

## C 1. Project Description

### a. Description of Existing Facility

This proposal would support the construction of a seawater system at the California Polytechnic State University's Marine Education and Research Center (MERC). The MERC is located 40 km from the Cal Poly San Luis Obispo campus on San Luis Obispo Bay at Avila Beach, approximately 160 km north of Santa Barbara (Figure 1).

**History:** In 1983 during an El Niño storm, the wooden petroleum transfer pier at Avila Beach was destroyed. Unocal Corp., the owners, received an emergency permit from the California Coastal Commission to rebuild over the site of the old pier and constructed a steel and concrete pier. The construction of the pier was completed in 1985 and petroleum operations were ongoing until in 1996 when Unocal discontinued its Central Coast oil operations. The pier was idle until earlier this year, when the facility and a maintenance endowment were donated to Cal Poly for use as an education and research laboratory.

**Facility:** The facility has two components, the base of the pier and the pier itself. The base of the pier is a two-acre open bluff with an existing fire suppression system for the pier and a parking area for vehicles. As the bluff has restricted access, the adjacent rocky intertidal areas are protected and serve as excellent field sites with a rich and diverse array of flora and fauna, including a harbor seal haul-out.

Approximately 200m off-shore, there is a 50 m wide kelp forest that transects the pier and has a resident population of sea otters as well as a subtidal kelp forest community.

The pier extends from this bluff 1 km into San Luis Obispo Bay (Figure 2). The structure is 7 m wide with a one-lane road for access to a large platform at the south end of the pier (Figure 3). The surface of the road is concrete for the first 300 m for enhanced structural integrity in the surf zone with a galvanized steel-grating surface for the rest of the length. The road transitions into a large 55 m long by 35 m wide platform at the southern end of the pier where the proposed seawater system will be installed (Figure 4). The platform is 10 meters above the water. There are two existing structures on this platform. The largest structure is approximately 10,000 sq.ft., with office space, a small wet laboratory,

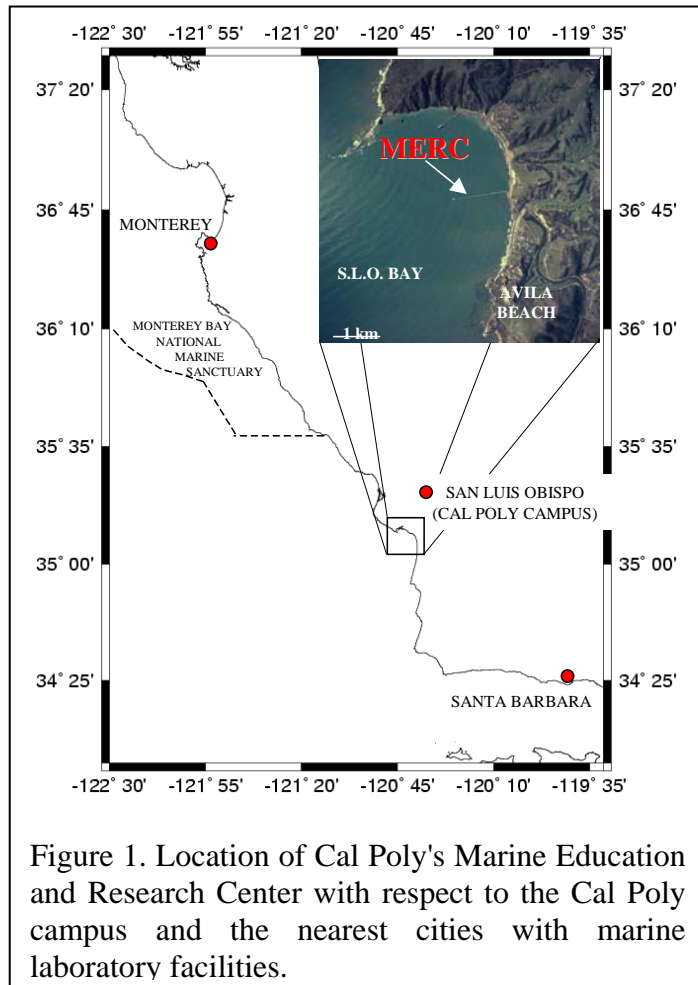


Figure 1. Location of Cal Poly's Marine Education and Research Center with respect to the Cal Poly campus and the nearest cities with marine laboratory facilities.

a machine shop, the electrical room, a storage room, a dive locker, a conference/classroom, a computer facility and restrooms with showers (Figure 5; the facility is connected to the local Avila Beach sewer system). The second structure serves as a boathouse and storage area. Prior to transfer of ownership, Unocal replaced the roofing on both structures.



