions from POTWs and industrial facilities from the North Coast Region, using NDs as detection limits, 1/2 detection limit, and zero.

Constituent	Units	TOTAL W DL	TOTAL W 1/2 DL	TOTAL W 0
Volume	L X 10^9	40	40	40
Load Total Suspended Solids (TSS)	mt	2.4E+02	2.4E+02	2.4E+02
Load Ammonia	mt	67	67	67
Load Biochemical Oxgen Demand (BOD)	mt	3.5E+02	3.5E+02	3.5E+02
Load Cadmium	mt	3.0E+04	1.5E+04	0
Load Chromium	mt	1.5E+05	7.4E+04	0.57
Load Copper	mt	2.2E+02	2.2E+02	2.2E+02
Load Mercury	mt	30	15	0
Load Nickel	mt	3.0E+02	1.5E+02	0.60
Load Lead	mt	1.5E+02	74	0
Load Zinc	mt	3.2E+02	3.2E+02	3.2E+02
Load Dioxin (TCDD)	mt	6.7E-05	3.3E-05	0

Note: Load=Mass Emission

Table VII-6. Total mass emissions from POTWs, industrial facilities, and PGS from the Central Coast Region, using NDs as detection limits, 1/2 detection limit, and zero.

Constituent	Units	TOTAL W DL	TOTAL W 1/2 DL	TOTAL W 0
Flow	L X 10^9	61	61	61
Load Total Suspended Solids	mt	1.1E+03	1.1E+03	1.1E+03
Load Nitrate	mt	81	80	79
Load Nitrite	mt	9.8E-02	9.8E-02	9.8E-02
Load Ammonia	mt	1.4E+03	1.4E+03	1.4E+03
Load Biochemical Oxgen Demand (BOD)	mt	1.9E+03	1.9E+03	1.9E+03
Load Carbonaceious Biochemical Oxgen Demand (CBOD)	mt	3.4E+02	3.4E+02	3.4E+02
Load Cadmium	mt	0.37	0.18	3.5E-04
Load Chromium (Hexavalent)	mt	0.64	0.52	0.40
Load Copper	mt	1.5	1.4	1.4
Load Mercury	mt	3.9E-02	3.3E-02	2.6E-02
Load Nickel	mt	2.2	1.4	0.53
Load Lead	mt	0.82	0.41	7.6E-04
Load Selenium	mt	0.72	0.36	5.9E-03
Load Zinc	mt	4.4	3.1	1.9
Load PCBs	mt	2.3E-02	1.1E-02	0
Load PAHs	mt	0.21	0.10	0
Load Dioxin (TCDD)	mt	4.0E-08	2.2E-08	3.3E-09
Load DDTs	mt	7.0E-03	3.5E-03	0
Load Chlordane	mt	2.9E-02	1.4E-02	0
Load Dieldrin	mt	2.6E-03	1.3E-03	0
Load Total Phosphate	mt	39	39	39

Note: Load=Mass Emission

Table VII-7. Percentages of stormwater runoff mass emissions based on land uses for the North and Central Coast Regions.

North Coast Constituent	Urban	Agriculture	Open	Central Coast Constituent	Urban	Agriculture	Open
TSS	1%	22%	77%	TSS	5%	80%	15%
Cr	2%	17%	82%	Cr	9%	72%	19%
Cd	3%	14%	83%	Cd	19%	61%	20%
Pb	15%	15%	70%	Pb	50%	40%	10%
Ni	2%	9%	89%	Ni	16%	56%	28%
Zn	9%	13%	79%	Zn	39%	46%	15%
Cu	2%	12%	86%	Cu	13%	63%	24%
Hg	1%	0%	99%	Hg	16%	2%	82%
Se	2%	1%	97%	Se	23%	13%	64%
Ammonia	4%	28%	68%	Ammonia	13%	77%	10%
BOD	1%	5%	94%	BOD	13%	44%	43%
Nitrate	1%	10%	89%	Nitrate	8%	62%	31%
Chlordane	10%	2%	87%	Chlordane	63%	13%	24%
Chlorpyrifos	51%	21%	28%	Chlorpyrifos	74%	24%	2%
DDT	2%	20%	78%	DDT	9%	75%	16%
Diazinon	44%	42%	14%	Diazinon	55%	44%	1%
Dieldrin	1%	-	99%	Dieldrin	20%	-	80%
Nitrite	4%	-	96%	Nitrite	47%	-	53%
PCB	3%	-	97%	PCB	39%	-	61%
Phosphate	32%	68%	-	Phosphate	36%	64%	-

VIII. CONCLUSION

The limited and inconsistent availability of monitoring data for surface waters in northern and central California generally lead to estimates of total mass emissions that lack the accuracy and confidence needed for effective surface water management. The modeled results reported here demonstrate that stormwater runoff is likely the largest source of chemical contaminants to ocean waters, however lack of empirical data limits the utility of this conclusion. The methods used in this study are generally adequate for gross estimation of mass emissions but dependence on inadequate data makes the accuracy of estimates questionable. Only through enhanced monitoring efforts and generation of long term data can estimates of mass emissions be refined to assess effectiveness of pollution control measures and management strategies.

IX. RECOMMENDATIONS

1) *A significant effort must be made to standardize point source monitoring programs, inter-calibrate analytical facilities, and centralize data reporting to facilitate analyses between pollutant pathways in the North and Central Coast Regions.*

   Efforts at data gathering for this research have demonstrated significant deficiencies in the methods and reporting of point source (NPDES) monitoring information. Analytical methods, analytes and reporting limits are not standardized leading to poor comparability among point source monitoring efforts. Data rarely are reported or compiled in digital format and are not centralized. Attempts to compile information are extremely laborious and compromise the utility of a vast resource of point source monitoring information. For these data to be useable for purposes other than isolated effluent management, substantial effort must be made to standardize effluent monitoring programs, inter-calibrate analytical facilities and centralize data reporting.

2) *For surface waters to be effectively monitored and managed, a consistently monitored, reported, and maintained network of stream gauging stations must be established in the North and Central Coast Regions.*

   Stormwater flow to ocean waters has been estimated in this research by computer modeling of rain runoff. This was necessary because river flow is not measured for most rivers in northern and central California. Measured flow is critical to accurate determination of river base flows and stormwater events, however, the distribution of gauging stations is sparse and in decline. For surface waters to be effectively monitored and managed, a consistently monitored, reported and maintained network of stream gauging stations must be established.

3) *Consistency among voluntary and mandated monitoring efforts should be established in the North and Central Coast Regions. Method detection limits for participating monitoring programs should be standardized, and non-detected values should be treated in a standardized manner.*

   Chemical constituents are poorly monitored in rivers, discharge waters and stormwaters of northern and central California. Stormwater runoff monitoring is not mandated for the relatively small urban areas in northern and central California. It is essential that consistency among a diverse assortment of voluntary and mandated monitoring efforts is coordinated, and appropriate analytes or chemical surrogates targeted for analysis. Detection limits must be standardized and a quality assurance system, based on regimented inter-calibration exercises, should be implemented to ensure analytical sensitivity and accuracy for participating laboratories. Where analytical methodologies are currently inadequate for detection of ambient concentrations of chemicals of concern in surface waters, integrated water sampling and pre-concentration techniques must be used. Non-detected values should be treated in a standardized manner, where needed, but the elimination of non-detectable values in data reporting should be a primary objective of improved monitoring. This can be accomplished for most constituents using current performance based techniques and pre-concentration techniques. Chemical analyses of water samples must assess both the dissolved and particulate fractions of the sample for mass emissions to be accurately determined.

