Naval Command, Control and Ocean Surveillance Center
RDT&E Division
San Diego, CA 92152-5000

Environmental Quality Technology

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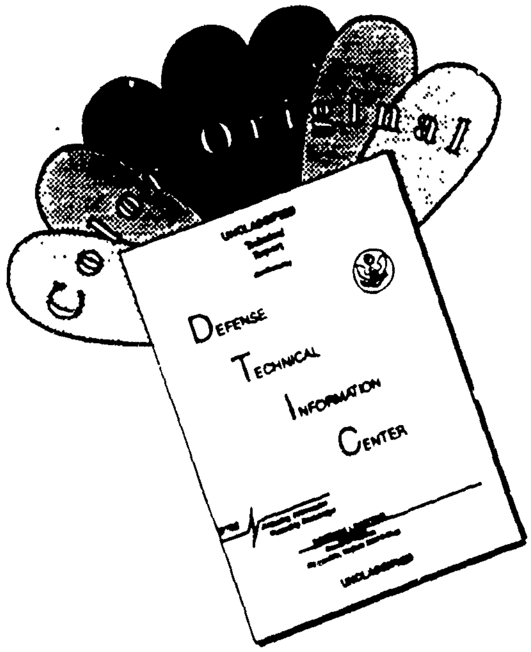

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INTRODUCTION

The Navy has ships and facilities in nearly every coastal state, and therefore, has a long-term interest in protecting the environmental health of marine ecosystems, specifically those located in harbors and estuaries where the Navy has port facilities. The Navy's goals are to obtain environmentally safe ships and shore facilities, to investigate and remediate past hazardous waste (HW) disposal sites, and to comply with the National Environmental Policy Act, the Clean Water Act, and other legislative and regulatory requirements. The Environmental Quality Science and Technology program at the Naval Command, Control and Ocean Surveillance Center RDT&E Division (NRaD), Environmental Sciences Division, consists of research, development, test, and evaluation projects (RDT&E) in support of this effort. The primary focus of the RDT&E program is on environmental risk assessment and restoration issues. Specific emphasis is placed on environmental measurement and monitoring instrumentation, contaminant fate and effects methodologies, biotechnology, and integrated risk assessment methods. In addition, the program provides support and information to interested Navy sponsors and other agencies.

The Navy has made a strong commitment to the Environmental Quality Science and Technology program through its investment in research facilities, instrumentation, and personnel within the Environmental Sciences Division. NRaD personnel working in the environmental area have expertise in chemistry, biology, physiology, biochemistry, microbiology, oceanography, engineering, physics, management, and environmental sciences and health. Various well-equipped laboratories, facilities, and analytical instrumentation provide the necessary tools with which to conduct research and development. A Marine Environmental Support Office (MESO) provides direct support to the Fleet and to facilities working in marine environmental science and the technology transfer of environmental RDT&E. Cooperative efforts have been established with other agencies and universities, including a Memorandum of Agreement (MOA) with the U.S. Environmental Protection Agency (EPA) Environmental Research Laboratory, Narragansett, RI, and research agreements with the Scripps Institution of Oceanography, Tufts University, Virginia Institute of Marine Science, Clemson University, Skidaway Institute of Oceanography, San Diego State University, and others. Although cooperative efforts are pursued, the majority of R&D is conducted at NRaD, resulting in over 300 peer-reviewed journal articles, symposia, and technical reports.

As environmental issues become increasingly important to the Navy, and the cost of environmental compliance continues to escalate, the work being accomplished at NRaD in the area of marine and estuarine environmental quality and environmental restoration continues to provide technically innovative and cost-effective methodologies and solutions to many of these environmental problems.

TECHNOLOGY AREAS

The Environmental Quality Science and Technology program is a comprehensive RDT&E effort (including site-specific demonstration projects) that focuses on many aspects of the risk assessment and restoration process. The research and development projects being conducted address the areas of contaminant loading to the environment, transport pathways of pollutants, eventual fate of the pollutant, biological consequences, remediation, and long-term monitoring of the environment. All of these areas are important to the overall understanding of environmental risk assessment, management, and communication. By integrating these research and technology efforts, scientists at NRaD are able to understand and describe the overall impact of pollutants on the aquatic environment from naval activities and operations, and support is provided for improved pollution control measures and regulatory compliance.

The specific areas of R&D being conducted at NRaD, and in cooperation with other agencies, are discussed below.

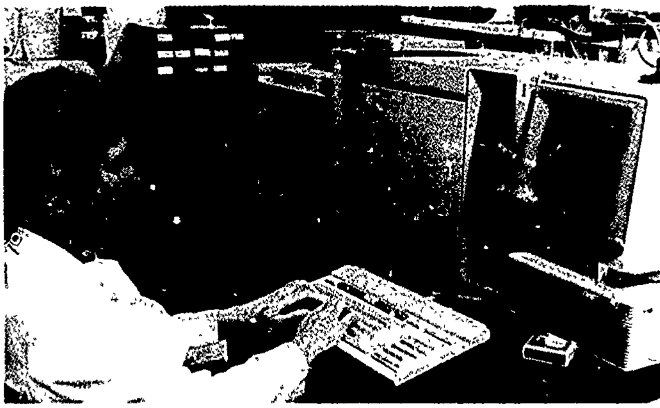
MEASUREMENT TECHNOLOGY

Realtime and near-realtime field instruments are preferred to satisfy the increasingly comprehensive regulations for environmental monitoring and hazard assessment. NRaD is at the forefront in developing instruments that provide *in-situ* chemical measurements having greater temporal and spacial detail and improved accuracy in a cost-effective and timely manner.

Systems and methods completed or currently under development include the following:

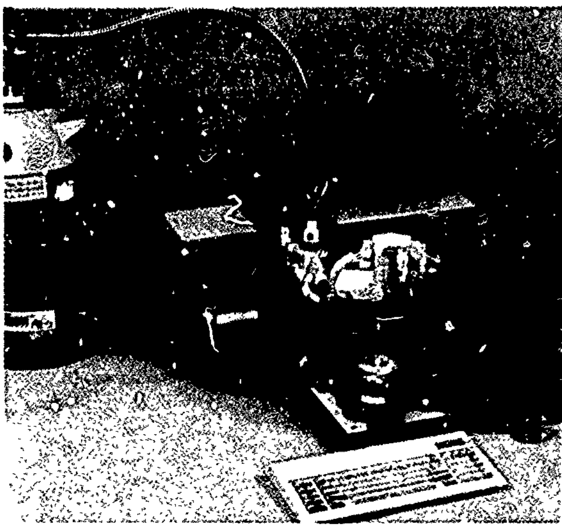
- **Rapid Chemical Screening Methods**
- **Automated Organometals Analyzer**
- **Hand-Held Lead Analyzer**
- **Benthic Flux Sampling Device**
- **Fiber-Optic Chemical Sensor**
- **Cone Penetrometer Sensor**

RAPID CHEMICAL SCREENING METHODS



Researcher working with a gas chromatograph-mass spectrometer instrument used for the identification of unknown organic compounds.

