

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 91-87

AUTHORIZATION TO ACCEPT GRANT FUNDS AND ENTER INTO
A COOPERATIVE AGREEMENT WITH THE NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION (NOAA) TO STUDY BIOEFFECTS ASSOCIATED WITH
CONTAMINATED SEDIMENTS IN SOUTHERN CALIFORNIA

WHEREAS:

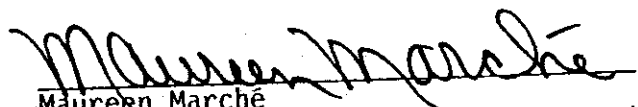
1. The State Water Resources Control Board (State Board) and California Regional Water Quality Control Boards are required by legislation (Porter-Cologne Act, Division 7, Section 13390 et seq.) to develop sediment quality objectives and identify toxic hot spots in the enclosed bays and estuaries of California.
2. The development of sediment quality objectives and identification of toxic hot spots will require the collection of sediment chemistry and biological data from the enclosed bays and estuaries of the State to evaluate toxicant-related bioeffects.
3. The NOAA Status and Trends Program is required by Congress to collect similar sediment data throughout the United States.
4. The State Board has applied to NOAA for a \$165,000 grant and proposed a Cooperative Agreement for FY 1991-92 to study bioeffects associated with contaminated sediments in Southern California.

THEREFORE BE IT RESOLVED:

1. That the State Board authorize the Executive Director, or his designee, to accept a grant from NOAA of up to \$165,000 and enter into a Cooperative Agreement to study the bioeffects associated with contaminated sediments in Southern California.
2. That the State Board authorize the Executive Director, or his designee, to negotiate and execute an interagency agreement with the California Department of Fish and Game to implement the Cooperative Agreement.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on September 26, 1991.


Maureen Marché
Administrative Assistant to the Board

SEP 10 1991

STATE WATER RESOURCES CONTROL BOARD MEETING
SACRAMENTO, CALIFORNIA
SEPTEMBER 26, 1991

ITEM: 8

SUBJECT: CONSIDERATION OF A RESOLUTION TO AUTHORIZE ACCEPTANCE OF GRANT FUNDS AND ENTER INTO A COOPERATIVE AGREEMENT WITH THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) TO STUDY BIOEFFECTS ASSOCIATED WITH CONTAMINATED SEDIMENTS IN SOUTHERN CALIFORNIA

DISCUSSION: The proposed resolution authorizes the Executive Director to enter into a Cooperative Agreement and accept funds from NOAA to study the effects of contaminated sediments on marine organisms in Southern California. Approval of the program will provide Federal funding and support to the Bay Protection and Toxic Cleanup Program's (BPTCP) investigation into bioeffects associated with contaminated marine sediments.

The Porter-Cologne Act (Division 7, Section 13390 et seq.) requires the State Water Resources Control Board (State Board) and the California Regional Water Quality Control Boards (Regional Boards) to develop sediment quality objectives and apply those objectives in assessment of California coastal bays and estuaries. The objectives are to be based upon scientific information including, but not limited to, chemical monitoring, bioassays, or established modeling procedures. At a recent BPTCP-sponsored workshop agreement was reached on a strategy for developing these objectives, including the collection of new sediment chemistry and biological data for analysis and evaluation.

Congress has, through the National Status and Trends (NS&T) program, mandated NOAA to conduct a marine pollution research and monitoring program. Presently, NOAA intends to conduct an NS&T program in the bays and estuaries of Southern California. Part of this is a program focused on the magnitude and extent of toxicant-associated bioeffects in selected coastal embayments and estuaries, with data collected similar to the Porter-Cologne requirements.

The proposed Cooperative Agreement (attached) will enable the State Board and NOAA to extend the scope of their respective studies. The Cooperative Agreement is presently scheduled for one year with a potential for two additional years.

The State Board has applied for a grant of \$165,000 in Federal funds from NOAA to enter into a Cooperative Agreement for FY 1991-92. The State match for the proposed Cooperative Agreement will be \$170,022 with \$85,000 coming from the Hazardous Waste Account fund and \$85,022 from the BPTCP fees when they become available. The Cooperative Agreement funds will support \$335,022 in laboratory services to be conducted by the California Department of Fish and Game.

SEP 10 1991

POLICY ISSUE: Should the State Board authorize the Executive Director, or his designee, to accept Federal funds and enter into a Cooperative Agreement with NOAA to study bioeffects associated with toxicants in Southern California marine sediments?

FISCAL IMPACT: The proposed State share of the Cooperative Agreement is budgeted at \$170,022 with \$85,000 from the Hazardous Waste Account and \$85,022 from BPTCP annual fees.

REGIONAL BOARD IMPACT: Yes. Los Angeles and Santa Ana Regional Boards.

STAFF RECOMMENDATION: That the State Board authorize the Executive Director, or his designee, to accept grant funds from NOAA and enter into a Cooperative Agreement to study bioeffects associated with toxicants in Southern California marine sediments.

Policy Review 8/19/91
Fiscal Review W 8/20/91
Legal Review Jh. 9/21/91

SEP 10 1991

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 91-

AUTHORIZATION TO ACCEPT GRANT FUNDS AND ENTER INTO
A COOPERATIVE AGREEMENT WITH THE NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION (NOAA) TO STUDY BIOEFFECTS ASSOCIATED WITH
CONTAMINATED SEDIMENTS IN SOUTHERN CALIFORNIA

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2. The development of sediment quality objectives and identification of toxic hot spots will require the collection of sediment chemistry and biological data from the enclosed bays and estuaries of the State to evaluate toxicant-related bioeffects.
3. The NOAA Status and Trends Program is required by Congress to collect similar sediment data throughout the United States.
4. The State Board has applied to NOAA for a \$165,000 grant and proposed a Cooperative Agreement for FY 1991-92 to study bioeffects associated with contaminated sediments in Southern California.