4) *Long term monitoring stations at representative sites in North and Central Coast Regions should be established for trend analyses.*

   No trend analysis is possible for estimating whether mass emissions are increasing or decreasing in the North Coast or Central Coast Regions. A commitment should be made to establish long term monitoring stations at representative sites in northern and central California. This will provide critical information for assessing the effectiveness of mass emission management strategies.

X. REFERENCES

California Department of Fish and Game (CDFG). 1998. California Watershed Map (Calwater 2.0) Computer Database. 9 October 1999. <http://ceres.ca.gov/catalog/bin/show_record?record=433>.

California Gap Analysis Project (CA-GAP). 1998. California Gap Analysis Project Interactive CD-ROM. 1 March 2000. <http://www.biogeog.ucsb.edu/projects/gap/gap_cdrom.html>.

California Rivers Assessment (CARA). 1997. California Rivers Assessment Interactive Web Database. Ed. Scott Clemons. <http://endeavor.des.ucdavis.edu/newcara/>.

Daly, C., R.P. Neilson, and D.L. Phillips. 1994. A statistical-topographic model formapping climatological precipitation over mountainous terrain. Journal of Applied Meteorology 33: 140-158. <http://www.ocs.orst.edu/prism/state_products/ca_maps.html>.

Daly, C., G.H. Taylor, and W.P. Gibson. 1997. The PRISM approach to mapping precipitation and temperature, In reprints: 10th Conf. on Applied Climatology, Reno, NV, American Meteorological Society, 10-12. <http://www.ocs.orst.edu/prism/state_products/ca_maps.html>.

Department of Water Resources (DWR). 1993. Dams within jurisdiction of the State of California. Department of Water Resources Bulletin 17. 2 February 1996. <http://elib.cs.berkeley.edu/kopec/b17/html/home.html>.

Downing, J., R. Fairey, C. Roberts, E. Landrau, R. Clark, J. Hunt, B. Anderson, B. Phillips, C. Wilson, F. LaCaro, G. Kapahi, K. Worcester, M. Stephenson, and M. Puckett. 1998. Chemical and biological measures of sediment quality in the Central Coast Region. Sacramento, CA. 96pp.

Jacobi, M., R. Fairey, C. Roberts, E. Landrau, J. Hunt, B. Anderson, B. Phillips, C. Wilson, G. Kapahi, F. LaCaro, B. Gwynne, M. Stephenson, and M. Puckett. 1998. Chemical and biological measures of sediment quality and tissue bioaccumulation in the North Coast Region. California State Water Resources Control Board. Sacramento, CA. 211pp.

Ladd, J., S. Hayes, M. Martin, M. Stephenson, s. Coale, J. Linfield, and M. Brown. 1984. California State Mussel Watch: 1981-1983 biennial report. State Water Resources Control Board. Water Quality Monitoring Report No. 83-6TS. Sacramento, CA.

National Climatic Data Center (NCDC). 1995. Summary of the Day-First Order. National Climatic Data Center Dataset Documentation. 16 February 2000. <http://www4.ncdc.noaa.gov/ol/documentlibrary/datasets.html>.

Rasmussen, D. 1996. State Mussel Watch Program Data Report 1993-1995. State Water Resources Control Board Water Quality Report 96-2 WQ 75pp.

Rasmussen, D. 1995. State Mussel Watch Program Data Report 1987-1993. State Water Resources Control Board Water Quality Report 94-1 WQ 303pp.

Regional Water Quality Control Board (RWQCB). 2000. San Lorenzo River Watershed Total Maximum Daily Load for Nitrate Santa Cruz, California. Draft Report. Central Coast Regional Water Quality Control Board. Sacramento, CA. 86pp.

Regional Water Quality Control Board (RWQCB). 1994. Basin Plan for the Central Coast Region. Central Coast Regional Quality Control Board.

Regional Water Quality Control Board (RWQCB). 1993. Basin Plan for the North Coast Region. North Coast Regional Water Quality Control Board.

Regional Water Quality Control Board (RWQCB). 1991. North Coast Region Regional Monitoring Plan; Surveillance, Monitoring, and Planning Unit. North Coast Regional Water Control Board.

Schiff, K. and J. Cross. 1992. Estimates of ocean disposal inputs to the southern California Bight. pp. 39-88, In: Cross, J. and C. Francisco (eds.), Southern California Coastal Water Research Project Annual Report 1990-91 and 1991-92. Long Beach, CA

State Water Resources Control Board (SWRCB) and California Coastal Commission (CCC). 2000. Plan for California's nonpoint source pollution control program. State Water Resources Control Board and the California Coastal Commission. Sacramento, CA.

State Water Resources Control Board (SWRCB). 1998. 1998 CWA Section 305(b) Report on Water Quality. State Water Resources Control Board, Division of Water Quality, Sacramento, CA.

Stephenson, M.D., S.L. Coale, M. Martin, and J.H. Martin. 1980. California State Mussel Watch 1979-1980. Trace metal concentrations in the California mussel *Mytilus californianus* and the Bay mussel, *Mytilus edulis*, along the California coast and selected harbors and bays. California State Water Resources Control Board. Water Quality Monitoring Report No. 80-8.

United States Army Corps of Engineers (USACE). 1999. Ocean Disposal Database (ODD). 1 January 2000. <http://www.wes.army.mil/el/dots/database.html>.

United States Army Corps of Engineers (USACE). 1991. Bioassay, bioaccumulation, and chemistry of sediments from Humboldt Bay Harbor (Draft Report). E.V.S._Project no: 4/274-10.9. Prepared by E.V.S. Consultants, Inc. for U.S. Army Corp San Francisco Division.

United States Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA). 1998. Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual. EPA-503/8-91/001, Washington, DC.

United States Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA). 1991. Evaluation of Dredged Material Proposed for Discharge in Water of the U.S.-Testing Manual. EPA-823-B98-004, Washington, DC.

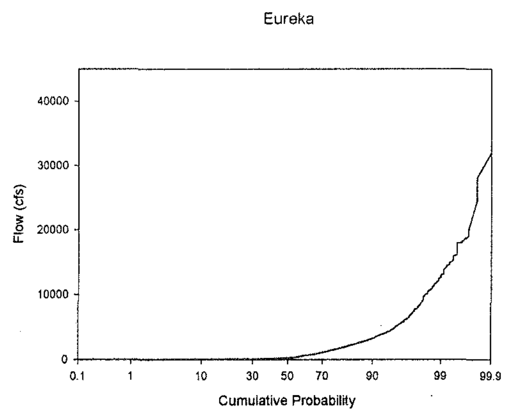
Watershed Institute, California State University Monterey Bay, and Moss Landing Marine Laboratories. 1997. Comprehensive watershed management solutions to nonpoint source pollution in the Salinas Valley and Pajaro River Basin. Final Report. Central Coast Regional Water Quality Control Board. 1995 319h Grant contract No. 5-069-253-0. 57pp.