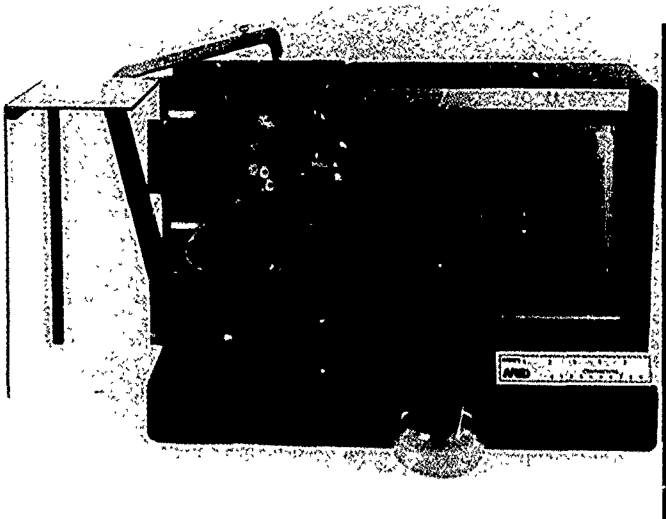
The Navy has a need for methods of measurement, both chemical and instrumental, that are adaptable to field and/or fast response requirements of hazard assessment. Developing and testing these methods requires the use of a wide variety of spectrophotometers: Fourier Transform Infrared (FTIR), ultraviolet-visible (UV-Vis), mass spectrometers coupled to a gas chromatograph, and fluorometers. Since organic pollutants are often complex mixtures, various separation techniques are used. Simple techniques and portable field instrumentation are tested using sophisticated laboratory-based equipment such as gas chromatographs with a number of detectors, including a mass spectrometer and High-Performance Liquid Chromatographs (HPLC).



Automated organometals analyzer system showing LN_2 reservoir, detector/computer unit, analytical unit, keyboard and display.

AUTOMATED ORGANOMETALS ANALYZER

Organometals are important contaminants in aquatic and terrestrial HW sites. Adequate rapid speciation protocols are not currently available. This project has developed an automated organometals analysis system for monitoring aquatic HW sites to provide near-realtime analysis with speciation that can determine the extent of contamination, improve assessment capability, and reduce monitoring costs.



Lead analyzer system: The computer controls all aspects of operation, data acquisition, and analysis.

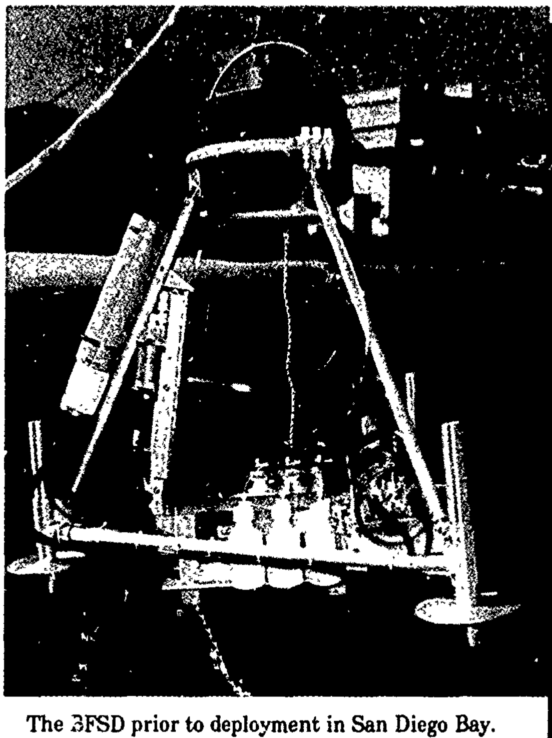
HAND-HELD LEAD ANALYZER

Lead contamination is recognized as a significant national health problem. The U.S. EPA has lowered the lead drinking water standard, necessitating a large monitoring program at Navy facilities. A field analysis capability can lower analytical costs significantly as well as reduce the required time for this effort.

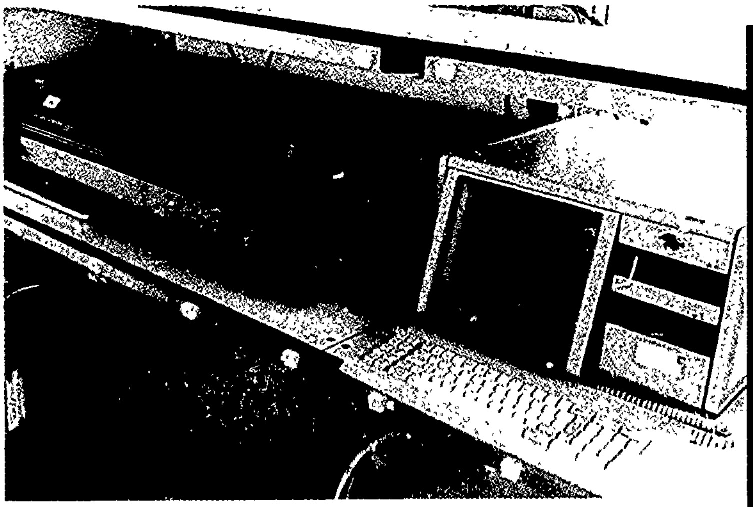
A new-generation trace metal analyzer, based on potentiometric stripping analysis, has been developed to provide a rapid, *in-situ* measurement capability for lead, cadmium, zinc, and copper. The instrument is currently transitioning to an advanced prototype model for field test and evaluation. The system is truly portable and capable of batch or continuous sampling operation from shoreside or mobile platforms.

BENTHIC FLUX SAMPLING DEVICE

In conjunction with scientists from Scripps Institution of Oceanography, NRaD has developed a Benthic Flux Sampling Device (BFSD) to quantify mobility of toxicants from contaminated sediments. The BFSD is a remote instrument for *in-situ* measurement of toxicant flux from sediments. A flux out of, or into, the sediment is measured by isolating a volume of water above the sediment, drawing off samples from this volume over time, and analyzing these samples for increase or decrease in toxicant concentration. Increasing concentrations indicate the toxicant is fluxing out of the sediment. Decreasing concentrations indicate the toxicant is fluxing into the sediment. Initial tests carried out in conjunction with Scripps and EPA's Environment Research Laboratory (Newport, OR) show that the system is capable of measuring a variety of contaminant and nutrient fluxes.



The BFSD prior to deployment in San Diego Bay.

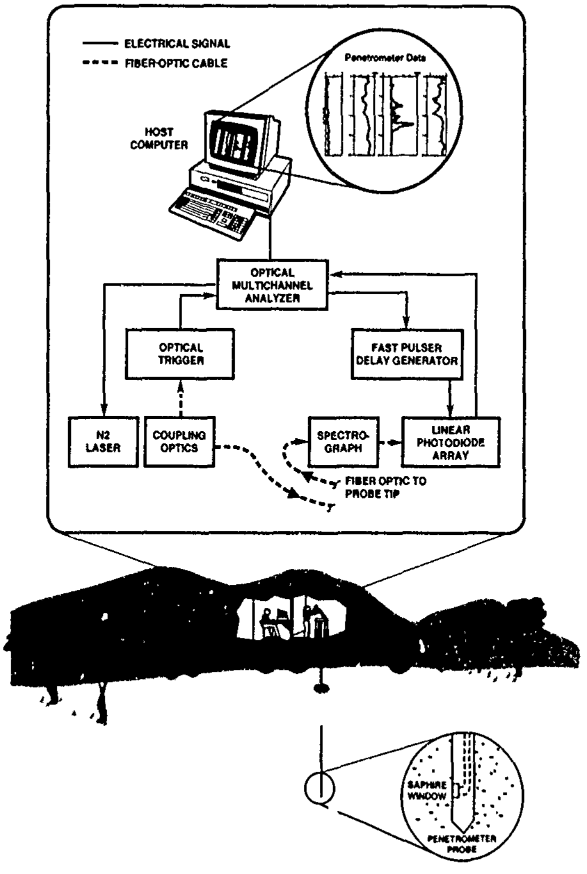


Photograph of fiber-optic-based chemical sensor system installed on MESC survey craft. The sensor uses a fiber-optic cable (up to 100 meters in length) to facilitate remote laser-induced fluorescence measurements of contaminants directly in seawater, groundwater, and soils.