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THEREFORE BE IT RESOLVED:

1. That the State Board authorize the Executive Director, or his designee, to accept a grant from NOAA of up to \$165,000 and enter into a Cooperative Agreement to study the bioeffects associated with contaminated sediments in Southern California.
2. That the State Board authorize the Executive Director, or his designee, to negotiate and execute an interagency agreement with the California Department of Fish and Game to implement the Cooperative Agreement.

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CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on September 26, 1991.

Maureen Marché
Administrative Assistant to the Board

Attachment

**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
STATE WATER RESOURCES CONTROL BOARD**

**MEASURES OF BIOEFFECTS ASSOCIATED WITH
TOXICANTS IN SOUTHERN CALIFORNIA**

PROPOSAL FOR A COOPERATIVE AGREEMENT

JULY 10, 1991

NOAA/CALIFORNIA PROPOSAL FOR A COOPERATIVE AGREEMENT
MEASURES OF BIOEFFECTS ASSOCIATED WITH TOXICANTS
IN SOUTHERN CALIFORNIA

A. INTRODUCTION

The State Water Resources Control Board (State Board) and the National Oceanic and Atmospheric Administration (NOAA) propose to develop a Cooperative Agreement to assess adverse biological effects in the inshore waters of Southern California. The program as proposed is for FY 1991-92 with an option for two additional years. In FY 1991-92 NOAA will provide \$165,000 to the State Board. The State Board will initially provide \$85,000 for the program and an additional \$85,022 when the Bay Protection and Toxic Cleanup Program fees become available.

These funds will be used to determine the sediment toxicity of 33 sites; determine the utility of using selected biomarkers; assess condition of selected fish species in the study area; and measure sediment chemistry on a limited number of samples.

This workplan is divided into several sections including Background, Rationale, Research, Tasks, Benefits of the Research to NOAA, Benefits of Research to California, Cooperative Agreement and Costs.

Background

NOAA is mandated by Congress to conduct a program of research and monitoring on marine pollution. Much of this research is being conducted through the National Status and Trends (NS&T) Program. The NS&T Program performs

regional intensive studies of the magnitude and extent of toxicant-associated bioeffects in selected coastal embayments and estuaries. The areas chosen for these regional studies are those in which the contaminant concentrations indicate the greatest potential for biological effect. These biological studies augment the regular chemical monitoring activities of the Program and provide answers to the proverbial "So what?" question regarding toxicants. NOAA intends to conduct one of these intensive NS&T programs in southern California over a one to three-year period.

The State Water Resources Control Board (State Board) and its nine Regional Boards are mandated by the Porter-Cologne Act (California Water Code, Div. 7, Sections 13390 et seq.) to develop sediment quality objectives and apply those objectives in assessments of California's coastal bays and estuaries. The intent of the sediment quality objectives is to protect the beneficial uses of bays and estuaries, including protection of human health and aquatic life. The objectives are to be based upon scientific information, including but not limited to chemical monitoring, bioassays or established modeling procedures, and are intended to provide adequate protection for the most sensitive aquatic organisms. A strategy was developed for preparing these objectives in a workshop convened in February 1991 and the State Board approved a workplan for the development of sediment quality objectives on June 20, 1991. The strategy includes the collection of new data from California to verify toxicity thresholds previously determined in research performed in California and elsewhere. Matching, paired chemical and biological data will be collected in studies performed in California for analysis and evaluation.

Rationale

The proposed research will be performed in southern California coastal bays. A considerable amount of research has been performed on toxicants and measures of effects associated with them in southern California. Most of this work has focused upon Santa Monica Bay and the continental shelf off the large municipal treatment plants in the Los Angeles, Orange County and San Diego metropolitan areas. Numerous studies have been performed that have demonstrated alterations to benthic communities; fin rot and other external disorders in fish; histopathological disorders in fish; changes in kelp communities; and elevated chemical concentrations in sediments, mussels and fish. Limited research in some areas has been performed that indicated sea surface microlayer toxicity; water column toxicity; sediment toxicity; elevated chemical concentrations in sea birds and mammals; impaired reproductive success in fish; impaired reproductive success of marine mammals; elevated hydrocarbon metabolites in fish bile; and reduced scope for growth in intertidal mussels. These data, if merged together, could be useful for estimating the magnitude and extent of toxicant-associated effects among some sections of the coastal shelf.

A considerable amount of sediment chemistry data exist for the Los Angeles/ Long Beach Harbor, parts of San Pedro Bay, and parts of San Diego Bay, the major embayments of Southern California. These data have been collected mostly as prerequisites to dredging projects. Sediment toxicity has been determined to a lesser extent in these embayments in a number of small pre-dredging studies, but not in any large synoptic surveys. In Los Angeles/ Long Beach Harbor, most of the sediment toxicity data are available for specific maritime berths and navigation channels. No synoptic survey of

the harbor has been conducted on a larger scale. Similarly, data from a number of small site-specific surveys of sediment toxicity are available for San Diego Bay. Other data from one broad survey in San Diego have been collected by EPA, but are not available, thus far.

While these areas have received the most attention thus far, very little or no information exist for other areas in southern California. A number of coastal lagoons, bays, estuaries and marinas have not been studied to determine the occurrence and incidence off bioeffects associated with toxicants. These places include Tijuana Slough (which is a NOAA National Estuarine Reserve), lower San Diego Bay, Mission Bay, Batiquitos Lagoon, Aqua Hedionda Lagoon, Buena Vista Lagoon, Dana Point Marina/San Juan Creek, Newport Bay, Bolsa Chica Ecological Reserve, Huntington Harbor, Anaheim Bay, Alamitos Bay, and parts of San Pedro Bay.