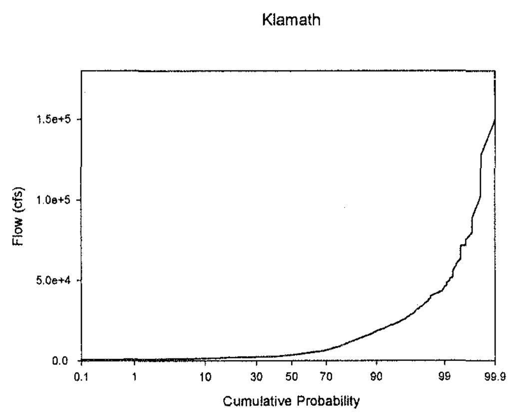
Watkins, D., C. Reiner, and D. Crane. 1984. Toxic substances monitoring program. 1983. Data Report. California Department of Fish and Game. Laboratory Report No. 84-2.

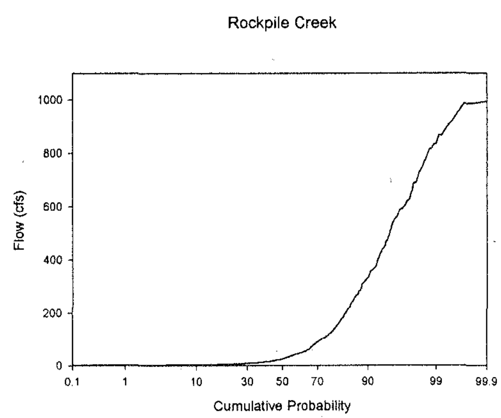
Appendix C1:

