Section 1
Scope of Work

At over 1620 ha (4000 acres), Mission Bay Park is the West Coast's largest aquatic park and represents one of the City of San Diego's unique treasures. The Park is used year-round for walking, jogging, picnicking, swimming, rowing, sailing, fishing and water-skiing. Besides its value for recreation, Mission Bay Park also hosts a diverse assemblage of species indigenous to the southern California coastline, and is home to several wildlife preserves that provide important habitat for the federally endangered least tern, brown pelican and lightfooted clapper rail. Designated beneficial uses of the Park include water recreation, commercial and sport fishing, shellfish harvesting, spawning, migration, marine habitat and wildlife habitat.

Unfortunately, the effects of urbanization within the Mission Bay watershed have affected the overall water and sediment quality of the Bay. The Regional Water Quality Control Board has identified 623 ha (1540 acres) of Mission Bay as impaired under the Federal Clean Water Act due to elevated coliform bacterial levels, while portions of the Bay also are listed as impaired for lead and eutrophication (Regional Water Quality Control Board 1994). While some monitoring has been performed in Mission Bay, the data collection efforts typically have focused solely on bacteria and human health impacts of pollution, ignoring a systematic approach aimed at studying, understanding and preserving ecological communities within the Bay.

To better understand and address problems regarding the ecological status of communities in Mission Bay, the University of San Diego, in conjunction with project partners San Diego BayKeeper and AMEC Earth and Environmental, implemented a multiyear study of water quality, sediments, and pelagic and benthic communities in Mission Bay. The "**Mission Bay Water and Sediment Testing Project**" began in November 2001 and continued through May 2003, with sampling at six sites, one each near the three major sources of fresh water input to Mission Bay (Tecolote Creek Inlet, Cudahy Creek Inlet, Rose Creek Inlet), two representative of large regions of the bay (Fiesta Bay, Sail Bay), and one site (Ventura Point) near the mouth of the bay (Fig. 1).

This project was undertaken with three major goals:

1) Develop baseline water quality, sediment and benthic community monitoring data for Mission Bay and begin the process of analyzing the relation between monitoring data and environmental factors in the watershed.
2) Provide the City of San Diego, regulatory agencies, and other stakeholders with the necessary data to make informed choices while developing and implementing an effective Watershed Management Plan and other pollution prevention strategies.
3) Utilize the citizen monitoring aspect of the project as a means to educate students and the general public about the environmental and human health impacts of urban runoff and other pollution sources.

Figure 1. Aerial view of Mission Bay showing approximate locations of sampling sites at Tecolote Creek Inlet (TC), Cudahy Creek Inlet (CC), Rose Creek Inlet (RC), Fiesta Bay (FB), Sail Bay (SB), and Ventura Point (VP). Image source: www.globexplorer.com

To address these goals, the project was broken into five major tasks.

Task 1: Program Management and Administration
Task 2: Development of Monitoring Program
Task 3: Program Implementation
Task 4: Development and Implementation of Community Education and Outreach Program
Task 5: Draft and Final Report

These tasks have been accomplished, as described below.

Task 1: Program Management and Administration

1.1 Provide all technical and administrative services as needed for contract completion

The work performed in conjunction with this project was monitored, supervised and reviewed, as stipulated in the contract. The contract itself was completed within budget in accordance with approved procedures, applicable laws and regulations.

1.2 Quarterly Status Reports

Status reports were submitted to the Contract Manager in March, July, and December 2002 and July 2003. Each report described the project status and major developments since the previous report.

1.3 Summary Form for Contract Execution

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1.4 Execution of Subcontracts

Subcontracts with San Diego BayKeeper and Amec Earth & Environmental were executed.

1.5 Project Summary Form

An executive summary is included with this final report.

Task 2: Development of Monitoring Program

2.1 Meet with Representatives of the City, Regional Board, and Other Stakeholders

Prior to the initiation of sampling, a series of planning meetings was conducted to set goals for the program, determine major issues of concern in the watershed area, determine sampling parameters, discuss methods to be used to measure each parameter, and set up a plan for volunteer training, as well as begin the development of appropriate quality assurance procedures (QAP) for the monitoring program.