Many of these lagoons and bays receive runoff from large upland areas, and inputs of toxicants from industry, residential areas and boats. They often have limited flushing. Some of the small lagoons are documented as being important nursery areas for species of coastal fish, such as the California halibut. A limited amount of research has been performed in these places to characterize toxicants and their effects. These studies have included a few sediment toxicity tests with limited samples in a few of the areas; some bioaccumulation analyses of transplanted mussels in a few of the areas; some evaluations of survival of transplanted invertebrates held in cages in one of the areas; and ongoing research on the life history of the California halibut. High levels of some contaminants have been found in some scattered surveys of sediments. In terms of research on bioeffects of toxicants, these areas are largely unstudied, yet the toxicants in some of these areas

have a potential for causing biological effects. In summary, the necessary data are not available to estimate the magnitude and extent of effects in these areas. Therefore, there is very limited evidence available with which to judge the need to remediate toxicant-effects and initiate cleanup actions.

Work either underway or planned as part of the Santa Monica Bay Restoration Project and NOAA's Damage Assessment Plan will, again, focus upon the coastal shelf off the treatment plants and/or within Santa Monica Bay. Studies of sediment contamination and toxicity are planned for some inshore areas of Santa Monica Bay using methods similar to those proposed here. Also, studies of bioaccumulation of toxicants in nearshore fish are planned for Santa Monica Bay. The NOAA Damage Assessment Plan tentatively includes research on uptake, bioaccumulation, and bioeffects in nearshore coastal fish and invertebrates off Palos Verdes, bioaccumulation and effects in birds and mammals offshore, and limited sediment quality studies in parts of San Pedro Bay. The research proposed here will complement, but not duplicate, these studies that are either planned or underway.

Objectives

1. Determine the presence or absence of adverse biological effects in selected inshore and coastal areas of southern California;
2. Determine the relative degree or severity of toxicant effects;
3. Determine the spatial distribution of toxicant-associated effects in selected areas of Southern California;

4. Determine the relationships between toxicants and measures of effects in Southern California;
5. Determine the relative performance of a battery of biomarkers.

Scope of Study

The study area extends from the Palos Verdes Peninsula south to the Mexico/USA border. It extends from approximately the 60 m isobath to the upper limit of tidal-influenced saltwater; however, most of the work will focus upon selected coastal bays and lagoons.

The research will involve biological and chemical analyses of sediments and chemical tissue analysis, histological and other biomarker analyses of resident demersal fish. Samples for biological and chemical analyses of sediments will be collected synoptically. Biological and chemical analyses will be performed with portions from each station resulting in matching, paired data.

B. Research Tasks for FY 1991-92

Three research tasks are to be implemented in FY 1991-92: (1) measures of sediment contamination, (2) measures of sediment toxicity, and (3) measures of bioeffects in resident fish (e.g., gobies). Measures of bioaccumulation and bioeffects in bivalves mollusks (i.e., mussels) are proposed for the second and third years of the study, if funded.

The State Board will consult with experts in the field during the first year of the study to determine appropriate biomarkers in bivalves. The results of these interviews together with final recommendations will be provided to NOAA at the end of the first year of the study.

Measurements will be performed in San Pedro Bay, Los Angeles Harbor, Long Beach Harbor, Anaheim Bay, Alamitos Bay, and Huntington Harbour in the first year. Should the program be continued for the full three years, sampling will be conducted in Mission Bay, San Diego Bay, and Tijuana Slough in the second year and in Newport, Bolsa Chica, Oceanside, and Del Mar area in the third and final year. Specific details of sampling schedules will be determined jointly by NOAA and the State of California.

Samples will be collected at sites in each embayment that will serve at least two purposes: (1) to characterize the magnitude and spatial extent of toxicant-associated bioeffects in Southern California inshore areas; and (2) to determine relationships between concentrations and mixtures of sediment-associated toxicants, bioavailability and uptake of these chemicals, and the occurrence and severity of bioeffects. The sampling sites chosen must meet several criteria: (1) the sites must be depositional (muddy), and, therefore, should represent recently deposited toxicants; (2) each site must represent the integrated accumulation of toxicants from multiple sources; (3) the grid of sediment sampling sites must be representative of conditions throughout the study area; (4) the grid of sampling sites must be suitable for estimating the spatial extent of toxicant-associated bioeffects; and (5) a subset of the sediment sampling

sites must have the target fish (e.g., gobies) available and conditions suitable for collecting resident mussels or transplanting mussels.

The data from the research will be merged to form a synopsis of conditions in the study area. These data, in turn, will be compared with those from other parts of the study area that have been previously studied with similar methods. Data evaluations will be conducted jointly by NOAA and the State of California.

Task 1. Survey of Sediment Contamination and Toxicity

Rationale

Sediment toxicity tests provide a direct means to determine the relative biological significance of sediment-associated contaminants. Sediment-associated toxicants can be assumed to be bioavailable and concentrated to unacceptable levels when toxicity tests demonstrate that the sediments are toxic. Standardized methods have been developed and are available for use in these tests.

Analyses of sediment toxicity are underway in a large survey of outer Los Angeles/Long Beach Harbor (Dr. Ray Markel, ToxScan, Inc., personal communication) and have been performed in a number of other small studies in parts of the harbor (e.g., Marine Bioassay Laboratories, 1985, 1986). Most of the previous studies have been performed for the port authorities or the Army Corps of Engineers as evaluations of prospective dredge material, and, therefore, have focused upon specified maritime berths, piers, and navigation channels. In a number of small, unrelated studies in San Diego

Bay, sediment toxicity tests have been performed by the EPA, the Navy, and commercial laboratories sponsored by a variety of Federal, State, and local agencies in the northern and outer portions of the bay and around maritime berths and piers in parts of the central portion of the bay, but not to any extent in the southern reaches of the bay. A few samples from Newport Bay have been tested for toxicity. No large scale, comprehensive surveys in the other coastal lagoons and bays have been performed thus far.