Stormwater Runoff Data

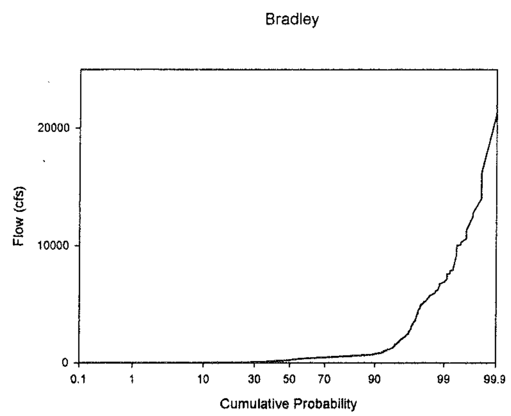
Cumulative Plots
North Coast Region

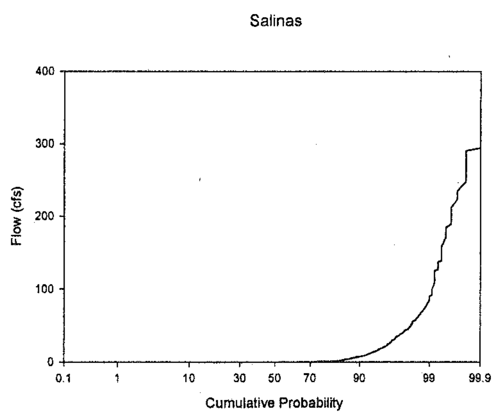


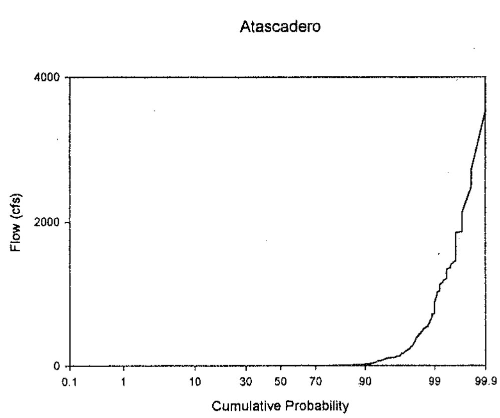




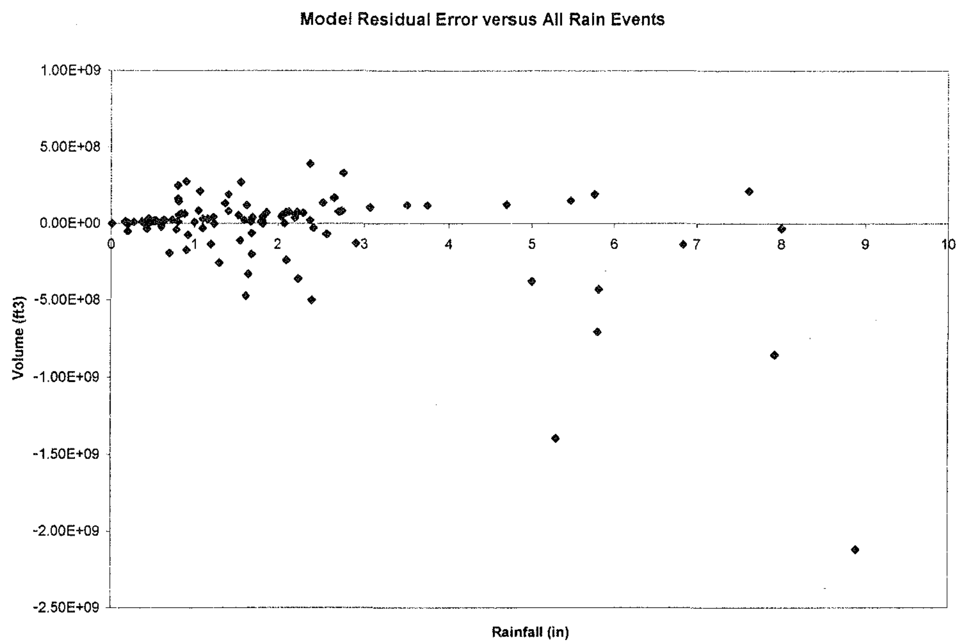
Central Coast Region

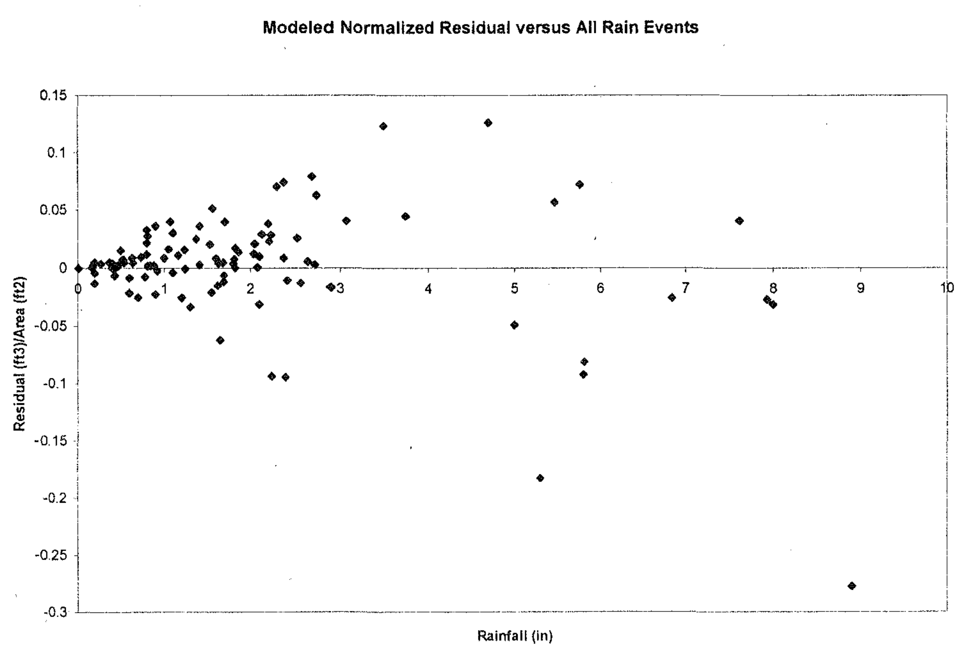






Residual Plots





Total estimated runoff volume and percentages for the North Coast Region

North Coast Region			Runoff volumes by land use (m3)				
HUC Name	**Area Name**	**Subarea Name**	**Urban**	**Ag**	**Open**	**T Runoff Vol (m3)**	**T HUC vol (m3)**
CAPE MENDOCINO	Capetown		0	4.7E+07	1.0E+08	1.5E+08	
CAPE MENDOCINO	Mattole River		4.8E+06	4.1E+07	5.7E+08	6.2E+08	
CAPE MENDOCINO	Oil Creek		0	9.5E+06	1.4E+07	2.4E+07	7.9E+08
EEL RIVER	Lower Eel River	Ferndale	0	3.3E+07	9.0E+07	1.2E+08	
EEL RIVER	Lower Eel River	Larabee Creek	0	0	1.0E+08	1.0E+08	
EEL RIVER	Lower Eel River	Scotia	0	6.3E+05	7.8E+07	7.9E+07	
EEL RIVER	Middle Fork Eel River	Black Butte River	0	0	2.3E+08	2.3E+08	
EEL RIVER	Middle Fork Eel River	Eden Valley	0	0	2.3E+08	2.3E+08	
EEL RIVER	Middle Fork Eel River	Round Valley	7.3E+06	0	1.1E+08	1.2E+08	
EEL RIVER	Middle Fork Eel River	Wilderness	0	0	3.0E+08	3.0E+08	
EEL RIVER	Middle Main Eel River	Sequoia	0	0	2.1E+08	2.1E+08	
EEL RIVER	Middle Main Eel River	Spy Rock	0	0	4.8E+08	4.8E+08	
EEL RIVER	North Fork Eel River		0	0	3.3E+08	3.3E+08	
EEL RIVER	South Fork Eel River	Benbow	1.1E+07	2.8E+06	1.3E+08	1.4E+08	
EEL RIVER	South Fork Eel River	Weott	1.0E+04	1.5E+06	2.0E+08	2.0E+08	
EEL RIVER	Upper Main Eel River	Outlet Creek	9.6E+06	0	1.7E+08	1.8E+08	
EEL RIVER	Upper Main Eel River	Tomki Creek	0	0	2.0E+08	2.0E+08	
EEL RIVER	Van Duzen River	Bridgeville	0	0	3.3E+08	3.3E+08	
EEL RIVER	Van Duzen River	Hydesville	0	0	3.5E+07	3.5E+07	
EEL RIVER	Van Duzen River	Yager Creek	0	0	1.6E+08	1.6E+08	3.4E+09
EUREKA PLAIN			2.1E+07	4.1E+06	1.6E+08	1.9E+08	1.9E+08
KLAMATH RIVER	Lower Klamath River	Klamath Glen	6.9E+06	0	8.4E+08	8.4E+08	
KLAMATH RIVER	Lower Klamath River	Orleans	2.0E+06	0	3.4E+08	3.4E+08	
KLAMATH RIVER	Middle Klamath River	Beaver Creek	8.2E+05	3.6E+06	1.4E+08	1.5E+08	
KLAMATH RIVER	Middle Klamath River	Happy Camp	0	1.1E+06	2.9E+08	2.9E+08	
KLAMATH RIVER	Middle Klamath River	Hornbrook	5.1E+05	7.9E+06	4.4E+07	5.3E+07	
KLAMATH RIVER	Middle Klamath River	Iron Gate	0	0	7.8E+06	7.8E+06	
KLAMATH RIVER	Middle Klamath River	Seiad Valley	0	9.8E+05	1.2E+08	1.3E+08	
KLAMATH RIVER	Middle Klamath River	Ukonom	0	0	6.6E+08	6.6E+08	
KLAMATH RIVER	Salmon River	Cecilville	0	0	2.3E+08	2.3E+08	
KLAMATH RIVER	Salmon River	Lower Salmon	0	0	1.2E+08	1.2E+08	
KLAMATH RIVER	Salmon River	Sawyers Bar	0	0	2.2E+08	2.2E+08	
KLAMATH RIVER	Salmon River	Wooley Creek	0	0	1.7E+08	1.7E+08	
KLAMATH RIVER	Scott River	Scott Bar	0	0	1.0E+08	1.0E+08	
KLAMATH RIVER	Scott River	Scott Valley	6.2E+05	3.4E+07	2.7E+08	3.1E+08	
KLAMATH RIVER	Shasta Valley		4.6E+06	2.4E+07	1.8E+08	2.1E+08	3.8E+09

MAD RIVER	Blue Lake		1.4E+07	4.4E+06	4.8E+07	6.6E+07	
MAD RIVER	Butler Valley		0	0	3.2E+08	3.2E+08	

Total estimated runoff volume and percentages for the North Coast Region (continued)