FIBER-OPTIC CHEMICAL SENSOR/CONE PENETROMETER SENSOR

A fiber-optic-based chemical sensor system has been developed permitting remote, realtime, *in-situ* measurements of chemical contaminants in water or in soils at contaminated sites. The system employs laser-induced fluorescence measurements to directly quantify petroleum hydrocarbons. A novel renewable indicator delivery system is under development that will extend the technique to chemical species that do not normally fluoresce (e.g., trace transition metals). A time-grated, one-dimensional photodiode array permits rapid quantification of complete emission-spectra and fluorescence-decay signatures as a means of improving sensor specificity. The system has recently been adapted and tested with a cone penetrometer system used to insert the optical-fiber sensor into the ground to depths of 150 feet or more. This permits realtime, *in-situ* screening of petroleum hydrocarbons in soils and ground water at HW sites. This system should be adaptable to remote use for monitoring effluents and detecting leaks and spills.

Cone Penetrometer Fiber Optic Fluorometer
(Double Fiber System)



Schematic of laser-induced, fiber-optic chemical sensor system used for *in-situ* subsurface screening of petroleum hydrocarbons. Realtime depth profiles of petroleum-oil-lubricants (POL) are generated and displayed as the penetrometer probe is pushed into the ground at a rate of approximately 1 meter/minute.

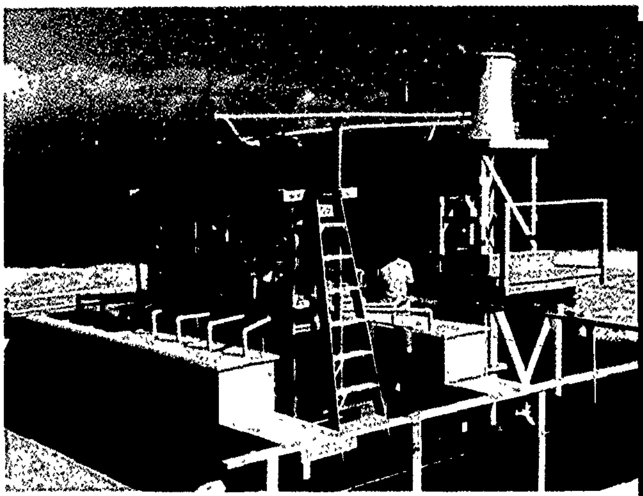
CONE PENETROMETER SYSTEM

The cone penetrometer system is a new cost-effective system for rapid subsurface screening of HW sites. The system, developed under a triservice (Army, Navy, Air Force) program, is capable of making realtime *in-situ* measurements of petroleum-oil-lubricants (POL) using a novel laser-powered, optical-fiber sensor system and determining soil characteristics with conventional, cone-penetrometer strain gauge measurements. Information is displayed in realtime as the probe is pushed into the ground to depths of 150 feet. As a rapid-screening tool, the penetrometer system can be used to locate and define the extent of subsurface contaminant plumes. This provides a means for intelligent placement of monitoring wells, thereby reducing the number of wells (and associated costs) required for a site assessment.

CONTAMINANT FATE AND EFFECTS METHODOLOGY

Determining the distribution fate and effects of specific contaminants in marine and estuarine environments is a scientifically challenging process requiring a multidisciplined approach. NRaD is conducting a variety of research projects to improve the methodology of accomplishing this goal, drawing on the latest technological advances biology, chemistry, hydrodynamics, and computer modeling and prediction. A number of recently completed and on-going projects and capabilities are listed below.

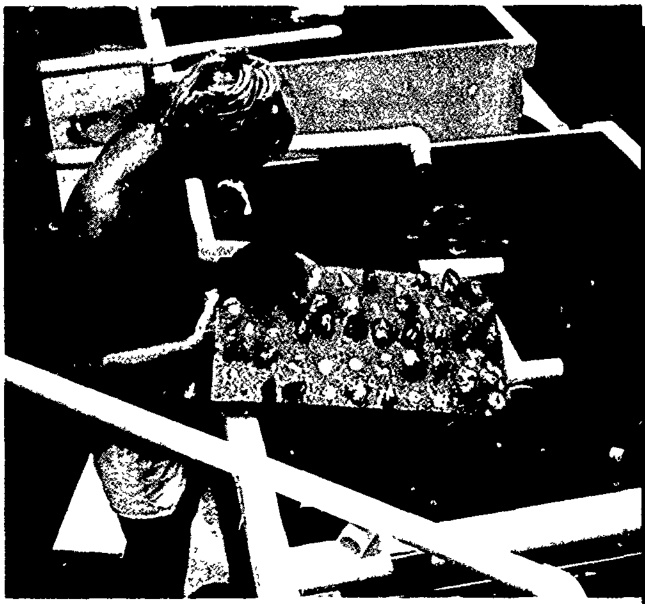
- **Portable Microcosms for Environmental Testing (POMFRET)**
- **Nonpoint Source (NPS) Assessment and Technology**
- **Aquatic Multiparameter Near-Realtime Mapping**
- **Contaminant Dispersion and Prediction Model**
- **Bioindicator Development**



POMFRET system testing efforts of dredge spoils at the Ulupau Microcosm Facility.

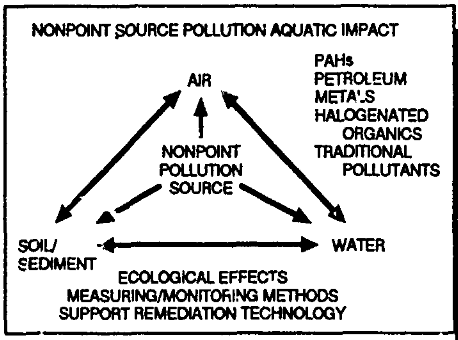
PORTABLE MICROCOSMS FOR ENVIRONMENTAL TESTING (POMFRET)

POMFRET is a system developed by NRaD scientists that can be deployed at specific aquatic sites (e.g., Navy-used harbors) to evaluate the chronic effects of pollutants or altered physical factors on resident marine organisms. The core of the system consists of 12 outdoor 100-gallon aquaria (microcosms) capable of maintaining low- to medium-diversity assemblages of organisms for periods of several months. The microcosms are provided with a continuous flow of unfiltered seawater and are exposed to normal sunlight. As such, they are linked energetically to the natural world, receiving input of ambient sunlight and nutrients, and are colonized by larval organisms entering with the supply water. Typical experiments run for 1 to 6 months. By controlling all parameters and selectively introducing specific pollutant levels to the tanks using a novel diluter system, chronic effects data are produced that can provide information on the long-term effects that elevated temperatures, altered salinities, or pollutants such as heavy metals, pesticides, sewage effluents, dredge spoils, hydrocarbons, and hazardous waste have on natural populations of marine organisms.