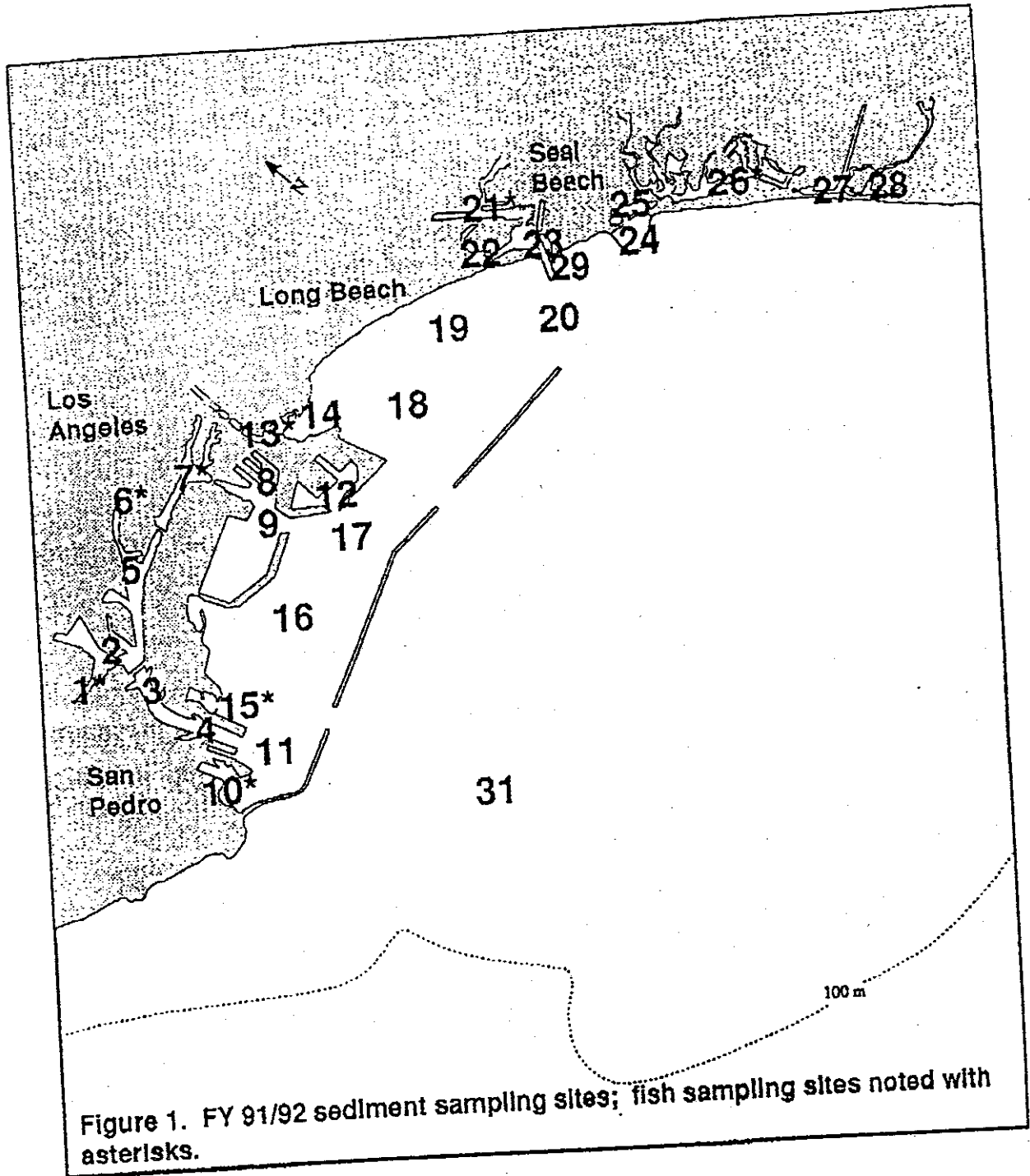
Sample Collections

In this task, surficial sediments (upper 2 cm) representative of selected lagoons and bays will be collected for chemical analyses and toxicity testing. The number of sampling sites in each embayment will be tailored to the size and configuration of that bay. For comparative purposes, selected sampling sites along the coast seaward of the selected bays also will be sampled. Three stations per site will be sampled and tested independently. The three stations at each site will be arranged in either triangular or linear configurations with the stations located 100m to 200m apart. Care will be taken to locate the stations away from the center of the channels where maintenance dredging has taken place in the past 10 years. All sampling sites will represent integrated conditions from multiple nearby sources of toxicants; sites influenced solely by a lone source of toxicants will be avoided. The purpose of this approach is to sample a gradient throughout the study area. A Kynar-lined modified Van Veen grab or box core will be used to collect sediments using methods that will not contaminate the samples. Multiple deployments of the sampler will be required to obtain sufficient material at each station for the battery of toxicity tests and chemical analyses.

Care will be taken to ensure that cross-contamination between samples does not exist. After completing sampling at each site, the sampler will be washed with seawater and cleaned with hexane.

Sites in which sediment samples will be collected are tentatively identified below (Figure 1).