North Coast Region			Runoff volumes by land use (m3)				
HUC Name	Area Name	Subarea Name	Urban	Ag	Open	T Runoff Vol (m3)	T HUC vol (m3)
MAD RIVER	North Fork Mad River		0	0	5.9E+07	5.9E+07	
MAD RIVER	Ruth		0	0	2.3E+07	2.3E+07	4.7E+08
MENDOCINO COAST	Albion River		1.9E+06	8.0E+05	5.0E+07	5.3E+07	
MENDOCINO COAST	Big River		1.1E+06	3.3E+04	1.6E+08	1.6E+08	
MENDOCINO COAST	Garcia River		0	0	1.3E+08	1.3E+08	
MENDOCINO COAST	Gualala River	Buckeye Creek	0	0	3.5E+07	3.5E+07	
MENDOCINO COAST	Gualala River	Gualala	0	0	8.7E+07	8.7E+07	
MENDOCINO COAST	Gualala River	Norh Fork	3.4E+05	0	4.2E+07	4.2E+07	
MENDOCINO COAST	Gualala River	Rockpile Creek	1.0E+06	0	3.0E+07	3.1E+07	
MENDOCINO COAST	Gualala River	Wheatfield Fork	0	0	1.1E+08	1.1E+08	
MENDOCINO COAST	Navarro River		5.1E+05	1.4E+06	2.3E+08	2.4E+08	
MENDOCINO COAST	Noyo River		6.0E+06	5.2E+05	1.7E+08	1.7E+08	
MENDOCINO COAST	Point Arena	Alder Creek	0	0	3.3E+07	3.3E+07	
MENDOCINO COAST	Point Arena	Brush Creek	0	0	1.9E+07	1.9E+07	
MENDOCINO COAST	Point Arena	Elk Creek	0	0	2.5E+07	2.5E+07	
MENDOCINO COAST	Point Arena	Greenwood Creek	0	5.7E+05	2.7E+07	2.8E+07	
MENDOCINO COAST	Rockport	Ten Mile River	0	1.1E+04	1.4E+08	1.4E+08	
MENDOCINO COAST	Rockport	Usal Creek	0	4.0E+06	5.1E+07	5.5E+07	
MENDOCINO COAST	Rockport	Wages Creek	0	4.1E+06	6.7E+07	7.1E+07	
MENDOCINO COAST	Russian Gulch		0	0	1.5E+07	1.5E+07	1.4E+09
REDWOOD CREEK	Beaver		0	0	1.4E+08	1.4E+08	
REDWOOD CREEK	Lake Prairie		0	0	1.0E+08	1.0E+08	
REDWOOD CREEK	Orick		0	0	1.7E+08	1.7E+08	4.1E+08
RUSSIAN RIVER	Lower Russian River	Austin Creek	1.1E+06	0	6.1E+07	6.2E+07	
RUSSIAN RIVER	Lower Russian River	Guerneville	0	0	4.8E+07	4.8E+07	
RUSSIAN RIVER	Upper Russian River	Forsythe Creek	9.9E+06	8.4E+06	6.2E+07	8.0E+07	
RUSSIAN RIVER	Upper Russian River	Ukiah	2.2E+07	2.1E+07	2.0E+08	2.4E+08	4.3E+08
SMITH RIVER	Lower Smith River	Mill Creek	0	0	5.7E+07	5.7E+07	
SMITH RIVER	Lower Smith River	Rowdy Creek	0	0	5.4E+07	5.4E+07	
SMITH RIVER	Lower Smith River	Smith River Plain	5.2E+06	1.3E+06	1.4E+08	1.4E+08	
SMITH RIVER	Middle Fork Smith River		7.7E+06	0	3.0E+08	3.0E+08	
SMITH RIVER	North Fork Smith River		0	0	1.5E+08	1.5E+08	

SMITH RIVER	South Fork Smith River	0	0	5.9E+08	5.9E+08	
SMITH RIVER	Wilson Creek	0	0	3.2E+07	3.2E+07	1.3E+09

Total estimated runoff volume and percentages for the North Coast Region (continued)

North Coast Region			Runoff volumes by land use (m3)				
HUC Name	**Area Name**	**Subarea Name**	**Urban**	**Ag**	**Open**	**T Runoff Vol (m3)**	**T HUC vol (m3)**
TRINIDAD	Big Lagoon		0	1.6E+06	9.7E+07	9.9E+07	
TRINIDAD	Little River		2.6E+06	0	5.7E+07	5.9E+07	1.6E+08
WINCHUCK RIVER			0	0	3.2E+07	3.2E+07	3.2E+07
Totals			**1.4E+08**	**2.6E+08**	**1.2E+10**	**1.3E+10**	

Total Runoff Volumes and Percentages for the Central Coast Region

Central Coast Region			Runoff volumes by land use (m3)				
HUC Name	Area Name	Subarea Name	Urban	Ag	Open	T Runoff Vol (m3)	T HUC vol (m3)
BIG BASIN	Ano Nuevo		0	2.5E+06	6.6E+06	9.2E+06	
BIG BASIN	Santa Cruz	Aptos-Soquel	1.3E+07	9.0E+06	1.5E+07	3.7E+07	
BIG BASIN	Santa Cruz	Davenport	2.7E+06	1.0E+07	3.2E+07	4.4E+07	
BIG BASIN	Santa Cruz	San Lorenzo	3.8E+07	3.7E+06	3.4E+07	7.5E+07	1.7E+08
BOLSA NEUVA			7.5E+06	7.8E+06	2.8E+06	1.8E+07	1.8E+07
CARMEL RIVER			4.8E+06	1.6E+06	1.6E+07	2.2E+07	2.2E+07
ESTERO BAY	Arroyo Grande	Nipomo Mesa	4.4E+06	2.8E+06	6.2E+05	7.8E+06	
ESTERO BAY	Arroyo Grande	Oceano	1.2E+07	6.1E+06	5.0E+06	2.3E+07	
ESTERO BAY	Cambria	Arroyo De La Cruz	0	0	7.1E+06	7.1E+06	
ESTERO BAY	Cambria	Cayucos	0	6.6E+04	2.1E+06	2.2E+06	
ESTERO BAY	Cambria	Old	0	0	2.7E+05	2.7E+05	
ESTERO BAY	Cambria	San Carpoforo	0	1.8E+05	7.9E+06	8.0E+06	
ESTERO BAY	Cambria	San Simeon	9.2E+05	0	0	9.2E+05	
ESTERO BAY	Cambria	Santa Rosa	2.6E+06	6.9E+05	5.8E+06	9.1E+06	
ESTERO BAY	Cambria	Toro	2.6E+05	9.1E+04	0	3.5E+05	
ESTERO BAY	Cambria	Villa	0	2.1E+05	0	2.1E+05	
ESTERO BAY	Point Buchon	Chorro	2.0E+06	1.0E+06	6.1E+06	9.1E+06	
ESTERO BAY	Point Buchon	Los Osos	3.1E+06	1.9E+06	2.4E+06	7.4E+06	
ESTERO BAY	Point Buchon	Morro	1.5E+06	8.3E+05	3.5E+06	5.8E+06	
ESTERO BAY	Point Buchon	Pismo	8.9E+05	1.5E+06	4.5E+06	6.9E+06	
ESTERO BAY	Point Buchon	Point San Luis	1.6E+05	4.9E+05	6.5E+06	7.2E+06	
ESTERO BAY	Point Buchon	San Luis Obispo Creek	6.5E+06	4.5E+06	9.7E+06	2.1E+07	1.2E+08
PAJARO RIVER	Pacheco-Santa Ana Creek		4.6E+05	1.0E+06	1.8E+07	1.9E+07	
PAJARO RIVER	San Benito River		0	7.7E+06	6.4E+07	7.1E+07	
PAJARO RIVER	Santa Cruz Mountains		3.2E+06	3.2E+06	2.2E+07	2.8E+07	
PAJARO RIVER	South Santa Clara Valley		2.2E+07	4.2E+07	5.1E+06	6.8E+07	
PAJARO RIVER	Watsonville		2.0E+07	2.6E+07	6.2E+06	5.1E+07	2.4E+08
SALINAS	Arroyo Seco		2.2E+05	4.8E+05	7.2E+07	7.2E+07	
SALINAS	Gabilan Range		1.6E+06	1.4E+07	8.5E+07	1.0E+08	
SALINAS	Monterey Peninsula		6.0E+06	7.5E+05	4.0E+06	1.1E+07	
SALINAS	Paso Robles	Atascadero	1.8E+07	3.0E+07	1.0E+08	1.5E+08	
SALINAS	Salinas Valley	Chualar	1.2E+06	2.0E+07	3.1E+06	2.5E+07	
SALINAS	Salinas Valley	El Toro	1.3E+06	5.6E+05	2.8E+06	4.6E+06	