Figure 2. Aerial view of the MERC from the South.

The total electrical capacity of the facility is 12Kv with multiple 480volt circuits. The high power design was required to power a moored ship, high capacity pumps, power the multiple banks of stadium-type lighting that exists around the platform, and two new 1-ton capacity hoists. The petroleum transfer equipment, such as the petroleum pumps, two additional oil-line hoists, and switching equipment, were removed when the facility was donated to Cal Poly. This high capacity power available will facilitate the installation of the seawater system.

The steel pilings of the pier extend to the bedrock and are filled with concrete, which mushrooms at the base of each piling for added structural integrity. The facility was constructed with a cathodic protection system to prevent corrosion. Before receiving the facility, Cal Poly assessed the state of this system and determined that after 15 years of operation, 80% of the cathodic system is still available. Projecting into the future, the existing system should provide protection without significant maintenance until 2060.



Figure 3. View of the facility from the North.

The surface of the platform at the south end of the pier is galvanized steel grating with the exception of a 20 x 20 m concrete surface in the center of the east side. On the west side of the platform is a counterbalanced trap door that opens to a staircase for access to the water and boats. The water access points are two 3 x 6 m platforms that alternate use depending on the tidal water height (Figure 6). Wooden pilings and a fender

system are installed along this side to accommodate day vessels ranging in size from day boats to 120-160 ft. ships. This area has high output mercury lamps for lighting during night operations. Directly above this access point to the water, is a 1-ton capacity electric hoist to lower boats and/or equipment that is operated from the main platform (Figure 7). A second hoist is positioned in the northeast corner of the platform for similar functions (Figure 4). The facility presently has two day-boats (1-28 ft; 1-22 ft) for sampling the offshore water column and accessing the many remote coastal sites. This direct access to the water surface will facilitate the installation and maintenance of the seawater system. Hydraulic capstans are installed around the end of the pier to tie off ships on both the east and west sides of the pier (the east side was designed for ships of up to 600ft to moor off



Figure 4. View of main platform, buildings and associated hoists

the pier). The nearby breakwater (Figure 1; inset) provides excellent protection against wave action, which greatly facilitates small boat and ship operations. Two moorings are situated to the north to allow boats/ships to moor off the pier during rare southerly storms, when peak swells occur.

The facility is presently being outfitted with a continuous real-time monitoring capability, measuring changes in physical, biological and chemical parameters (i.e. salinity, temperature, chlorophyll fluorescence and nutrients in the water column. In addition to the

in situ monitoring instrumentation, a meteorological station measuring wind speed and direction, relative humidity, air temperature, barometric pressure, and rainfall is being installed. These measurements are made for baseline information for instruction and public consumption as well as for targeted process studies. At the moment, a server is planned to archiving the data (see below in Proposed Improvements). Two telephone lines exist on the pier for data transfer to and from campus.

There is one two-lane road access to Port San Luis and the Pacific Gas & Electric Diablo Canyon power plant, 10km to the north. To avoid potential congestion in Avila Beach, access to the MERC for students is by vanpool with individual access given to resident and visiting faculty, staff and to those graduate students directly involved in instruction and/or research projects.



Figure 5. Main building on platform, with dive locker, conference/classroom, machine shop, offices and electrical circuitry.

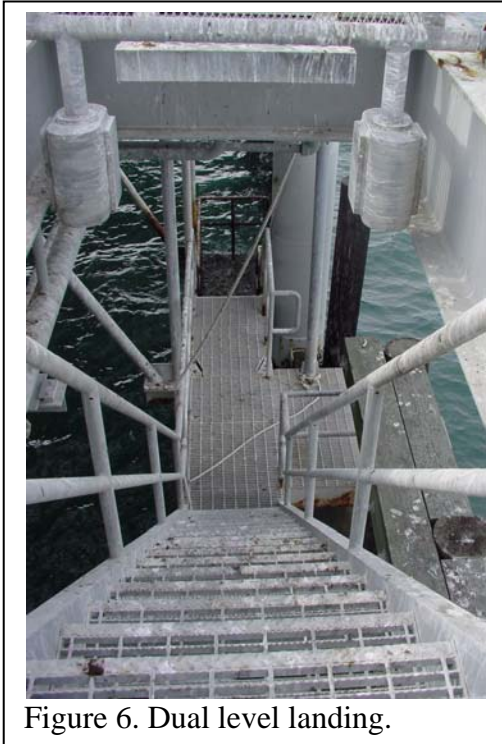


Figure 6. Dual level landing.