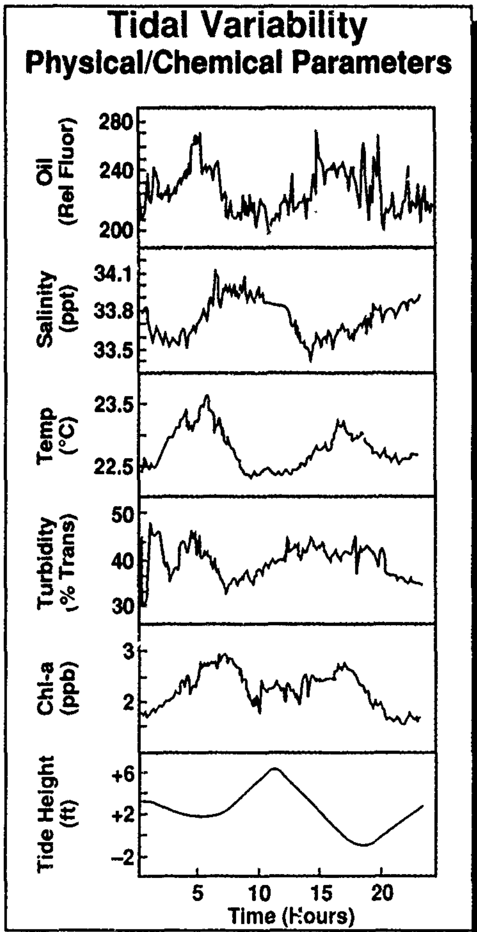
Evaluating the effects of tributyltin on oysters by using the POMFRET system.

NONPOINT SOURCE (NPS) ASSESSMENT AND TECHNOLOGY



NPS pollution is not confined to a single environmental partition. Cross contamination leads to complicated ecological impacts.

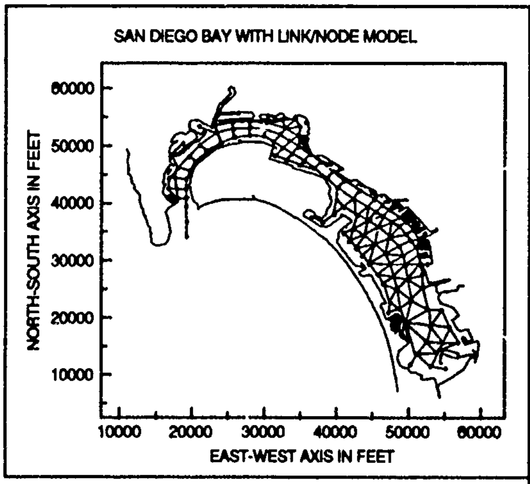
The U.S. EPA's 1984 report to Congress states nonpoint source (NPS) pollution, chiefly from storm drains, is the largest contaminant source in the nation's rivers, lakes, and estuaries. Since then, restrictions on point source pollution have tightened while NPS is largely uncontrolled. Humans are at risk because we drink, swim, and fish in waters with unsafe levels of contaminants due to NPS pollutants. Aquatic biota in these habitats are also at risk. Risk assessment methods are needed to provide the means to measure environmental and human impact as well as to define appropriate remediation levels. A program is underway at NRaD to evaluate the environmental risks from Navy NPS and provide input for remediation strategies



Time series data from a site in San Diego Bay showing tidal variability of various physical/chemical parameters.

AQUATIC MULTIPARAMETER NEAR-REALTIME MAPPING

This project is developing a modular, water quality mapping system that can be used to conduct realtime chemical analyses, support biological studies, and determine hydrographic parameters in harbors, bays, estuaries, and other near-shore environments. The system is generally used aboard the NRaD 40-ft research vessel *ECOS* to map harbors and estuaries used by the Navy.



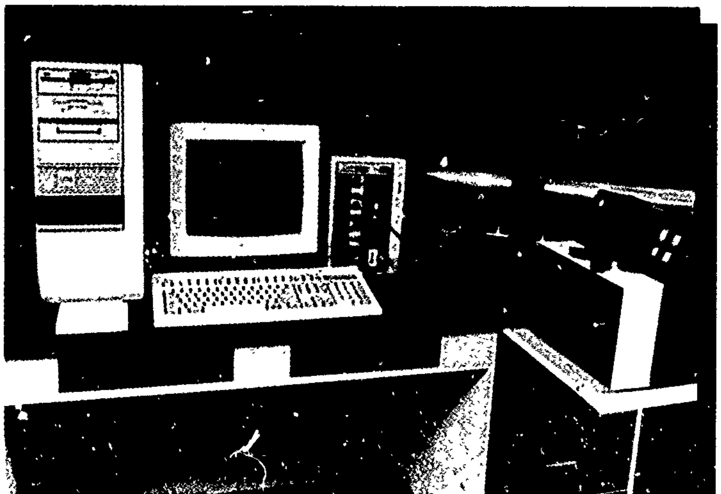
The physical layout of an EPA link/node model for San Diego Bay. Water and toxicants are allowed to flow along the links (lines), and toxicant concentrations are periodically calculated at the nodes (line intersections).

CONTAMINANT DISPERSION AND PREDICTION MODEL

The objective of this project is to validate hydrodynamic and toxicant transport models predicting toxicant dispersal and partitioning into water column, sediment, and biological fractions. This effort will initially focus on harbors and bays, and contaminants that are of special interest to the Navy.

BIOINDICATOR DEVELOPMENT

This project will extend current biological toxicity assays for both lab and field use and develop correlation methods to allow realistic comparisons of field and laboratory biological data. Organism-based assays and biochemical methods to detect sublethal biological effects of contaminants will provide sensitive bioindicator systems for direct and cost-effective evaluation of effects of toxicant impact on marine biological systems.



The QWIKLITE bioassays comprise a suite of new and innovative toxicity tests designed to measure acute and chronic biochemical effects in phytoplankton populations and marine organisms found in coastal areas. Shown is the lab assay instrumentation.

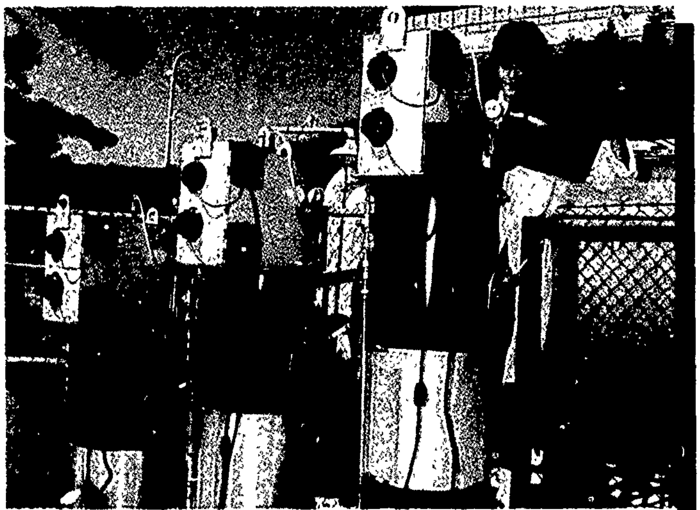
These tests measure reductions in bioluminescence from marine dinoflagellates, chlorophyll fluorescence from marine algae, and adenosine triphosphate (ATP) from phytoplankton, zooplankton, and other marine organisms in response to their exposure to contaminants and hazardous wastes. These bioassays can be set up within a few hours and run with minimal effort for short (3 hours to 96 hours) and long term (10 days) toxicity tests. The immediate advantages for the Navy represent substantial savings in cost when compared to the cost of conducting more "traditional" bioassays and provide ample sensitivity for detecting biological impact.