SALINAS	Salinas Valley	Lower Salinas Valley	5.5E+06	2.1E+07	7.4E+05	2.8E+07	
SALINAS	Salinas Valley	Monterey	8.7E+06	6.3E+05	0	9.3E+06	

Total Runoff Volumes and Percentages for the Central Coast Region

Central Coast Region			**Runoff volumes by land use (m3)**					
HUC Name	**Area Name**	**Subarea Name**	**Urban**	**Ag**	**Open**	**T Runoff Vol (m3)**	**T HUC vol (m3)**	
SALINAS	Salinas Valley	Moro Cojo	2.6E+06	2.3E+06	3.6E+05	5.2E+06		
SALINAS	Salinas Valley	Prunedale	2.5E+06	9.2E+05	7.4E+05	4.2E+06		
SALINAS	Salinas Valley	Soledad	3.2E+05	2.3E+07	3.1E+06	2.6E+07		
SALINAS	Salinas Valley	Upper Salinas Valley	2.1E+06	1.9E+07	1.6E+06	2.3E+07	4.6E+08	
SAN ANTONIO			1.9E+06	3.1E+06	2.1E+07	2.6E+07	2.6E+07	
SANTA MARIA	Cuyama Valley		0	0	2.1E+06	2.1E+06		
SANTA MARIA	Guadalupe		1.2E+07	2.5E+07	1.0E+07	4.8E+07		
SANTA MARIA	Sisquoc		3.7E+06	4.5E+06	6.7E+07	7.5E+07	1.2E+08	
SANTA LUCIA			1.4E+06	7.4E+05	1.1E+08	1.2E+08	1.2E+08	
SANTA YNEZ	Buellton		3.4E+05	3.7E+06	8.9E+06	1.3E+07		
SANTA YNEZ	Lompoc		4.9E+06	6.3E+06	8.4E+06	2.0E+07		
SANTA YNEZ	Los Olivos		1.1E+06	7.9E+06	1.4E+07	2.4E+07		
SANTA YNEZ	Santa Rita		0	9.1E+06	1.2E+07	2.1E+07	7.7E+07	
Totals							**2.2E+08**	**3.3E+08**
						8.1E+08	**1.4E+09**	

Runoff mass emission flux by land use for the North Coast Region

North Coast Region Units in kg/km2	Urban	Agriculture	Open	Total
TSS	63478	330185	35879	44648
Ammonia	323	655	49	70
Nitrate	1421	3986	1164	1243
Nitrite	99	-	23	23
Phosphate	294	183	-	8
BOD	12557	14688	8634	8790
Cd	1.19	1.35	0.25	0.29
Cr	13	35	5	6
Cu	21	35	8	9
Hg	1.22	0.05	1	1
Ni	22	26	8	8
Pb	41	11	2	2
Se	2.04	0.42	1.17	1.15
Zn	176	74	14	17
Chlordane	0.14	0.01	0.01	0.01
Chlorpyrifos	2.13	0.25	0.01	0.04
DDT	0.06	0.17	0.02	0.03
Diazinon	0.73	0.20	0.00	0.01
Dieldrin	0.03	-	0.02	0.02
PCB	0.32	-	0.11	0.10

Runoff mass emission flux by land use for the Central Coast Region

Central Coast Region **Units in kg/km2**	**Urban**	**Agriculture**	**Open**	**Total**
TSS	27559	143335	4952	25477
Ammonia	140	284	7	53
Nitrate	617	1730	161	398
Nitrite	43	-	3	5
Phosphate	128	80	-	18
BOD	5452	6376	1192	2079
Cd	0.52	0.59	0.03	0.14
Cr	6	15	0.73	3
Cu	9	15	1	3
Hg	0.53	0.02	0.17	0.16
Ni	9	11	1	3
Pb	17865	4907	231	1760
Se	0.89	0.18	0.16	0.19
Zn	77	32	2	10
Chlordane	0.06	0.004	0.001	0.005
Chlorpyrifos	0.92	0.11	0.001	0.06
DDT	0.02	0.07	0.003	0.01
Diazinon	0.32	0.09	0.0003	0.03
Dieldrin	0.01	-	0.003	0.003
PCB	0.14	-	0.01	0.02

Appendix C2:

Publicly Owned Treatment Works Data

Project	Arcata	Arcata DL	Arcata 1/2DL	Arcata 0	Eureka	Eureka DL	Eureka 1/2 DL	Eureka 0	Crescent City	Crescent City Seafood
Flow (GD)	3.9E+06				7.7E+06				2.3E+06	6.6E+04
Flow (L)	5.4E+09				1.1E+10				3.2E+09	9.1E+07
TSS (mt)	1.9E+02				NA				3.2E+01	1.8E+01
Ammonia (mt)	NA				NA				NA	NA
BOD (mt)	1.6E+02				7.7E+01				5.8E+01	NA
Cd (mt)	NA				ND	1.1E+04	5.3E+03	0	NA	NA
Cr (mt)	NA				ND	5.3E+04	2.7E+04	0	NA	NA
Cu (mt)	NA				2.2E+02				NA	NA
Hg (mt)	NA				ND	1.1E+01	5.3E+00	0	NA	NA
Ni (mt)	NA				ND	1.1E+02	5.3E+01	0	NA	NA
Pb (mt)	NA				ND	5.3E+01	2.7E+01	0	NA	NA
Zn (mt)	NA				3.2E+02				NA	NA
TCDD (mt)	NA				NA				NA	NA
T Coliform (MPN)	ND	1.1E+11	5.4E+10	0	NA				NA	NA
Fecal Coli (MPN)	ND	1.1E+11	5.4E+10	0	NA				2.2E+11	NA

(Continued from above)

Project	Fort Bragg	Louis Pac (outfall 001)	Louis Pac DL	Louis Pac 1/2 DL	Louis Pac 0 DL	TOTAL W DL	TOTAL W 1/2 DL	TOTAL W 0
Flow (GD)	9.2E+05	1.4E+07				2.9E+07	2.9E+07	2.9E+07
Flow (L)	1.3E+09	1.9E+10				4.0E+10	4.0E+10	4.0E+10
TSS (mt)	NA	2.1E+00				2.4E+02	2.4E+02	2.4E+02
Ammonia (mt)	2.3E+01	4.9E+01				6.7E+01	6.7E+01	6.7E+01
BOD (mt)	4.8E+01	3.6E+00				3.5E+02	3.5E+02	3.5E+02
Cd (mt)	NA	ND	1.9E+04	9.5E+03	0	3.0E+04	1.5E+04	0
Cr (mt)	NA	ND	9.5E+04	4.8E+04	0	1.5E+05	7.4E+04	0
Cu (mt)	NA	NA				2.2E+02	2.2E+02	2.2E+02
Hg (mt)	NA	ND	1.9E+01	9.5E+00	0	3.0E+01	1.5E+01	0
Ni (mt)	NA	ND	1.9E+02	9.5E+01	0	3.0E+02	1.5E+02	0
Pb (mt)	NA	ND	9.5E+01	4.8E+01	0	1.5E+02	7.4E+01	0
Zn (mt)	NA	NA				3.2E+02	3.2E+02	3.2E+02
TCDD (mt)	NA	ND	6.7E-05	3.3E-05	0	6.7E-05	3.3E-05	0
T Coliform (MPN)	2.2E+12	NA				2.4E+12	2.3E+12	2.2E+12
Fecal Coli (MPN)	NA	NA				3.3E+11	2.7E+11	2.2E+11