Facilities Administration: Facilities administration and curriculum/research planning occurs through a steering committee comprised of the dean of the College of Science and Mathematics, the chair of the Biological Sciences Department, three participating faculty members (including both authors), a representative of the Environmental Biotechnology Institute, the pier manager, and two representatives from Administration and Finance (A & F; Facilities Services and Risk Management offices). Educational and programmatic issues are primarily developed and administered by the Biological Sciences Department, and coordinated by the pier manager at the college level. Maintenance plans and safety policies of the MERC have been developed by and are addressed through A & F.

Research and Education Activities and Objectives: The MERC will serve as a primary focus for research efforts in the region by providing marine science expertise by way of

faculty, staff and students and facilities such as on site access to a seawater system, raw seawater, boat access, and water quality monitoring. The university is committed to this effort and is completing the process of hiring a new faculty member in Marine Ecology. This will bring the total number of faculty that are working in the marine environment to nine. In addition, the College of Science and Mathematics has hired a marine station manager, whose responsibilities will include overseeing safety procedures, diving operations, small boat handling, scheduling use of the facility, assisting in curricular needs and supervise a newly hired facilities technician.

The Biological Sciences Department at Cal Poly San Luis Obispo provides a cooperative atmosphere and sharing equipment among faculty is the norm, thereby increasing access to a large variety of high quality equipment. This cooperative approach also exists at the MERC. The following equipment is available for the MERC's education and research needs include; 12 PC computers (Pentium 3 & 4) and 2 Macintosh (G3 & G4), an Hewlett Packard 1100 HPLC, Shimatzu scanning spectrophotometer, a turner AU-10 fluorometer, Bio Rad Mini Protean gel-electrophoresis apparatus and Mini trans-blot



Figure 7. Boat hoist and trap door access to water surface (behind).

cells for western blotting, and power supplies a -80°C freezer, refrigerated bench-top and microcentrifuges, International Light broad band spectral underwater sensors (UVB and UVA) and radiometer, a SBE-19 CTD, a HOBILABS HS-2 profiling spectral backscatter sensor, HOBILABS HS-6 profiling spectral backscatter sensor, two profiling HOBILABS HYDRORAD-3 hyperspectral radiometers, two custom-built bathyphotometers, and a REMUS Autonomous Underwater Vehicle (AUV) outfitted with a CTD, an upward and downward looking ADCP, a Chlorophyll fluorometer, and backscatter sensor. In addition to numerous teaching microscopes, the following research microscopes are available 1) an Olympus BX 60 with fluorescence optics and an Optronics DEI 750 (Olympus) digital imaging system. 2) 4 each BH2 microscopes (with DIC, phase, and one with fluorescence, 3) an Olympus SZH dissecting) microscope, 4) an Olympus IMT-2 inverted compound microscope, and 5) an Olympus CK-II inverted compound microscope.

*The location of the new facility will provide the only marine laboratory facility along 320 km of some of the nation's least impacted coastline from Santa Barbara to Monterey.* Because of a chronic lack of facilities and access to the marine environment in this location and because of new pressures on marine resources in the area, there has been increased scientific interest in studying the biological dynamics in the region. The pier facility transects both rocky and sandy inter and subtidal habitats. At the base of the facility there is a pristine rocky intertidal community with a kelp forest extending 200m offshore. The facility is also near the SLO creek outlet and is an ideal location to examine the effects of seasonal rainfall runoff events on these coastal habitats. Morro Bay Estuary, designated as a National Estuary, is 20 km to the north of the facility. Point Conception (one of the most important oceanographic biogeographic features of the West Coast) is approximately 100km to the south. The majority of the coastline to the north extending to the Monterey Bay National Marine Sanctuary is relatively undeveloped and is ideal for the educational/research goals of the Center.

*One of the primary missions of the MERC is to combine our nationally recognized student body with our “learn-by-doing” philosophy on education in marine biology and related marine fields.* California Polytechnic State University, San Luis Obispo (Cal Poly) is a nationally ranked, four-year, public university (~18,000 students) whose primary mission is to educate undergraduate and Master’s level students. Cal Poly evolved from a vocational school to a major university, and emphasizes a “learn-by-doing” philosophy. The curriculum promotes active learning methods and includes a high proportion of laboratory and fieldwork in courses and student research. For example, typical courses have 2 hours of formal lecture per week versus 6 hours of laboratory/field experience. For science faculty, this means establishment of strong research programs that depend heavily on student participation. The University recognizes that an active research program will enhance student-learning experiences by providing an environment and opportunities for students to experience research first hand. In addition, involvement in research helps the professors as instructors and advisors to these students.