1. southwest slip, Los Angeles Harbor;
2. turning basin, Los Angeles Harbor;
3. lower channel, Los Angeles Harbor;
4. mouth of channel, Los Angeles Harbor;
5. confluence of East Basin and Cerritos Channel, Los Angeles Harbor;
6. mouth of Dominguez Channel, Los Angeles Harbor;
7. inner harbor, Long Beach Harbor;
8. middle harbor, Long Beach Harbor;
9. west basin, Long Beach Harbor
10. Cabrillo Beach Salt Marsh Lagoon;
11. outer harbor, off Cabrillo Beach;
12. mouth of Southeast Basin, Long Beach Harbor;
13. upper Queensway Bay, Long Beach Harbor;
14. lower Queensway Bay, Long Beach Harbor;
15. entrance to Fish Harbor, western San Pedro Bay;
16. western San Pedro Bay;
17. western San Pedro Bay;
18. eastern San Pedro Bay;
19. eastern San Pedro Bay;
20. eastern San Pedro Bay;
21. northern Alamitos Bay;



22. western Alamitos Bay;
23. southern Alamitos Bay;
24. outer Anaheim Bay;
25. inner Anaheim Bay;
26. lower Huntington Harbour;
27. middle Huntington Harbour;
28. upper Huntington Harbour;
29. mouth of San Gabriel River;
30. offshore, south of San Pedro Breakwater;
31. Control 1: located outside the study area;
32. Control 2: sandy material located within the study area;
33. Control 3: fine material located within the study area.

NOAA and the State of California will jointly select the final locations of the sampling sites, including controls, using the five criteria described above. The final adjustments will be made during the actual sampling cruise. The exact coordinates for each site will be determined at that time.

The sampling sites will be sampled in multiple legs, each leg consisting of 5 to 10 sites. Controls will be resampled and tested with each batch of samples collected in each of the legs. The controls will be collected from areas previously demonstrated to be not toxic and relatively uncontaminated.

Sediment samples for possible future benthic community analysis will be collected at the same time the samples are collected for the toxicity tests and chemical analyses. At each station 5 mini-cores (7 cm diameter, 5 cm

deep) will be collected from a single deployment of the sampler. The entire contents of each core will be screened in the field through a 1 mm screen preserved in formalin and stored in alcohol for at least two years or until taxonomic identifications are performed. These samples will be stored and maintained by the California Department of Fish and Game. NOAA and the State of California will determine jointly which samples will be examined for benthic community composition.

Chain of Custody

The California Department of Fish and Game (DFG) has developed a Chain of Custody procedure for the Department's chemistry lab (State of California, California Department of Fish and Game, 1991). These procedures will serve as the Chain of Custody procedures for the proposed program. The actual field and laboratory data sheets for the individual tasks will be developed prior to the initiation of the program. These data sheets will be provided to NOAA for inspection and comments prior to their use.

Toxicity Tests

Two independent tests of sediment toxicity will be performed with each sample: 10-day solid phase tests with amphipods and a 48-hour elutriate test using sea urchin embryos. Each test will be conducted using a negative and positive control. Control sites will be located within the Long Beach/Los Angeles Harbor complex and outside the harbors (see page 11). The second site will be selected after conferring with local experts. If control areas become difficult to identify sediments from the site of test

species collection be used as a control. The positive control (chemical reference) will involve the use of cadmium chloride as a standard toxicant.

Sediment samples will be shipped by air freight to the laboratory in sealed glass containers on ice. Once at the laboratory, samples will be held at 4° C. The holding time will not exceed 10 days.

Amphipod tests will be undertaken using either Rhepoxynius abronius or Eohaustorius estuarius. These species have been found to have similar sensitivities to contaminated sediments in San Francisco Bay (Karen Taberski, San Francisco Regional Water Quality Control Board, personal communication). Rhepoxynius will be the primary amphipod species used based on advise of NOAA and experts in the use of the test species. Eohaustorius will be used when reduced salinity makes test sediment intolerant to Rhepoxunius.

Amphipod toxicity tests will be 10-day static mortality survival tests with laboratory procedures following those outlined in ASTM (1991). Five static replicate samples will be tested from each station. Each replicate test will be run in a 1-liter beaker with a 2 cm layer of test sediments on the bottom and enough clean sea water to fill the beaker approximately three-quarters full. The beakers will be continuously aerated and maintained at 15° C under constant light. Each beaker will be checked daily. Dead amphipods on the surface of the sediments will be removed and enumerated. At the end of the 10-day test period, the percent mortality in each replicate will be determined and the mortality at each station and site will be statistically compared with the controls.

The sea urchin embryo test will be performed using the embryos of Strongylocentrotus purpuratus. The test is a 48-hour elutriate exposure test using percent normal development as the end point. The elutriate is a 4:1 dilution of sea water to test sediment (U.S. Environmental Protection Agency, Department of the Army, U.S. Army Corps of Engineers, 1990). Techniques for the test follow those outlined in Long and Buchman (1989). For each station, elutriate samples will be divided into five-220 ml replicate samples and inoculated with embryos (approximately 75,000/replicate). Exposure will be for 48 hours at 17° C. Following exposure, 10 ml aliquots will be removed from each replicate and the percentage of normally developed embryos determined. Control waters will be collected from the sites identified for sediment collection. A positive control with cadmium chloride will be used. The results from each treatment station and site will be compared with controls to determine if statistically significant percentage of normal is present.

Approximately 10 ml of the test waters with embryos will be removed from each replicate and preserved for cytogenetic examination (Hose, 1985). This analysis will be performed if additional funds can be secured.