Appendix C3:

Industrial Discharger Data

Project	Avila	Highlands San	Highlands San DL	Highlands San 1/2 DL	Highlands San 0	San Simeon	Carmel	Carmel DL	Carmel 1/2DL
Flow (GD)	5.6E+04	5.7E+03	5.7E+03	5.7E+03	5.7E+03	6.1E+04	2.4E+06	2.4E+06	2.4E+06
Flow (L)	7.7E+07	7.9E+06	7.9E+06	7.9E+06	7.9E+06	8.5E+07	3.3E+09	3.3E+09	3.3E+09
TSS (mt)	6.2E-01	3.9E-01				3.9E-01	2.8E+01		
Nitrate (mt)	NA	NA				NA	7.9E+01		
Nitrite (mt)	NA	NA				NA	9.8E-02		
Ammonia (mt)	NA	2.3E-01				NA	1.8E+00		
BOD (mt)	1.4E+00	3.1E-01				4.2E-01	1.3E+01		
CBOD (mt)	NA	NA				NA	NA		
Cd (mt)	NA	ND	3.9E-05	2.0E-05	0	3.2E-04	ND	2.0E-02	1.0E-02
Cr (mt)	NA	ND	3.9E-05	2.0E-05	0	6.5E-04	1.3E-01		
Cu (mt)	NA	0.000346524				1.3E-03	7.5E-02		
Hg (mt)	NA	ND	1.6E-06	7.9E-07	0	1.3E-03	ND	8.1E-04	4.1E-04
Ni (mt)	NA	ND	3.9E-05	2.0E-05	0	6.6E-03	2.1E-01		
Pb (mt)	NA	1.65386E-05				6.5E-04	ND	6.5E-02	3.3E-02
Se (mt)	NA	ND	3.2E-05	1.6E-05	0	6.8E-04	NA		
Zn (mt)	NA	0.000748177				6.6E-03	3.3E-01		
PCBs (mt)	NA	NA				NA	ND	1.3E-03	6.5E-04
PAHs (mt)	NA	NA				NA	NA		
TCDD (mt)	NA	NA				NA	NA		
DDTs (mt)	NA	NA				NA	ND	3.3E-04	1.7E-04
Chlordane (mt)	NA	NA				NA	ND	1.6E-03	8.1E-04
Dieldrin (mt)	NA	NA				NA	ND	1.1E-04	5.7E-05
T Phosphate (mt)	NA	NA				NA	NA		
T Coliform (MPN)	2.6E+10	3.6E+10				2.5E+09	1.0E+12		
Fecal Coli (MPN)	NA	NA				NA	NA		
Entero (MPN)	NA	NA				NA	NA		

Project	Project	Carmel 0	Pismo Beach	Santa Cruz	Santa Cruz DL	Santa Cruz 1/2 DL	Santa Cruz 0	Watsonville	Watsonville DL
Flow (GD)	Flow (GD)	2.4E+06	1.2E+06	1.1E+07	1.1E+07	1.1E+07	1.1E+07	7.4E+06	7.4E+06
Flow (L)	Flow (L)	3.3E+09	1.7E+09	1.5E+10	1.5E+10	1.5E+10	1.5E+10	1.0E+10	1.0E+10
TSS (mt)	TSS (mt)		1.9E+01	4.4E+02				8.6E+01	
Nitrate (mt)	Nitrate (mt)		NA	ND	1.5E+00	7.3E-01	0	NA	
Nitrite (mt)	Nitrite (mt)		NA	NA				NA	
Ammonia (mt)	Ammonia (mt)		1.3E+01	6.0E+02				1.1E+02	
BOD (mt)	BOD (mt)		3.8E+01	1.6E+03				1.9E+02	
CBOD (mt)	CBOD (mt)		NA	NA				NA	
Cd (mt)	Cd (mt)	0	0	ND	1.5E-01	7.3E-02	0	ND	5.1E-02
Cr (mt)	Cr (mt)		0	2.6E-01				ND	1.0E-01
Cu (mt)	Cu (mt)		8.6E-03	1.1E+00				ND	1.0E-01
Hg (mt)	Hg (mt)	0	0	ND	2.9E-03	1.5E-03	0	ND	4.1E-03
Ni (mt)	Ni (mt)		0	ND	1.5E+00	7.3E-01	0	3.1E-01	
Pb (mt)	Pb (mt)	0	0	ND	7.3E-02	3.6E-02	0	ND	5.1E-01
Se (mt)	Se (mt)		0	ND	7.3E-02	3.6E-02	0	ND	5.1E-01
Zn (mt)	Zn (mt)		3.0E-01	ND	2.2E+00	1.1E+00	0	2.0E-01	
PCBs (mt)	PCBs (mt)	0	0	ND	7.3E-03	3.6E-03	0	NA	
PAHs (mt)	PAHs (mt)		0	ND	7.3E-02	3.6E-02	0	NA	
TCDD (mt)	TCDD (mt)		0	2.9E-09				ND	3.7E-08
DDTs (mt)	DDTs (mt)	0	0	ND	2.2E-03	1.1E-03	0	ND	4.1E-04
Chlordane (mt)	Chlordane (mt)	0	0	ND	7.3E-03	3.6E-03	0	ND	5.1E-03
Dieldrin (mt)	Dieldrin (mt)	0	0	ND	7.3E-04	3.6E-04	0	ND	4.1E-04
T Phosphate (mt)	T Phosphate (mt)		NA	3.9E+01				NA	
T Coliform (MPN)	T Coliform (MPN)		NA	6.9E+14				9.4E+14	
Fecal Coli (MPN)	Fecal Coli (MPN)		3.4E+11	4.4E+13				2.5E+15	
Entero (MPN)	Entero (MPN)		NA	1.4E+14				NA	