In keeping with the hands-on mission, undergraduate participation in research is required for graduation by the College of Science and Mathematics at Cal Poly. Teaching and research are intertwined and students enjoy learning by example while doing science, in a program that combines coursework with involvement in primary research. Many students become involved in research prior to their senior year and have learning experiences that can extend throughout their time at Cal Poly. All graduates in the University complete a senior thesis project. This ensures that each student has exposure to research before making critical career choices and it ensures that students are highly qualified for future employment and graduate school. Students learn that science is

accessible and have the opportunity to present this work at scientific meetings and to share authorship with the faculty on publications.

Cal Poly State University has been ranked as the best regional public university in the West nine consecutive years (1); rated 5<sup>th</sup> overall (public and private) regional university in the West (2), the 2<sup>nd</sup> most selective public university (3), with the Biological Sciences being the 3<sup>rd</sup> most selective biology department in California behind only UC Berkeley and Stanford University. By exposing these quality students to active research programs and providing hands on experience at the MERC, *we are in the unique position to fill the gap in marine education targeting undergraduates*. This proposal will help provide a basic system to meet these goals. The flowing seawater system at the MERC and the University's reputation will attract visiting scientists to collaborate on research projects. The Department also offers a quarter-at-sea program in collaboration with the CSU California Maritime Academy.

We are in an excellent position to enhance the learning opportunities of our diverse student body. As of Fall 2001, 45% of the student body was female and 29.3% of the population consisted of minorities. The College of Sciences and Mathematics distribution of students is similar, allowing us to involve students of all backgrounds to the marine environment and to increase research and educational opportunities for traditionally underrepresented students at MERC. Once we have the infrastructure in place (i.e. the proposed seawater system) we will be able to pursue more focused mentoring opportunities for undergraduates in environmental sciences and for minorities. The facility upgrade will also enhance our program and marine science by enabling us to compete for more National Science Foundation-funded opportunities, such as the Minorities in Marine Science Undergraduate Program (MIMSUP), Undergraduate Mentoring in Environmental Biology (UMEB), the Research in Undergraduate Institutions (RUI), and Research Experience for Undergraduate (REU) site awards. These programs will benefit Cal Poly students as well as visiting scientists and students visiting from other institutions.

The existing curriculum offers a Marine Biology concentration within the Biological Sciences Department with focused courses offered in Marine Biology, Phycology, Ichthyology, Marine Resources, Invertebrate Zoology, Functional Invertebrate Zoology, Aquaculture, Fisheries Biology, Marine Mammals, Reptiles and Birds, and Special Problems. Each one of these courses will utilize the MERC in formal classes by modifying or adding more field and/or experimental components to the laboratory sections of courses. Some courses will use the MERC for the majority of their laboratory courses, whereas others many use it to supplement the course for one or two labs. For example, Marine Biology students will come to the pier and perform water sampling and plankton tows from the floating docks or boats, but they will also expand this experience by culturing organisms they collect. This past year the Invertebrate Zoology students took one field trip to the rocky intertidal zone. Many other invertebrate phyla are distributed in different habitats and to illustrate this to students, a significant effort had to be made for individual collections to illustrate this point in the classroom. Next year, this course will utilize the MERC heavily for housing animals, water-sampling lessons, and to observe the adaptive zones of many marine invertebrates first hand. We intend to use the flowing seawater system to set up demonstrations of a sandy beach community to house sand crabs, mudflat tanks that reveal burrows of the occupants in the mud (in cross sectional view, similar to an ant farm), and we have kreisels that are designed to house delicate gelatinous organisms such as ctenophores and jellyfish. These specialized and valuable demonstrations are almost impossible to maintain without flowing seawater to provide oxygen rich water to these organisms. These demonstrations underscore the importance of the seawater system because they will expose the students to the wide

diversity of local invertebrates and provide learning opportunities for non-majors students in introductory classes that will start visiting the facility and for others in the surrounding community. These aquaria will be a highlight of laboratory tours with outreach programs and can also be utilized in research projects by faculty and students.