2.2 Map the Mission Bay Sampling Sites

Six sampling sites within Mission Bay were identified and mapped with GPS during the initial stages of the field sampling. For sampling of sediments and benthic communities, three subsites within each site also were identified and mapped with GPS. Sites were selected based on accessibility, safety, and usefulness in meeting project goals by covering the three major sources of fresh water input to Mission Bay (Tecolote Creek Inlet, Cudahy Creek Inlet, Rose Creek Inlet), large regions of the bay (Fiesta Bay, Sail Bay), and one control site (Ventura Point) near the mouth of the bay.

2.3 Purchase Equipment and Supplies Needed to Analyze Water Samples

Equipment and supplies were purchased as needed for the collection and analysis of water samples from Mission Bay.

2.4 Contract with Licensed Water Quality Lab for Metals Testing of Samples

San Diego BayKeeper and AMEC contracted with Calscience Environmental Laboratories, Inc., to analyze metals in water samples collected quarterly at the six sampling sites.

2.5 Develop a Quality Assurance Plan (QAP) for the Program

Quality Assurance Plans (QAPs) and QA/QC handbooks were developed by San Diego BayKeeper and AMEC. These plans and handbooks are not part of this report but are being submitted as separate documents.

2.6 Work with San Diego BayKeeper to Develop Training Materials

Training materials were developed to instruct interns and volunteers in the proper techniques and procedures for data collection, analysis and reporting. Copies of those materials are included as an appendix to this report.

2.7 Work with San Diego BayKeeper to Mobilize Water Monitoring Volunteers

Student interns and student and community volunteers monitored water quality as a complement to the monitoring being carried out by students and faculty from the University of San Diego. A list of interns and volunteers is included as an appendix to this report.

Task 3: Program Implementation

3.1 Pelagic and Benthic Community Assessment

Biweekly sampling of phytoplankton and zooplankton communities was conducted using a towed plankton net at six sites within Mission Bay from November 2001 through May 2003. The first collection of samples on 6 November took place less than 36 hours following a rainfall event that deposited more than 0.20" of rain on much of the San Diego area. This collection satisfies the requirement to include a wet-weather sampling event in the data set. Species abundance and composition of phytoplankton and zooplankton were determined in each tow sample. Sediment fauna were collected monthly from November 2001 through December 2002 using surface-deployed grab samplers. Species abundance and composition of benthic meiofauna were determined in some of the grab samples. The analysis of benthic fauna is not yet complete; results to date are reported here, and the remainder will be submitted as an addendum to this report. Grain size distributions have been determined for some of the sediment samples collected with the grab. Additional grain size distribution measurements are being conducted and will be submitted as an addendum to this report upon completion. Although not specified in the original scope, water content and organic content also were determined for sediment samples collected with the grab.

3.2 Water Column Sampling and Analysis

This aspect of the program was overseen by USD instead of San Diego BayKeeper, as originally specified.

3.2.1 Volunteer training

Volunteer training was conducted by San Diego BayKeeper throughout the course of this program.

3.2.2 Collection and analysis of water samples

Biweekly water column sampling was conducted at six sites within Mission Bay from November 2001 through May 2003. On each sampling date, the sites were examined visually and general conditions were noted. Water samples were collected with a Van Dorn bottle at the sea surface and at 2 m depth. As described for the plankton sampling, the first collection of samples on 6 November took place less than 36 hours following a rainfall event that deposited more than 0.20" of rain on much of the San Diego area. This collection satisfies the requirement to include a wet-weather sampling event in the data set. At each biweekly sampling event, the water column was profiled with a digital multimeter at 0.5 m intervals from the sea surface to just above the sea floor. Measurements included temperature, salinity, dissolved oxygen

concentration, turbidity and pH. Water samples were brought to USD, filtered, and analyzed for nitrate, phosphate and silica.