ENVIRONMENTAL BIOTECHNOLOGY

Potential advantages resulting from microbial biodegradation processes, such as lowered costs and improved efficiency, make research in biotechnology and bioremediation at NRaD important for the future. Developing biochemical methods for identifying stress factors in natural organism populations will also provide significant savings when conducting environmental assessments and remediations.

Current programs include the following:

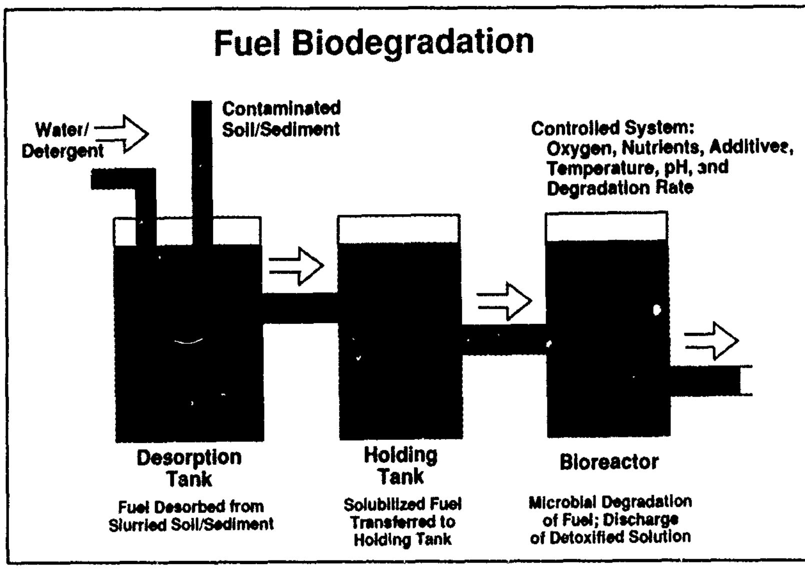
- **Bioreactor Project**
- **Fuel Biodegradation**
- **Marine Biomarkers**



Slurry bioreactors arranged in a gravity-feed cascade permit maximum control of the degradative processes while allowing for maximum throughput of contaminated soil or sediments.

BIOREACTOR PROJECT

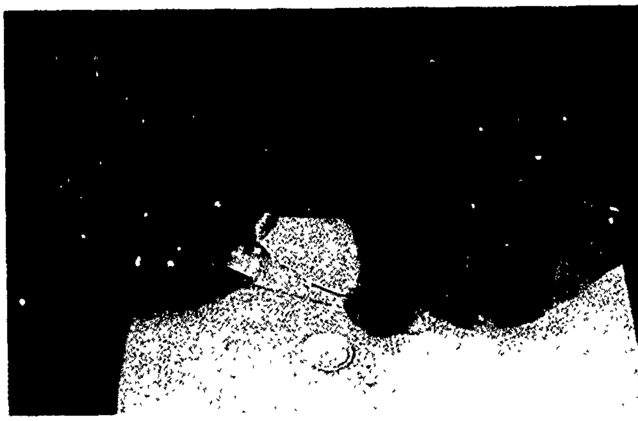
The use of enclosed reactor systems for degrading hazardous wastes provides complete control of biodegradation processes, improves monitoring of microbial metabolic activities and permits testing of microbes specifically engineered for enhanced degradation capabilities.



One of several options in the bioremediation of fuel-contaminated soils is to wash the contaminant from the soil by using various surface active agents. The cleaned soil can then be returned to the site while the wash water is treated in a series of aqueous bioreactors.

FUEL BIODEGRADATION

This fuel biodegradation project will optimize microbial enhancement procedures with emphasis on marine diesel fuels and Navy jet fuels. Fuel biodegradation is to include induction procedures for adapting or pre-adapting microbial populations to target contaminants. It also includes nutrient amendment studies and related methods for stimulating microbial attack on target contaminants. Fuel biodegradation further includes optimization of bulk culturing techniques to be employed with the selected and adapted microbes. Pilot scale work will be conducted using a cascaded, three-reactor system that will be scaled up for an on-site field demonstration.



Blood serum (haemolymph) and blood cells (haemocytes) from individual animals often contain sufficient stress proteins for analysis. Removal of these products with a hypodermic syringe and needle is both convenient and nonlethal to the donor animal.

The use of antibody-based assays, such as the enzyme-linked immunosorbent assay (ELISA), configured in 96-well microfilter plates, permits rapid, specific, and sensitive measurements of stress protein biomarkers.

MARINE BIOMARKERS

Monitoring of serum and tissue stress factors (biomarkers) from sentinel organisms (e.g., mussels) allows early assessment of the health status of endangered populations before significant mortality can occur. Careful monitoring of tissue stress proteins (heat shock proteins) can potentially provide information on the level or degree of stress as well as provide clues regarding the nature of the stressor. Following this, additional tests can be carried out to further define the causative agent (e.g., induction of cytochrome P450 would indicate elevated PAH levels, or increased metallothioneins would suggest an influx of heavy metals).

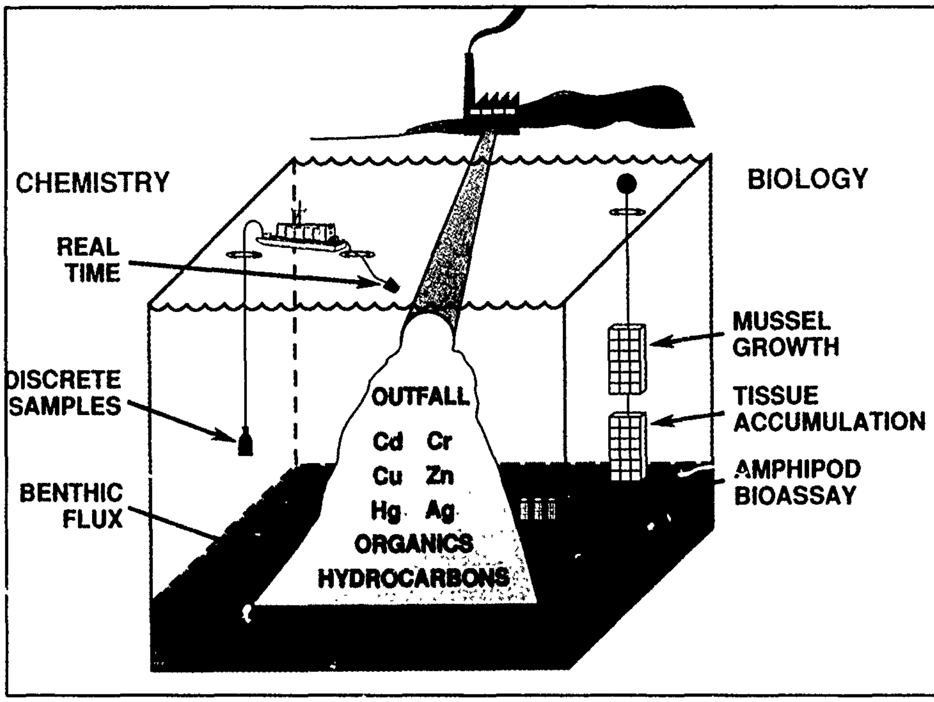
A parallel effort has been developed for evaluating the growth, development, and contaminant uptake in juvenile mussels. This system provides important data on sublethal effects and the bioavailability of contaminants under field conditions. Other candidate organisms include phytoplankton, mysids, and amphipods.