In addition, the senior thesis project provides an opportunity for undergraduates in the Marine Biology program to interact one on one with their instructors and design, implement and analyze a study. Examples of these projects range from examining multi-year population dynamics of the Northern Elephant seal at the Piedras Blancas colony to examining colonization rates of fouling communities in Morro Bay Estuary. These experiences are critical for their development as critical thinkers. A flowing seawater system at the MERC will allow students to expand the possibilities of research projects by creating the infrastructure for controlled experimental design. The primarily field-based observational studies could then be supplemented with projects that incorporate physiology, molecular biology, developmental biology, reproduction and general ecology of marine organisms.

The Masters program in the Biological Sciences Department is comprised of approximately 40 graduate students, 20-25% of which are conducting Marine related research. The Central Coast of California offers a wide diversity of marine habitats (rocky intertidal, sandy coastline, estuarine communities, kelp forest communities) in close (<1 Km) proximity to each other and the MERC. Graduate projects have and are taking advantage of this unique coastline, examining benthic processes (i.e. Eelgrass physiology and ecology) as well as water-column coastal processes (i.e. coastal bioluminescence, harmful algal blooms, fish population genetics). Graduate students also provide important mentorship for undergraduates, leading by example. This is promoted in the marine program and has been incredibly successful in focusing career paths of many students (both the mentors and the recipients). A flowing seawater system at MERC is vital to enable our students to expand their projects and learning experiences beyond basic fieldwork. The system will allow students and faculty to design more controlled experiments examine processes and to test the patterns observed in the field.

In addition to directed instruction, the Marine faculty members at Cal Poly pursue a number of research areas. Some specific core areas of research include; bioluminescence, population genetics in anadromous salmonids, *Zostera marina* physiology and mechanisms for distribution patterns, phytoplankton physiology/ecology, satellite remote sensing as applied to phytoplankton and physical forcing mechanisms, distribution and physiology of *Macrocystis* sp., invertebrate larval settling/development and developmental/cell biology in *Strongylocentrotus purpuratus*. Three projects are provided here as examples.

1. One specific set of projects that will rely on this seawater system will investigate effects of ultraviolet radiation (UVR) on marine invertebrates and the natural defenses they use to prevent damage. Many marine invertebrates and algae (especially planktonic organisms that float high in the water column) are exposed to damaging levels of naturally occurring UVR (290-400 nm). UVR inhibits primary productivity, interferes with reproduction, causes behavioral modifications, can be partially responsible for coral bleaching, induces production of protective compounds, effects food webs, and can cause death of marine organisms. Broadcast spawned gametes and free-living planktonic larvae of marine invertebrates are likely to be the most sensitive to UVR because most of them lack external coatings, they are transparent and small, and have limited control of their position in the water column. These stages are also exceptionally vulnerable because they are undergoing rapid cell division and growth and both processes are affected by UVR. Effects of UVR on molecules have been well

documented in mammalian somatic cells, but little is known about how UVR affects molecular targets in marine organisms and how those effects are translated to the whole organism. One of the best model organisms for studying effects of UVR at the molecular and organismal levels is the sea urchin embryo. UV-irradiation of sea urchin eggs and embryos delays cell division and can cause later developmental delays and gross abnormalities that lead to death or malformation of larvae. Such defects may decrease settlement and recruitment and can ultimately affect population dynamics.

Sea urchin eggs and embryos contain natural sunscreens, mycosporine-like amino acids (MAAs), which are thought to protect them from some UV-induced damage (Adams and Shick, 1996; 2001). However, it is not known what the molecular targets that lead to such damage are and how MAAs protect them. Our research will identify molecular targets in sea urchin eggs and embryos that are affected by UVR and whether these targets are protected by MAAs. Three specific aims are being addressed in this research. First, molecular targets of UVR will be identified to use as markers for assessing UV-induced cleavage delays in division in sea urchin (*S. purpuratus*) embryos. UV-exposure experiments will be performed in the laboratory to create consistent UV-dosages to identify targets of damage that can then be assessed in the field. Specifically, the cell cycle regulatory proteins will be examined as putative targets of UVR. Second, high performance liquid chromatography analysis of extracts of eggs and embryos will be conducted to determine the type and concentrations of MAAs present in eggs and embryos. Correlation analysis will determine whether there is a relationship between damage to molecular pathways with natural variation in concentrations of MAA in embryos. Third, experiments will be performed using natural solar radiation *in situ*, to determine how much damage and relative protection embryos may experience in the water column from solar UVR, whether damage is dosage dependent, and whether UVA (320-400 nm) and UVB (290-320 nm) have differential effects on embryos.