3.2.3 Quarterly analysis of water samples

Once each quarter, water samples were sent to a certified water quality lab to be analyzed for the heavy metals copper, cadmium, lead and zinc. Initial assays were conducted for organophosphorus pesticides as well, but this practice was discontinued when no pesticides had been detected in the water column through the first six months of the program.

3.2.4 Random quality reviews of analytical results

Results of water quality analysis were reviewed regularly through the initial stages of the program and less frequently once the reliability of the procedure and personnel had been established.

3.2.5 Development of "train the trainer" program

San Diego BayKeeper developed and implemented a "train the trainer" program to educate volunteers about monitoring goals and protocols. This program has been highly effective.

3.3 Sediment Collection, Analysis and Toxicity Testing

3.3.1 Monthly sediment collection

Sediments were collected at all six sites (18 subsites) on a monthly basis from November 2001 to December 2002. Sediment samples were collected using surface-deployed grabs of the same type employed to collect sediment fauna (see 3.1). One set of samples was collected following a rain event for comparison with samples collected during dry weather.

3.3.2 Sediment toxicity testing

Sediment toxicity testing was carried out on a quarterly basis, beginning in November 2001 and continuing through November 2002 (five testing periods). The effects of sediment toxicity were evaluated for the estuarine amphipod species, *Ampelisca abdita,* and larvae of the bivalve, *Mytilus galloprovincialis* (often misidentified as *M. edulis*). During the first testing period, additional bioassays were performed on a second amphipod species, *Eohaustorius estuarius*, for comparison to the *Ampelisca* results. *E. estuarius* appeared to be more sensitive to sediment toxicity than *A. abdita* and was used for all subsequent toxicity assays in conjunction with this program.

3.3.3 Pore water toxicity testing

Pore water toxicity testing was not carried out. Instead, water column water from each site was tested for toxicity using the same bivalve embryo test mentioned above (see 3.3.2).

3.3.4 Analysis of sediments

Sediment chemistry was analyzed on a quarterly basis, beginning in November 2001 and continuing through November 2002. Assays performed on sediment samples included percent solids, total organic carbon, concentrations of metals (cadmium, copper, lead, zinc), polycyclic aromatic hydrocarbons (PAHs), total recoverable petroleum hydrocarbons (TRPH), and organochlorine pesticides.

3.3.5 Data analysis

Correlation tests were run between sediment composition and toxicity. Interpretation of the benthic data has been carried out and is included in this report.

3.4 Compilation of Analytical Results

The majority of the results from this program have been compiled and are contained in this report. A comprehensive database containing the data from this program is under development and should be available for web access in the near future.

Task 4: Development and Implementation of Community Education and Outreach Program

4.1 Development of Informational Materials

Informational materials have been developed, and representative samples are not part of this report but are being submitted as separate items.

4.2 Presentations at Informational Meetings

Results of this program have been presented at all meetings of the Mission Bay Clean Water Technical Advisory Committee. In addition, presentations describing the results of this program have been presented at the University of San Diego, Scripps Institution of Oceanography (UCSD), and meetings of the California Estuarine Research Society (CAERS), Society of Environmental Toxicology and Chemistry (SETAC), and San Diego Association of Geologists (SDAG). Presentations of program results also are scheduled to take place at international meetings of the American Society of Limnology and Oceanography (ASLO) in February and June 2004.

4.3 Development and Distribution of Press Releases

Copies of press releases distributed in conjunction with this program are included as an appendix to this report. Local television news coverage accompanied the initiation of this program, and it is anticipated that the results will be distributed to the media, after they have been submitted to the City.

Task 5: Draft and Final Program Report

5.1 Preparation and Submission of Draft Final Program Report

A draft final report was prepared and submitted in December 2003. Comments on that draft were received from the Contract Manager and from other program participants.

5.2 Preparation and Submission of Final Program Report

This is the final program report being submitted as part of this program. Additional data and information stemming from this program will be submitted as supplements to this report. For example, it is anticipated that data from this program will constitute an important part of no fewer than four M.S. theses currently being completed by students in the Marine Science Graduate Program at the University of San Diego. Copies of those theses will be submitted as each is completed.