Chemical Analysis

Portions of each sediment sample will be set aside and frozen for chemical analyses. Chemical analyses will be performed at a total of 15 sites (total of 45 samples). NOAA and the State will jointly determine which 45 samples will be analyzed for chemical concentrations, following review of toxicity data. Additional sites may be analyzed as funds become available. Chemical

analyses will be performed for the trace metals, pesticides, hydrocarbons and selected normalizing parameters (e.g., grain size, total organic carbon) that are routinely quantified by the NS&T Program, plus acid volatile sulfide (AVS). Protocols developed by the NS&T Program will be used in the chemical analyses, including those for analyses of blanks and standard reference materials. AVS samples will be stored in non-contaminating collection jars so that no head space exists to ensure an oxygen free holding environment. Samples will be stored at -80° C, if feasible, or at least -40° C. Analytical procedures for AVS (AVS analysis only) will follow Gongmin et al. (1991).

The DFG's Laboratory Assurance Program Plan is provided in State of California, California Department of fish and Game (1991). The methods are those of the NS&T Program. The Program Plan summarizes the quality assurance and quality control (QA/QC) elements which ensure accurate and precise procedures for Department sampling and analyses, in the attainment of this project's goals and objectives. This "Program Plan" is designed to meet generic requirements of all DFG projects and specifically addresses all elements of the Environmental Protection Agency's Quality Assurance Management staff's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" QAMS-005/80. Additional special protocols for this study in the form of "Standard Operating Procedures" or SOPs will be published and reviewed by the Contract Manager to define project-specific analyses or requirements. The proposed Study will include a protocol for sediment sample cleanup: size-exclusion High Pressure Liquid Chromatography. DFG has participated for a number of years in NS&T/NIST QA/QC protocol development and will continue to participate during the study.

Data Evaluations

The data will be evaluated to determine:

1. Which sites were statistically significantly more toxic than controls,
2. Spatial patterns in toxicity,
3. Relative degree of toxicity among the sites,
4. Relationships between the toxicity and chemical data, and
5. Relative sensitivity of the two toxicity tests.

Statistical methods to be used for identification of significantly toxic sites will be specified and justified by NOAA and the State of California. The relative degree of toxicity will be determined according to the mean results for each site and reported graphically and in tabular formats. The relationships between the toxicity and chemical data will be determined in regression analyses, cluster analyses, concordance tests and other methods to be specified. In addition, the bioassay and chemical data will be entered into a project database and accumulated in that database. As each leg of the study plan is completed, the new data will be added to this database. Similar data collected elsewhere in the study area simultaneously with this task also will be entered into the database. Other similar data from pre-dredging programs and other research programs previously conducted in the study area by others also will be acquired and entered into this file. These matching data will be available for further evaluation to determine patterns in concordance, co-occurrence in sediment contamination and toxicity, apparent effects thresholds, no-effects levels or other analyses jointly agreed to.

Task 2. Bioaccumulation and Biomarkers in Mussels

Bioaccumulation and biomarker tests in mussels will be conducted in the second and third year of the study if funded by NOAA. The first year of the investigation will be used to determine the appropriate biomarkers for the bivalve study. The determination will be made after reviewing the available literature and consulting experts in the field. Once this determination is made, a study proposal for the bivalve bioaccumulation and biomarker investigation will be developed.

Task 3. Bioaccumulation and Biomarkers in Coastal Marsh Fish

Rationale

The tests of sediment toxicity will provide some information on the relative bioavailability and toxicity of sediment-associated toxicants to benthic animals. The analyses of mussels will provide information on uptake and bioeffects in sessile, transplanted mollusks whose recent history has been documented. But neither task will provide information on uptake and effects in resident demersal, feral animals closely associated with sediments. We, thus, propose to examine the effects of contaminated sediments on resident fish at selected stations in Los Angeles/Long Beach Harbor.

We will use one of three gobies, based on availability, that commonly occur in the Long Beach/Los Angeles Harbor region as well as the other harbors and lagoons of California. The gobies are the bay goby (Lepidogobius lepidus), the cheekspot goby (Ilypnus gilberti), and the arrow goby (Clevelandia ios).

All three species burrow in the sediments and are felt to be appropriate test species. Further, previous data indicate the species are abundant in the study area.

Prior to initiating the investigations, a methods evaluation step will be undertaken to determine if a number of selected biomarkers are suitable for use with the selected fish species: hepatic cytochrome P-450 and ethoxy resorufin O-deethylase (EROD) induction, condition index (CI) and gonadal/somatic index (GSI). In addition, a trawl survey will be undertaken to determine what species of goby will be used for the definitive test. The methods evaluation study will be conducted at a "clean" and contaminated site determined in the sediment/toxicity phase of this study. During the methods evaluation study, liver tissue will be analyzed for metals and synthetic organics and a gonadal/somatic index test will be performed on each fish sampled for enzymes. In addition, liver and kidney tissue be preserved for future histopathological analyses. The gonad index will be examined during the methods evaluation to determine its suitability as a biomarker in gobiid fish. Should any of these biomarker tests prove effective their use in further studies will be determined by the State and NOAA. If none of the biomarkers appear to be feasible or sensitive in the gobies, additional research and development on other methods or other species will be jointly agreed to by NOAA and the State of California.

Sample Collection

Fish will be collected with a beam trawl at eight sites and a control. The exact sampling sites will be jointly determined by the State and NOAA after

examining the sediment data. The minimum number of fish necessary to perform the biological and chemical analyses listed below will be captured at each site. Portions of the liver of each fish will be allocated for each of the analyses. Tissue samples will be pooled if necessary to collect sufficient amounts for analysis. In addition to the livers, gallbladders of each fish will be collected if possible. Bile from the gallbladders will be shipped to NMFS/NOAA in Seattle for possible bile metabolite analyses. Samples for enzyme and bile analysis will be removed in the field and quick frozen on dry ice. The samples will then be shipped to the lab where they will be held at a -40° C until processed for analysis. Histopathology samples will be removed in the field and fixed in appropriate fixative suitable for histopathological analyses.