Eggs and embryos of sea urchins will be protected from or exposed to UVR in chambers that will be suspended in natural seawater or held in seawater trays in flowing seawater. The results of the proposed experiments should give us a better understanding of cellular targets that are affected by artificial and natural UVR in marine organisms and what targets may be protected from natural sunscreens. In addition, once these targets are identified they will serve as molecular markers for assessing damage among marine organisms and can be used as tools to monitor effects of UVR across time and space. Side projects are already developing from this work including investigating the concentrations of MAAs in local algae. We plan to perform controlled dietary studies to manipulate the concentrations of MAAs in sea urchin eggs to further examine the role of MAAs as sunscreens (Adams and Shick, 1996; Carroll and Shick, 1996).

**Filtered flowing seawater is essential to all of these projects because it will provide the basic medium for culturing sea urchin embryos and other invertebrates, it will allow us to assemble aquaria on the pier where we can rear healthy embryos and adults in aquaria that can be exposed to or shaded from UVR, and it will allow us to rear sea urchins on controlled diets to manipulate the concentrations of MAAs in their tissues.** Sea urchins and many other marine invertebrates are incredibly sensitive to oxygen concentration and require a great deal of maintenance in a closed recirculating system. Their survivorship is increased in aquaria with a constant supply of well aerated, filtered, flowing seawater.

2. A second example of a project that would directly benefit from the flowing seawater system is an ongoing study examining bioluminescence in the coastal region. The

MERC is outfitted with a profiling bathyphotometer designed to measure bioluminescence with depth over time. A second bathyphotometer is on an AUV platform and provides the spatial structure of bioluminescence in the surrounding coastal area. The structure of bioluminescence in the water column is dependant on the composition of the planktonic community. Both autotrophic/heterotrophic dinoflagellates and heterotrophic zooplankton (copepods to ctenophores) produce light, so determining the proportion of the light produced by any given group is difficult without direct examination. Direct examination of the discrete samples (corresponding to the instrument measurements) requires that zooplankton, in particular, be maintained at ambient seawater temperature. The samples must first be acclimated to temperature in the dark for a period of time and then probed to identify those zooplankters that are bioluminescent. These organisms are then isolated and enumerate. There is also benefit in collection of these organisms (including dinoflagellates) for culturing for quantification of light output (on an individual basis), calibration of instrumentation and as excellent demonstrations for laboratory instruction. The seawater system will provide that ability to easily maintain ambient temperature and allow for culturing of bioluminescent organisms. As part of an ongoing collaboration in bioluminescence, the MERC will be a site for a recently (3/21/02) funded Defense University Research Instrumentation Program (DURIP) to J. Case (UCSB; see section 5c: Letters of Collaboration and Resource Commitment).

3. The seawater system will also meet the requirements for in-line instrumentation being installed to monitor change in San Luis Bay over a range of time scales, which will provide the temporal environmental context for ongoing experimentation at the center. Funding is already available from the California Regional Water Control Board to install an in-line fluorometer to examine hydrocarbon concentrations and an in-line nutrient auto analyzer to examine fluctuations in nutrient loads in the region over time. As the MERC is situated near the SLO creek outlet, measurements on the pier facility will be able to document the pulsing of nutrients that occur during the relatively short (December-March) and intense rainfall runoff events and the effects of this nutrient loading on, for example, the structuring of the phytoplankton community within the bay. Cal Poly is already participating in the California Mussel-watch program (managed out of UC Berkeley) that monitors the structure of phytoplankton and particularly *Pseudo-nitzschia* spp. The nutrient ( $\text{NO}_3$ ,  $\text{PO}_4$ ,  $\text{NH}_4$ ) monitoring would provide the temporal context to interpret fluctuations in this toxic phytoplankter.

The seawater system will also facilitate numerous collaborative projects on going with the Environmental Biotechnology Institute at Cal Poly, presently focused on quantifying microbial community diversity and marine biotechnology. These projects combine ecological, physiological, and molecular aspects that will teach students to take mutli-faceted approaches to investigating questions about the marine environment.

With the acquisition of the MERC, Cal Poly faculty now have direct access and a permanent presence on the coast to better facilitate research interests, education and collaborative efforts. **Since announcing the acquisition of the MERC, institutions along the West Coast have shown a tremendous interest in the potential of the facility and have shared their interests and desire to collaborate in various research efforts (see section 5c: Letters of Collaboration and Resource Commitment).** The common theme of their enthusiasm is derived from a previous point that the location of the MERC will provide the only marine laboratory facility along 320 km of coastline and because of the chronic lack of facilities and access to the marine environment in this region. This level of enthusiasm illustrates the potential of this facility to attract numerous collaborators and grow in its impact on research in this understudied region of the nation's coastline.