INTEGRATED ENVIRONMENTAL RISK ASSESSMENT

The concept of integrated biological and chemical analyses has been shown to provide more realistic data in the ecological risk assessment process. NRaD scientists working jointly with scientists from the U. EPA Environmental Research Laboratory, Narragansett, RI, and the Institute of Wildlife and Environmental Toxicology, Clemson University, SC, are advancing these concepts to support the risk assessment process for both aquatic and terrestrial site investigations at HW sites under CERCLA and other requirements.

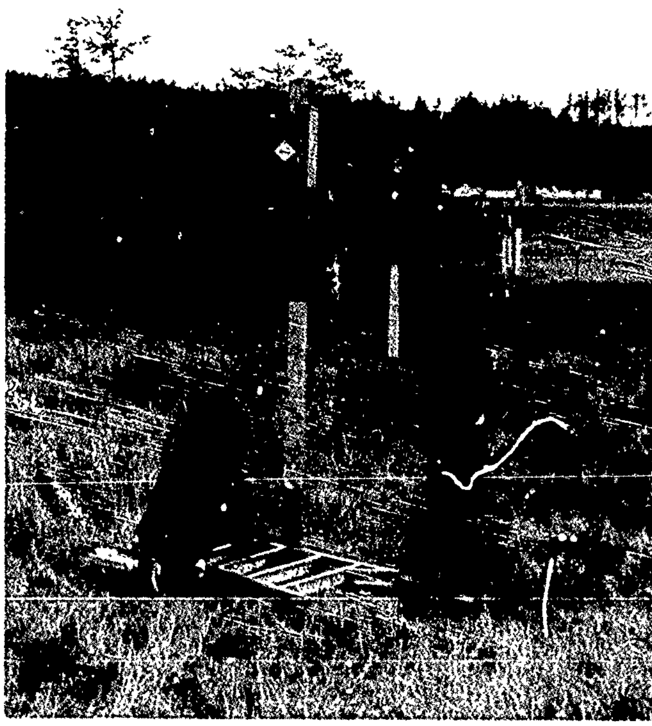
Current assessment projects proposed or underway include the following:

- **Naval Air Station (NAS) Whidbey Island, WA, Toxicology Demonstration**
- **Naval Construction Battalion Center (NCBC) Davisville, RI, Risk Assessment**



This figure depicts the collection of biological data: mussel growth-rate dynamics, accumulation of harbor contaminants in tissues of various organisms, and response of organisms when exposed to various contaminant concentrations in bioassay tests. Chemical data collected include realtime water parameter measurements (temperature, salinity, contaminant concentration, etc.), discrete collection of environmental samples (water, sediment, and tissues) for later laboratory analysis, and the movement, or flux of various chemicals either into or out of the harbor bottom sediments.

An example of integrated environmental risk assessment methodology for a "typical" harbor environment would employ multiple chemical, physical, and biological measurements, such as real-time measurements of various harbor parameters, water current speed and direction, determination of contaminant flux to and from the sediments, organism growth, toxicological response, and bioaccumulation. An integration of these parameters forms the basis for both contaminant and ecosystem characterization. Environmental monitoring and characterization data are used to determine contaminant exposure and ecosystem effects. These integrated data are evaluated to provide a quantitative assessment of risk to the environmental region of concern.



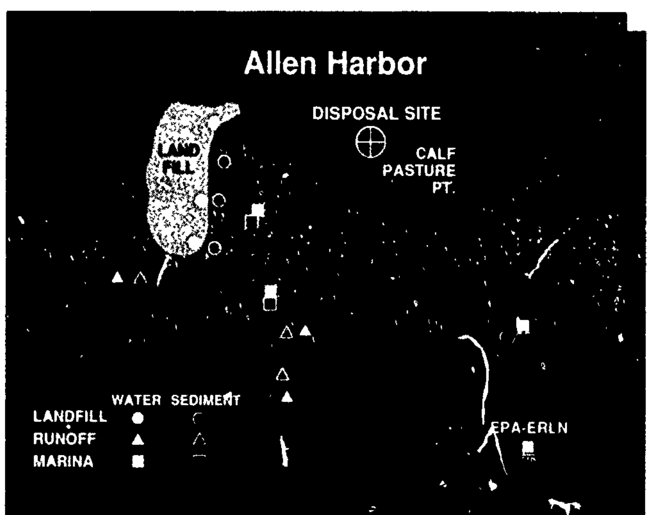
Field use of starling nest boxes for ecotoxicology studies.

NAS WHIDBEY ISLAND TOXICOLOGY DEMONSTRATION

The NAS Whidbey Island Toxicology Demonstration is funded to conduct toxicological studies to assess the potential impact of HW on wildlife and evaluate risks associated with remediation of waste sites, especially those included under the EPA's National Priority List (NPL).

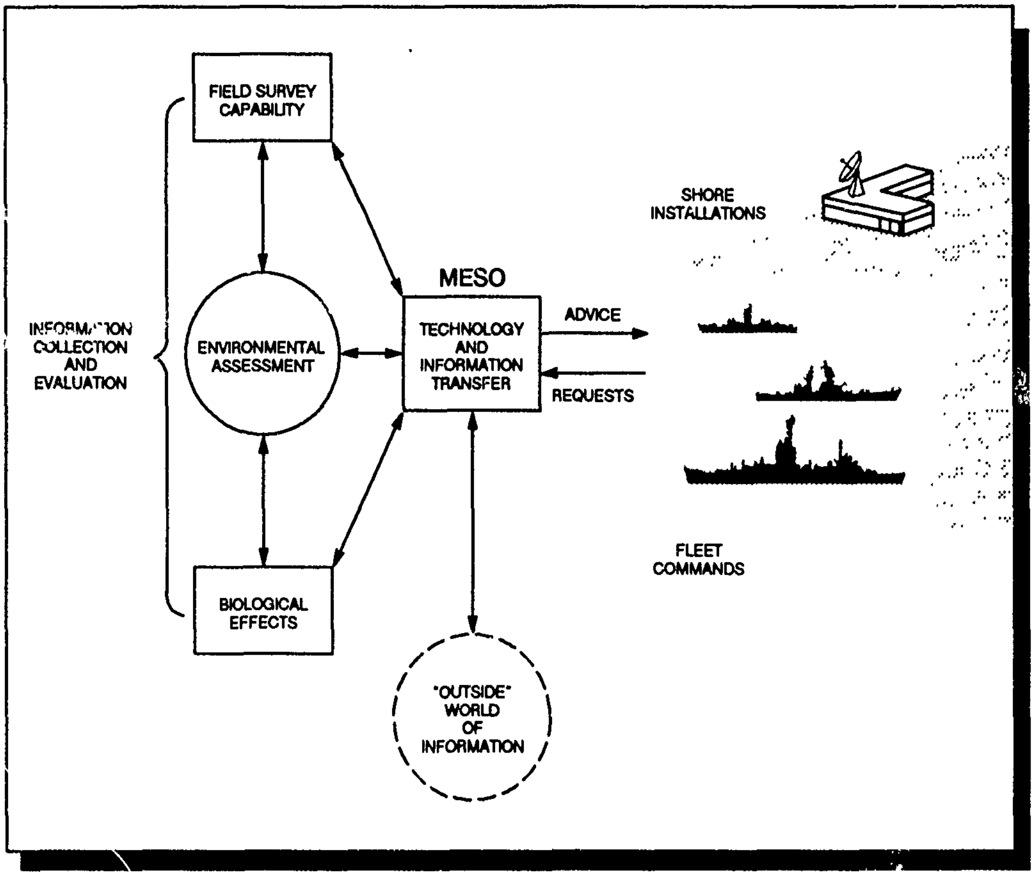
NCBC DAVISVILLE RISK ASSESSMENT

The focus of the NCBC Davisville project is to conduct an ecological risk assessment to determine the risk of HW sites on the marine environment, select the most cost-effective remediation, and develop guidelines for conducting future ecological risk assessments at impacted aquatic sites.