Biological Tests

The definitive list of biomarker end-points will be developed following the methods evaluation step. Tentatively, the following biological tests will be performed to examine the potential effects of contaminants on the test species of fish. The effects and exposure measurements will include:

1. Neoplasms in the livers and kidneys (Malins et al., 1987, Varanasi et al., 1988). At each site the liver and kidneys of up to a maximum of 30 individuals will be examined histologically for the presence of neoplasms.
2. Condition Index (Long and Buchman, 1989). Each specimen sampled for histological abnormalities will be examined and a condition index score

developed. These findings will be correlated with the results of the histology, enzyme and tissue chemistry results.

3. Cytochrome P450 and EROD Induction in Livers (Stegeman et al., 1988; Long and Buchman, 1989). Fifteen replicate liver samples will be collected from each site for protein normalized cytochrome P450 and EROD induction analysis.

Chemical Analyses

The liver tissues of the fish will be analyzed for trace metals, pesticides, and hydrocarbons routinely quantified in the NS&T Program. Analysis procedures are provided in DFG QA Program Plan.

Data Evaluations

The data will be evaluated to determine:

1. relative bioaccumulation of sediment-associated toxicants in the tissues of the fish;
2. the relative performance of each of the biomarkers;
3. the presence/absence of statistically significant results;
4. the relative degree of severity of effects observed in each site; and
5. the relationships between the sediment and tissue chemistry and biological data.

The statistical procedures to be used in the data evaluations will be determined jointly by NOAA and the State of California. The relative

sensitivity, range in response, within-site variability, and concordance with tissue chemistry data will be determined for each biomarker. Sampling sites at which mean results are significantly different than controls will be identified. Mean results will be used to determine spatial patterns in response among the sampling sites. Regression analyses, concordance analyses and other statistical procedures will be used to identify relationships between chemical and biological data.

C. Deliverables

Products to be delivered to NOAA include:

1. Cruise reports which will consist of station locations with longitude and latitude readings for each station, a chart with all stations plotted and any other appropriate notes or information on each sampling site or station.
2. Quarterly progress reports.
3. Final technical report of FY 1991-92 work which will include description of methods, raw data in tabular spreadsheet format, the results of the five data evaluations, and textual descriptions of the results.

D. Benefits of the Research to NOAA

This research program in Southern California will provide a number of programmatic benefits to NOAA. They include:

1. presence or absence of adverse biological effects in areas known to have relatively high chemical concentrations;
2. data to assess the degree or severity of toxicant effects;
3. spatial distribution of toxicant-associated effects in Southern California;
4. new data with which to supplement existing data on the relationships between toxicants and toxic effects in Southern California;
5. matching biological, sediment chemical data, and tissue chemistry with which to perform statistical analyses;
6. biological data with which to assess the significance of chemical data from the NS&T Program's monitoring activities; and
7. evaluations of the relative performance of a battery of biomarkers.

E. Benefits of the Research to California

The benefits of this program to the State of California would be similar to those to NOAA:

1. presence or absence of adverse biological effects in areas known to have relatively high chemical concentrations;
2. data to assess the degree or severity of toxicant effects;

3. spatial distribution of toxicant effects in Southern California;
4. new data with which to supplement existing data on the relationships between toxicants and toxic effects in Southern California;
5. matching biological and chemical data with which to perform statistical analyses. The data will be used to confirm sediment-water and water that predict the bioavailability of sediment-assorted toxicants;
6. biological data with which to assess the significance of chemical data from the Mussel Watch monitoring activities;
7. evaluations of the relative performance of a battery of biomarkers; and
8. data to be used in a research program to develop state marine sediment quality objectives.

F. Proposed Cooperative Agreement

This research will be implemented through a Cooperative Agreement between NOAA and the State of California. NOAA will transfer \$165,000 to the California State Water Resources Control Board (State Board), and the State Board will initially provide \$85,000 (Hazardous Waste Control Account Funds) for a total budget of \$250,000. These funds will be used to determine the toxicity of sediments at the 33 sites; perform the method evaluation to determine the utility of using the selected enzyme test with the gobied test species; perform fish condition index, histopathology and enzyme analysis; and perform as much sediment chemistry as the budget

allows. The remaining samples will be archived and analyzed when additional State funds become available in FY 1991-92. These additional funds (\$85,022) will be obtained from the Bay Protection and Toxic Cleanup Fund.

The State Board will be funding similar sediment chemistry and toxicity studies elsewhere in the Southern California Bight during FY 1991-92 which will use methods outlined in the proposed program. Data from these studies will be available to NOAA at no cost to NOAA.