**One other unique aspect of the MERC is that Cal Poly is home to one of the finest undergraduate engineering programs in the country (4).** At this point, there are two engineering faculty presently interested in participating. From a biologist's perspective, this is a significant untapped potential as the marine environment is often difficult to sample. The Biological Sciences Department has just acquired an advanced autonomous underwater vehicle (AUV) to quantify the distribution of phytoplankton and bioluminescence rapidly on small space scales. Introduction of this bio-sensing technology to the engineering faculty will likely increase interest and provide the spark to expand the activities of the facility.

*The MERC has a strong commitment from the Cal Poly State University campus and the California State University Board of Trustees to ensure the long-term resources and financial backing required for this new marine emphasis (see section 5c: Letters of Collaboration and Resource Commitment).* Cal Poly is also involved with a CSU-wide federal initiative (CI-CORE, California Center for Integrated Coastal Research) in partnership with Moss Landing Marine Labs, Tiburon Center (CSU-San Francisco), CSU-Hayward, Humboldt State, and San Jose State to build a network of institutions to address coastal issues such as toxic phytoplankton blooms, water quality and land margin interactions. Developing this new initiative alone has partnered these universities and fostered active collaborations.

#### b. Proposed Improvements

A seawater system is a basic need of any marine facility. We intend on using the seawater systems for two primary functions; to provide life support for the fauna and flora that exist in immediate area for both undergraduate education and collaborative research efforts and to provide the flow required for in-line monitoring instrumentation. Cal Poly has hired a design firm, Padre Associates, Inc., to develop the initial plans and cost estimate for this seawater system (see section 5b). We are proposing fabrication and installation of a 500-gpm capacity seawater system. The intake pipes (dual system with backup for continual maintenance) would be positioned alongside the water access point for facilitated maintenance. Because of the height of the platform off the surface of the water, there will be a two-tiered system, similar to that installed by UCSD Scripps Institution of Oceanography (SIO) at La Jolla, CA. The first tier will require a vacuum system to create a head to the pumps that will be located approximately 3-4 meters off the surface of the water where the pumps will be installed. 6-inch lines will then pump water to a high-capacity sand filtration system. Water will then be aerated to avoid O<sub>2</sub> supersaturation, mixed, and then distributed to the network of outdoor research tanks. The tank network will consist of two 500-gallon



Figure 8. Vacuum intake system at Scripps IO. The

green stone tanks, approximately seven 2,000-gallon fiberglass circular tanks, two 1,500-gallon fiberglass raceway tanks, a series of smaller tanks to provide space for contained experiments with marine invertebrates or algae, a re-circulating pump, automatic pressure regulating, flow control, and shutoff valve on all tanks (see Section 5b). The tank network will be situated on the concrete portion of the platform. Previous engineering assessment of the pier rated the concrete section of the platform as being able to support weights of 50-60 tons, which is well above the estimated weight of the water capacity in the proposed system. There will also be on demand seawater outlets at various locations around the platform for flexibility in project designs. The structure supports the lines for this system being placed under the grating system, which will allow for efficient space utilization. Seawater access will also be provided in the classroom and laboratory in the main building.

In order to reduce the problems associated with closed pipe systems, the SIO design was clever. After pumping the water to the top of the pier, a trough with top access was constructed to transport the unfiltered water to the shore for filtration and distribution around the campus. As we presently do not have the need to send water back to the base of the pier, we propose to use the same design, but only for discharge. After water has flowed through the tank systems, water will be transported via a trough approximately 400m towards the shore along the pier and discharged. This will facilitate cleaning and avoid the problems of fouling. Addressing the fouling problem on the intake side, a dual system will be used with one remaining dry at any given time. Access ports for pigs will be installed for routine servicing.

Permits required for this proposed seawater system are in the final stages of approval. For this project, permitting included the approval of a National Pollutant Discharge Elimination System (NPDES) permit under Section 401 of the Clean Water Act under jurisdiction of the State of California Regional Water Quality Control Board, Central Coast Region, and a Coastal Development Permit from the California Coastal Commission. Local (county) building permits will also be required with the approval of the local Port San Luis Harbor District.