Chemical and biological sampling locations are shown in Allen Harbor and Narragansett Bay. Samplings are used to evaluate potential aquatic impacts from the landfill site adjacent to the harbor.

MARINE ENVIRONMENTAL SUPPORT OFFICE (MESO)



Research studies conducted at NRaD have resulted in the accumulation of large amounts of information as well as experience pertaining to marine environmental issues. NRaD scientists maintain contact with regulatory agencies and research institutions to keep current with environmental requirements and state-of-the-art technologies. The Marine Environmental Support Office is available to provide scientific and technological transfer between the user organizations responsible for environmental compliance (such as Navy Engineering Field Divisions and other DoD agencies) and the environmental R&D community (such as NRaD scientists, academia, EPA, and NOAA Laboratories) and policy makers (such as Federal, State, and local regulators).

FUTURE R&D EFFORTS

ENVIRONMENTAL SENSOR SYSTEMS

FIBER-OPTIC SENSOR SYSTEMS FOR *IN-SITU* MEASUREMENTS IN MARINE SEDIMENTS

Extend the capabilities of the fiber-optic fluorescence sensor to enable *in-situ* sediment analysis.

FIBER-OPTIC SENSOR SYSTEMS FOR FACILITIES MONITORING

Extend the same technology (Fiber-Optic Sensor Systems) for use from piers and outfalls. These extensions would entail both hardware and analysis methodology modifications to the current system.

NEURAL NETWORK DATA ANALYZER

Develop a software Neural Network System that will automatically analyze two- and three-dimensional matrix-type sensor data and formulate decisions based on the analysis. Determine the expected accuracy of the results and data set requirements for training the networks.

UNDERGROUND SENSOR EMPLACEMENT SYSTEMS

Develop and test a system for inserting optical-fiber and/or solid-state sensors directly into the ground at HW sites. The system will employ a hydraulic-ram system that can push a "drop-off" sensor probe to a desired depth and then withdraw leaving the sensor probe in place. This capability would obviate the need for drilling wells in order to collect samples or install sensors. The system will provide an improved capability for long-term subsurface monitoring useful for evaluating the risk associated with movement of contaminant plumes, and evaluating the effectiveness of remediation efforts. Another important application is for locating leaks associated with underground storage tanks and distribution systems.

CRYSTAL DETECTOR FOR COPPER ION IN SEAWATER

Further develop the understanding and theoretical basis of Copper Ion Selective Electrodes to develop a highly sensitive, realtime detector of copper ion activity in seawater media. This detector would be a valuable and versatile environmental sensor for measuring toxic copper for the long-term defense of Navy use of copper AF systems.

ASSESSMENT, MONITORING, AND REMEDIATION TECHNOLOGY

IMAGING TECHNOLOGY FOR AQUATIC COMMUNITY ASSESSMENT (VIDEO FISH)

Develop and test a system for acquiring acoustic and optical images in conjunction with physical and chemical data integrated with high-precision underwater navigation to perform biological census surveys in the marine environment.

AUTONOMOUS ENVIRONMENTAL MONITORING SYSTEMS

Develop a stand-alone sensor and telemetry package that can be deployed from both stationary data buoys and free-swimming autonomous underwater vehicles. The integrated package will use newly developed and emerging technology in sensor systems, acoustic telemetry links, underwater vehicle design, and "smart" processing systems to facilitate collection and telemetry of long-term environmental data from moored buoys and short-term detailed mapping from underwater vehicles.

ENVIRONMENTAL MONITORING BY SPECTRAL RADIOMETRY

Use airborne and spaceborne remote sensing technology to develop a capability for large-scale, realtime environmental monitoring.

REMOTE SENSOR FOR DETECTION AND MAPPING OF OIL SPILLS AND SLICKS

Develop a noncontact, surface-scanning sensor for early warning of oil spills from ships and at berthing facilities, and for mapping of oil spills and slicks in the near-shore marine environment.

REMEDIATION OF MARINE SEDIMENTS

Develop a process for the remediation of marine sediments contaminated with complex mixtures of toxicants. This process would be a multistage treatment strategy integrating physical, chemical, and biological remediation techniques.

RISK REDUCTION AND REMEDIATION OF TOXIC EFFLUENTS

This project would evaluate the assimilative and detoxifying capacity of peat and other naturally occurring organic-rich material as a means of remediating and reducing the ecological risks of effluents from nonpoint sources, hazardous waste sites, and other toxic effluents.

RESOURCES

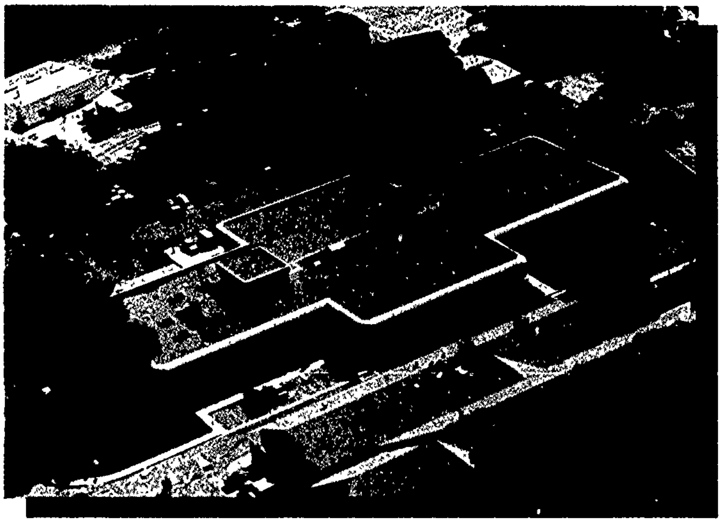
FACILITIES AND EQUIPMENT

INTERNAL AND EXTERNAL INFRASTRUCTURE AT NRaD, SAN DIEGO, CA

The broad range of Navy, academic, and industrial facilities associated with the Marine Environmental Quality Technology and Ocean Sciences programs makes the San Diego region a unique area for locating a Navy marine environmental research and development laboratory. Within 20 miles of NRaD are six major Naval and Marine Corps Commands, numerous smaller commands, and major subsurface, surface, and air assets available for environmental investigations.

Many state-of-the-art facilities, and a wealth of technical expertise from NRaD personnel, are available to support the Environmental Quality Science and Technology program. Available resources include advanced mechanical and electronic engineering facilities, a high-level computer center with a link to a super-computer, image- and signal-processing computers, machine shops, access to research and support vessels, and tethered and autonomous undersea vehicles.