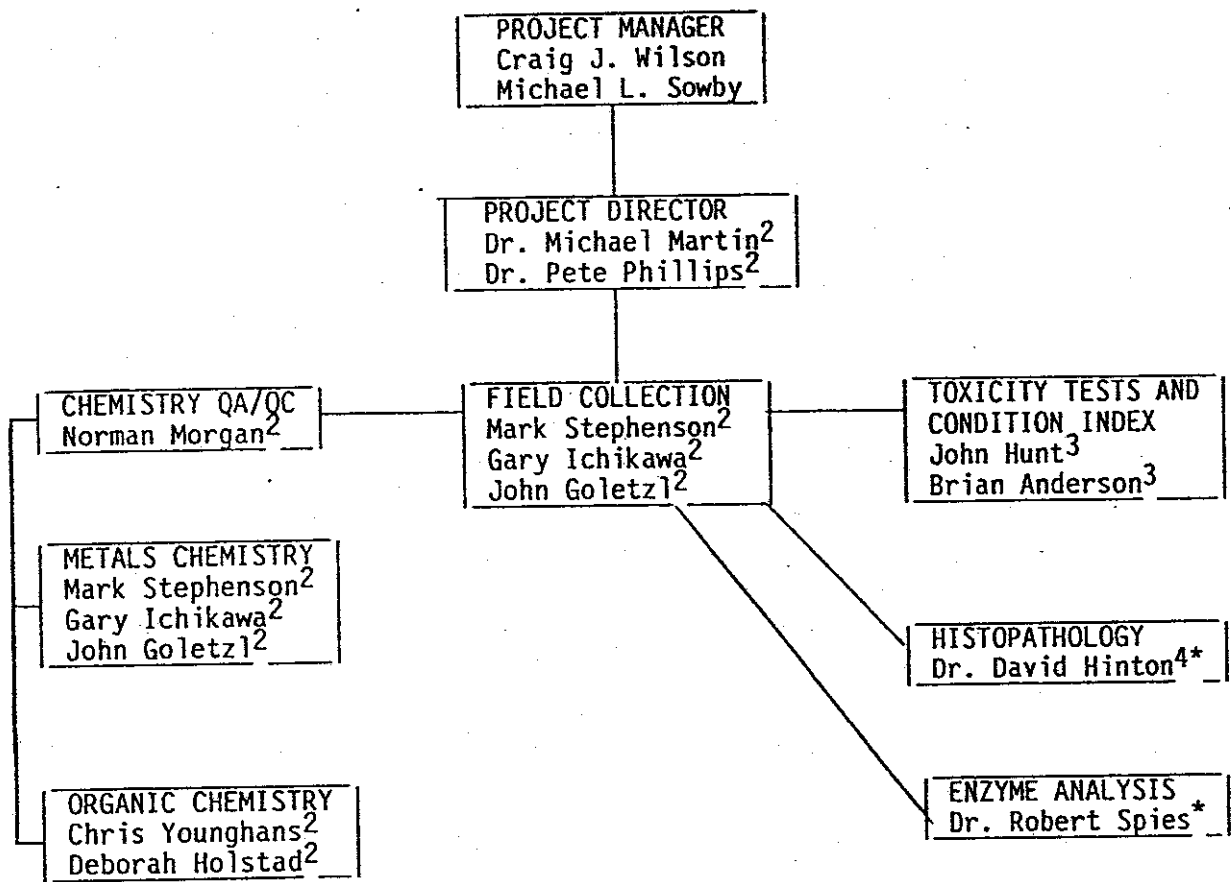
Responsibilities of overall programmatic and technical direction will be shared by both agencies. The State Board will disperse the merged funds to their prime contractor, DFG, for task implementation. If needed, the DFG will acquire certain skilled services from investigators at other state agencies, universities, and laboratories for implementation of the research. The DFG would be the principal contractor to the State Board for the project. Research results and products will be developed for review and access by all three agencies. All three agencies will provide technical staff support for program planning, determination of technical scope and methods, logistics planning and facilitation, data evaluation, report review, and agency interface.

A one to three year research program is planned by NOAA, beginning with a funding level of about \$165,000 in FY 1991. Collaboration with other NOAA offices and other Federal agencies would be handled by NOAA staff, while State of California interagency arrangements will be handled by the State Board.

In the first year the work will be focused upon the Los Angeles/Long Beach and Anaheim Bay area, and in the subsequent years the work, if funded, would shift further south down the coast. The State Board, NOAA and the DFG will summarize the results of the first year work. The State Board will prepare proposals for each subsequent year of research when NOAA confirms that funding is available. At the completion of subsequent years technical reports will be prepared by NOAA, State Board and DFG. This summary also will include similar data collected with the same methods, in other parts of the study area.

6. Project Staff

The State Board will provide the Project Manager for the program and he will have overall authority for the Program. The DFG will be the primary contractor for the proposed program and will provide personnel and resources for field collections and chemistry analyses. Subcontractors will include the University of California at Santa Cruz (UCSC) and Davis (UCD). The subcontract to UCSC will include all work associated with all sediment toxicity studies. USCD will also conduct the condition index and gonadial index (methods test only) on all test fish. The UCD subcontract will cover the histopathology and enzyme work to be conducted on the test species of fish. The project organization chart is presented in Figure 2.



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1. State Water Resources Control Board
 2. California Department of Fish and Game
 3. University of California at Santa Cruz
 4. University of California at Davis
- *Proposed Researcher

Figure 2. Project Organization Chart

J. Costs and Time Schedule

<u>TASK</u>	<u>COST/SAMPLE</u>	<u>COST</u>
o Sediment Toxicity 39 sites x 3 stations x	\$960	<u>\$112,320</u>
o Sediment Chemistry 15 sites x 3 stationx x	Metals \$250 AVS \$320 Organics + PAH \$906 TOC \$ 45 Grain Size \$ 35	\$11,250 14,400 40,770 2,025 1,575 <u>\$70,020</u>
o Methods and Evaluation Step for Enzyme Tests in Gobies 2 sites x 15 samples	x Enzyme Analysis \$270 x Gonad Analysis \$ 25 x Collection	8,100 750 1,890
2 sites x 3 samples	x Tissue Chemistry Metals \$250 Organics and PAH \$960	1,500 5,760 <u>17,900</u>
o Fish Tissue Chemistry 9 sites x 3 replicates x	Metals \$250 Organics + PAH \$906	6,750 24,462 <u>31,212</u>
o Fish Biomarker Survey 9 sites	x 30 Histological Samples @ \$ 50 x 30 Condition Index @ \$ 27 x 15 Enzyme Analyses @ \$270	13,500 7,290 36,450 <u>\$57,240</u>
o Sample Collection 49 stations x (cost/site)	\$895	<u>\$43,855</u>
o Benthic Sample Archival 33 sites x 3 stations x 5 cores x	\$ 25	2,475
	TOTAL	<u>\$335,022</u>

The time schedule for the Project is presented in Table 1.