Real-time data will be available to the public via the Web, requiring a couple of servers, one acting as the data server and the other as a host for the web interface for public consumption. The internet data link will be a cable line attached under the road at the base of the pier and will provide a dedicated connection to a server on the Cal Poly campus with the bandwidth necessary for web serving. A local non-profit, the Port San Luis Marine Institute, which serves K-12 marine education, is completing a public aquarium/museum in Avila Beach. The institute has offered space in this facility to be dedicated to illustrating the real-time data stream from the MERC as well as the ongoing research efforts to the general public. We see this as a mutually beneficial collaboration and an excellent “window to the community” (see section 5c: Letters of Collaboration and Resource Commitment).

#### c. and d. History of research and training at the facility

As this is a new facility, the sections relating to past Research/Educational Uses, Summary of Accomplishments in the past 5 years, Results from Prior FSML awards, and the Selected Bibliography pertaining to the facility cannot be addressed directly. The Description of Existing Facility highlighted the present programmatic design and outlined the plans and potential for growth in the future as well as examples of particular research programs that would directly benefit from the proposed system.

**We are creating a new marine laboratory and program that will fill a gap that has existed at Cal Poly and in the central coast of California. This facility will positively**

**impact student learning, public marine education and foster collaborations with other institutions around the country.** We have acquired a unique facility and have the strong support of the University and community to make this goal a reality. The Biological Sciences Department at Cal Poly underwent a 17-year hiring freeze from 1978 to 1995. Prior to 1995, the faculty were for the most part discouraged from actively participating in research activities. There has been a rapid shift in the Department's and University's thinking with regard to encouraging active faculty research programs. This is evident in the area of Marine Science, where three new marine positions (Biology) and one marine geologist (Soil Science) have been filled since 1998. These faculty have been encouraged to develop research programs with student participation. The active research programs in marine science have enhanced learning opportunities for the students and have increased collaboration with professors at other institutions, providing benefits for all professors, students, the University, the scientific and local communities.

*We are excited and confident that this facility will make a significant contribution to the study of Marine Biology/Science nationally and in this region of the California Coast.*

.e. Results from Prior NSF Support:

Neither author has received funding from NSF. N. Adams is a *Beginning Investigator* with no prior funding as a PI or Co-PI.

Last year, an NSF panel reviewed an earlier version of this proposal. We agree with the reviewers comments and believe we have addressed the four primary concerns of the panel. 1) We have included specific examples of the research projects that would directly benefit from the installation of the sea water system. 2) We have addressed the reason for needing this system and how it would help fulfill the educational and research goals of the center. 3) The long-term commitment by the University and the long-term vision of the center have been presented. 4) The cost of the proposed system has been more fully clarified in the Budget Justification section.

f. Selected Bibliography

**(Other relevant publications)**

- Adams, N.L.** and J.M. Shick (2001). Mycosporine-like amino acids prevent UVB-induced abnormalities during development of the green sea urchin *Strongylocentrotus droebachiensis*. *Marine Biology*. 138: 267-280.
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.g. Summary of Data Collection and Management

It is important to establish a data policy to help insure open and timely access to all datasets. This requires a data management strategy that facilitates data exchange and investigators taking responsibility for making data available. All real-time data collected and made available on the web interface at the MERC will be considered "community property." Both real-time data and on-demand archived data will fit in this category. Archived data will include consistent file formats as well as a complimentary info file, providing information of the type of instrument, responsible parties, data quality, servicing information etc. A web page will routinely update the progress of research and student projects at the MERC. Data will be made available through the Principal Investigators with the understanding the use of data will be by permission of the PI. Citation may be given to the investigators responsible for data collection, if desired, publications using MERC data sets. Reference to these data will include: a reference to publications describing the data or reference to the PI(s) if no papers are yet published

.i. Other: Community Partnerships

Cal Poly State University made a public announcement in 2000 of their intention to receive the pier facility from Unocal Corp. As part of this announcement, Cal Poly invited interested parties from the region. After this initial meeting and discussion of the vision for MERC, Cal Poly received letters of intent to partnership (see section 5c: Letters of Collaboration and Resource Commitment). These letters came from the three other educational entities in the region; Cuesta College, Hancock College (both Community Colleges), and the Superintendent of the San Luis Obispo County Schools, representing over 100,000 (K-14) students. Area non-profits have indicated their support including; Port San Luis Marine Institute (K-12 education), Salmon enhancement, and the Central Coast Aquarium Society. The Avila community, the Regional Water Quality Board, the California Fish and Game Department, the Port San Luis Harbor District Commissioners, the County Board of Supervisors, the local fishing associations and the general public have all provided overwhelming support for the MERC. As the MERC continues to be developed, these partnerships will be solidified to form a community center for marine education.