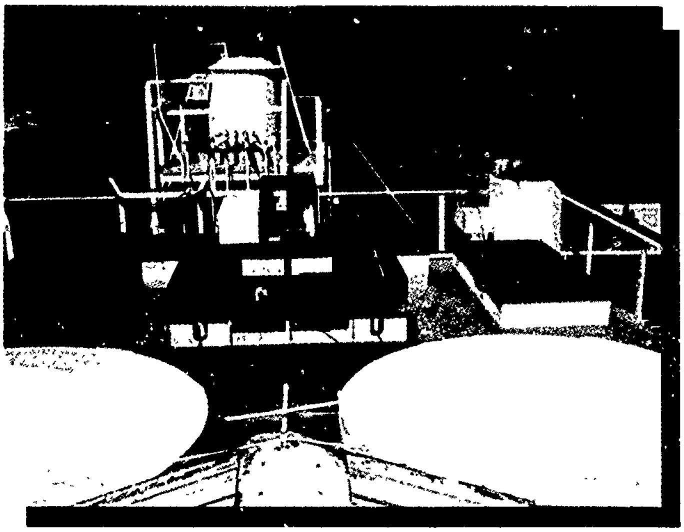
The Scripps Institution of Oceanography, Marine Physical Laboratory is colocated at NRaD, and several universities, including the University of California, San Diego, and San Diego State University are in close proximity to provide effective links with academia. In addition, many research and industry concerns associated with the marine environment are also located in the San Diego area, making it a world center for marine studies.



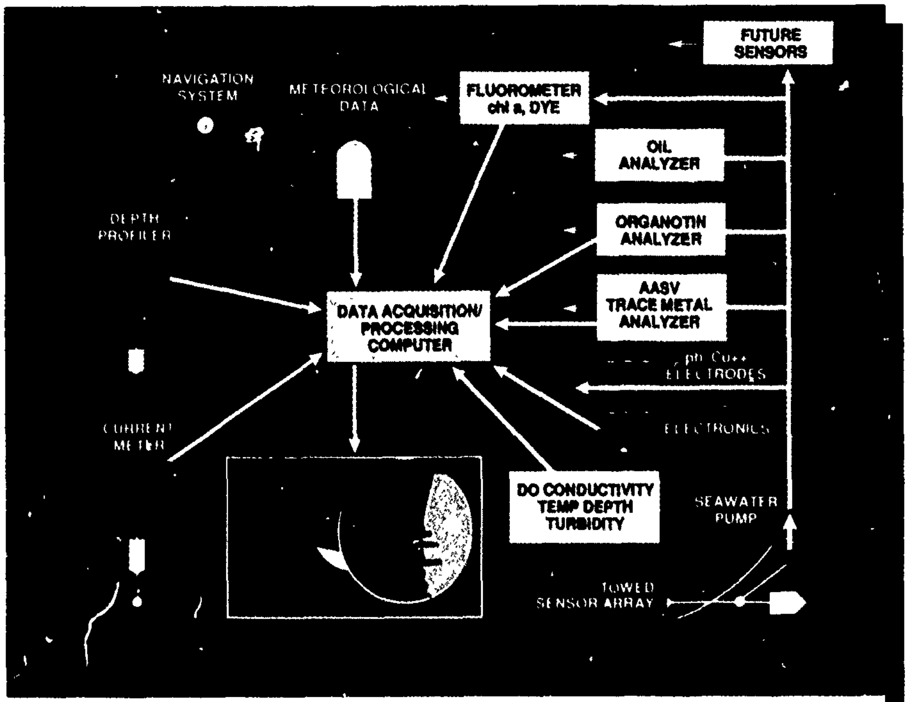
ENVIRONMENTAL OCEAN SCIENCES LABORATORY, NRaD, SAN DIEGO, CA

The Environmental Ocean Sciences Laboratory was constructed in 1986 and provides a state-of-the-art facility for RDT&E in Environmental Quality, Aquatic Risk Assessment, Biological Indicator Systems, Chemical Instrumentation, and Ocean Sciences. The 52,000-square-foot facility contains 7 Chemistry Labs, 3 Biochemistry Labs, 2 Biology Labs, and 3 Instrument and Sensor Development Labs. All labs are equipped with the most current analytical instrumentation. In addition, there are 15 Radiation Physics, Computer, and Electronics Labs, and a Machine Shop. The building features a high-capacity flow-through seawater system for biological studies. Nearby pier space is available for environmental survey and support craft. A mobile bioassay facility for flow-through marine assessment studies is also available.

MARINE MICROCOSM FACILITY, NRaD, KANEOHE, HI



The Marine Microcosm Facility is a unique flow-through, high-quality seawater laboratory on the open coast of Hawaii at Kaneohe Bay, and has been in use for 15 years. The 18-tank microcosm facility provides miniature ecosystems under natural conditions to evaluate risk to ecological communities from pollutants such as organotin and other antifoulants, fuel products, ship hull-cleaning debris, and other metals, organics, or environmental perturbations that may be caused by Navy activities and operations.



Schematic of MESC system showing integration of measurement systems and realtime display.

MARINE ENVIRONMENTAL SURVEY CAPABILITY, NRaD, SAN DIEGO, CA

The Marine Environmental Survey Capability (MESC) system provides rapid continuous measurement and mapping of environmental chemical, physical, and biological parameters in estuarine and marine systems to support environmental hazard assessment, global marine compliance, and environmental restoration requirements.

The system is incorporated in a custom aluminum 40-foot twin-diesel craft, the R/V *ECOS*, with a 200-square-foot lab with complete oceanographic measurement capability. The system is transportable and can be trucked or flown to any study area.

ANALYTICAL CAPABILITIES AND INSTRUMENTATION

The Environmental Sciences Division has a wide range of instrumentation, sensors, and computers that provide the necessary analytical capabilities to support RDT&E in the Environmental Quality Science and Technology program. A partial list of these capabilities and instruments follows.

Analytical Capabilities

- Realtime Fiber-Optic-Based Chemical Analysis
- Other Realtime Data Acquisition and Processing
- Modeling and Prediction
- Field and Laboratory Toxicity Assessment
- Invertebrate/Vertebrate Toxicity Assessment
- Field Monitoring
- Site-Specific Bioassays
- Bioaccumulation/Bioavailability Studies
- Assessment of Ocean Dump Sites
- Seawater Analysis
- Radiation Detection and Measurement
- Animal Serum and Tissue Chemistry and Biochemistry

Instrumentation

- Atomic Absorption Spectrophotometers
- ICP Atomic Emission Spectrophotometers
- Gas Chromatographs
- High-Performance Liquid Chromatography (HPLC)
- Gas Chromatograph with Mass Spectrometer (GC/MS)
- Ultraviolet-Visible Spectrometers
- Infrared Spectrometers
- Standard and Specialized Electrochemical Analytical Instrumentation
- Microwave Digestion System
- Scanning Electron Microscope
- Electrophoresis Instrumentation
- Cell Culture Instrumentation
- Automated Organotin and Trace Metal Analyzers
- Bioremediation Instrumentation
- Gamma Radiation Detectors
- Various Types of Scintillators
- Neutron Detectors
- Beta Particle Detectors
- Automated Systems for Biochemical/Molecular Biology Analysis
- Two Dimensional Densitometry System
- X-Ray Fluorescence

MANAGEMENT AND PERSONNEL

The resources and personnel of the Environmental Sciences Division are provided by the Commanding Officer, RDT&E Division (NRaD) of the Naval Command, Control and Ocean Surveillance Center (NCCOSC), through the Naval Space and Warfare Systems Command (SPAWAR). The Assistant Commander for Environment, Safety and Health, Naval Facilities Engineering Command, (NAVFACENGCOM), maintains approval and review authority of a major portion of this effort with additional support from the Naval Sea Systems Command (NAVSEA), and from the Office of the Chief of Naval Research (OCNR). The programs are managed by P. F. Seligman, Head, Environmental Sciences Division, Code 52, under the direction of H. O. Porter, Head, Marine Sciences and Technology Department, Code 50.

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