Project	Watsonville 1/2 DL	Watsonville 0	Scotts Valley	Highlands Inn	Morro/Cayucos	Morro/Cayucos DL	Morro/Cayucos 1/2 DL
Flow (GD)	7.4E+06	7.4E+06	9.8E+05	2.1E+04	1.4E+06	1.4E+06	1.4E+06
Flow (L)	1.0E+10	1.0E+10	1.4E+09	2.9E+07	2.0E+09	2.0E+09	2.0E+09
TSS (mt)			2.4E+01	4.7E-01	7.8E+01		
Nitrate (mt)			NA	NA	NA		
Nitrite (mt)			NA	NA	NA		
Ammonia (mt)			2.2E+01	2.2E-02	4.1E+01		
BOD (mt)			2.8E+01	5.0E-01	9.1E+01		
CBOD (mt)			1.2E+01	NA	NA		
Cd (mt)	2.5E-02	0	NA	2.4E-05	ND	1.2E-02	6.2E-03
Cr (mt)	5.1E-02	0	NA	1.2E-03	2.8E-03		
Cu (mt)	5.1E-02	0	NA	1.1E-03	ND	2.0E-02	9.9E-03
Hg (mt)	2.0E-03	0	NA	2.4E-02	ND	4.9E-04	2.5E-04
Ni (mt)			NA	7.0E-04	ND	7.3E-02	3.6E-02
Pb (mt)	2.5E-01	0	NA	8.7E-05	ND	4.0E-02	2.0E-02
Se (mt)	2.5E-01	0	NA	1.2E-04	5.1E-03		
Zn (mt)			NA	1.1E-03	ND	3.0E-01	1.5E-01
PCBs (mt)			NA	NA	ND	4.0E-04	2.0E-04
PAHs (mt)			NA	NA	NA		
TCDD (mt)	1.8E-08	0	NA	NA	NA		
DDTs (mt)	2.0E-04	0	NA	NA	ND	9.9E-06	4.9E-06
Chlordane (mt)	2.5E-03	0	NA	NA	ND	9.9E-04	4.9E-04
Dieldrin (mt)	2.0E-04	0	NA	NA	ND	9.9E-06	4.9E-06
T Phosphate (mt)			NA	NA	NA		
T Coliform (MPN)			2.4E+14	8.7E+08	NA		
Fecal Coli (MPN)			3.6E+13	1.1E+09	NA		
Entero (MPN)			8.5E+13	NA	NA		

Project	Morro/Cayucos 0	MRWPCA	MRWPCA DL	MRWPCA 1/2 DL	MRWPCA 0	TOTAL W DL	TOTAL W 1/2 DL	TOTAL W 0
Flow (GD)	1.4E+06	2.0E+07	2.0E+07	2.0E+07	2.0E+07	4.4E+07	4.4E+07	4.4E+07
Flow (L)	2.0E+09	2.7E+10	2.7E+10	2.7E+10	2.7E+10	6.0E+10	6.0E+10	6.0E+10
TSS (mt)		3.6E+02				1.0E+03	1.0E+03	1.0E+03
Nitrate (mt)		NA				8.1E+01	8.0E+01	7.9E+01
Nitrite (mt)		NA				9.8E-02	9.8E-02	9.8E-02
Ammonia (mt)		6.2E+02				1.4E+03	1.4E+03	1.4E+03
BOD (mt)		NA				1.9E+03	1.9E+03	1.9E+03
CBOD (mt)		3.2E+02				3.4E+02	3.4E+02	3.4E+02
Cd (mt)	0	ND	1.4E-01	6.8E-02	0	3.7E-01	1.8E-01	3.5E-04
Cr (mt)		ND	1.4E-01	6.8E-02	0	6.3E-01	5.1E-01	3.9E-01
Cu (mt)	0	1.9E-01				1.5E+00	1.4E+00	1.4E+00
Hg (mt)	0	ND	5.4E-03	2.7E-03	0	3.9E-02	3.3E-02	2.6E-02
Ni (mt)	0	ND	1.4E-01	6.8E-02	0	2.2E+00	1.4E+00	5.3E-01
Pb (mt)	0	ND	1.4E-01	6.8E-02	0	8.2E-01	4.1E-01	7.6E-04
Se (mt)		ND	1.4E-01	6.8E-02	0	7.2E-01	3.6E-01	5.9E-03
Zn (mt)	0	1.0E+00				4.4E+00	3.1E+00	1.9E+00
PCBs (mt)	0	ND	1.4E-02	6.8E-03	0	2.3E-02	1.1E-02	0
PAHs (mt)		ND	1.4E-01	6.8E-02	0	2.1E-01	1.0E-01	0
TCDD (mt)		3.8E-10				4.0E-08	2.2E-08	3.3E-09
DDTs (mt)	0	ND	4.1E-03	2.0E-03	0	7.0E-03	3.5E-03	0
Chlordane (mt)	0	ND	1.4E-02	6.8E-03	0	2.9E-02	1.4E-02	0
Dieldrin (mt)	0	ND	1.4E-03	6.8E-04	0	2.6E-03	1.3E-03	0
T Phosphate (mt)		NA				3.9E+01	3.9E+01	3.9E+01
T Coliform (MPN)		NA				1.9E+15	1.9E+15	1.9E+15
Fecal Coli (MPN)		NA				2.6E+15	2.6E+15	2.6E+15
Entero (MPN)		NA				2.2E+14	2.2E+14	2.2E+14

Appendix C4:

Power Generating Station Data

Project	Morro Bay 001E	Morro Bay 001F	Morro Bay Total	Diablo Canyon	
(Sanitary)	Diablo Canyon DL	Diablo Canyon 1/2 DL		Diablo Canyon 0	
Flow (GPD)	3.0E+03	3.4E+04	3.7E+04		
Flow (L) per year	4.1E+06	4.7E+07	5.1E+07	9.3E+02	9.3E+02
TSS (mt)	1.8E-02	3.8E-01	4.0E-01	NA	
Nitrate (mt)	NA	NA	NA	ND	9.3E-08
Ammonia (mt)	NA	NA	NA	4.9E-05	
T Phosphate (mt)	NA	NA	NA	1.8E-04	
Cd (mt)	NA	NA	NA	ND	4.7E-08
Cr (mt)	NA	NA	NA	ND	9.3E-08
Cu (mt)	NA	NA	NA	3.6E-06	
Hg (mt)	NA	NA	NA	ND	4.7E-09
Ni (mt)	NA	NA	NA	ND	9.3E-08
Pb (mt)	NA	NA	NA	ND	1.9E-07
Zn (mt)	NA	NA	NA	7.0E-06	

(Continued from above)

Project	Duke 002B	Duke 002D	Duke 002E	Duke 002E5		
	Duke Total	TOTAL W DL	TOTAL W 1/2 DL	TOTAL W 0		
	(SW Evapo Blowdown)	(Conden Polisher)	(Treated ww Sump)	(Air Preheater)		
Flow (GPD)	5.6E+04	7.0E+03	3.1E+04	2.0E+03	9.6E+04	
Flow (L) per year	7.7E+07	9.7E+06	4.3E+07	2.8E+06	1.3E+08	1.8E
TSS (mt)	4.7E+00	7.6E-02	2.9E-01	1.3E-02	5.0E+00	5.4E
Nitrate (mt)	NA	NA	NA	NA	NA	9.3E
Ammonia (mt)	NA	NA	NA	NA	NA	4.9E
T Phosphate (mt)	NA	NA	NA	NA	NA	1.8E
Cd (mt)	NA	NA	NA	NA	NA	4.7E
Cr (mt)	NA	NA	NA	NA	NA	9.3E
Cu (mt)	NA	NA	NA	NA	NA	3.6E
Hg (mt)	NA	NA	NA	NA	NA	4.7E
Ni (mt)	NA	NA	NA	NA	NA	9.3E
Pb (mt)	NA	NA	NA	NA	NA	1.9E
Zn (mt)	NA	NA	NA	NA	NA	7.0E