San Diego Moored Observation System Pilot Study

Workplan for Pilot Study of Thermocline and Current Structure off Point Loma, San Diego, California

Prepared by

The City of San Diego, Metropolitan Wastewater Department, Environmental Monitoring & Technical Services Division [1]

and

Scripps Institution of Oceanography [2]

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[1] Wendy E. Storms (wstorms@sandiego.gov) and Timothy D. Stebbins (tstebbins@sandiego.gov), City of San Diego, Environmental Monitoring and Technical Services Laboratory, 2392 Kincaid Road, San Diego, CA 92101

[2] P. Ed Parnell (edparnell@ucsd.edu), Scripps Institution of Oceanography, Integrative Oceanography Division, University of California, San Diego, La Jolla, CA 92093

Background

The Scripps Institution of Oceanography (SIO) was hired by the City of San Diego (City) to assess the adequacy of the City's Ocean Monitoring Program in providing the data and scientific understanding necessary to answer relevant questions about the effects of wastewater discharge via the Point Loma Ocean Outfall on the marine environment off San Diego. This work, the Point Loma Outfall Project (PLOP), was performed by a team of SIO scientists who reviewed the City's existing monitoring efforts and capabilities and compared these to programs conducted elsewhere for similar ocean outfalls. The results of this scientific review were summarized in a peer-reviewed report (SIO 2004), which was submitted to the City in September 2004. This information was also conveyed to state and federal regulators and to other interested stakeholders, including the San Diego Regional Water Quality Control Board (RWQCB), the United States Environmental Protection Agency (USEPA), and local environmental organizations (i.e., Bay Council). The final PLOP report included a summary of major findings and a subsequent list of prioritized recommendations for enhanced environmental monitoring of the San Diego coastal region. The findings and recommendations were organized into three main categories: (1) Physical oceanography, plankton and modeling; (2) Benthic monitoring; (3) Microbial monitoring. This study is the first part of a multi-phase project to address the physical oceanography component.

One of the greatest concerns regarding the City's discharge of treated effluent is that it not return shoreward and contaminate nearshore waters where there is heavy recreational use from swimmers, divers, surfers, and sport fishermen. It is postulated that due to the significant difference in depth between the discharge site (~98m) and theoretical seasonal thermocline (maximum ~40m) (see City of San Diego 2005), the pycnocline presents a ceiling through which the wastewater plume cannot rise. Additionally, the outfall diffuser legs and ports are designed such that dilution of wastewater is maximized. However, physical phenomena such as upwelling (which effectively displaces the thermocline upward), large storms, or breaking internal waves could cause plume waters to encroach upon surface nearshore waters (e.g., Lennert-Cody and Franks 1999, Pineda 1999).

This workplan describes a multi-phase project, the Moored Observation System Pilot Study (MOSPS), designed to begin examining the dynamics of the receiving waters off San Diego in the vicinity of the Point Loma Ocean Outfall (PLOO). Specifically, a system consisting of moored temperature loggers (thermistor strings) and Acoustic Doppler Current Profilers (ADCPs) will be deployed for a period of at least two years. The thermistors will enable tracking of the thermocline, including its dynamics and strength, while the ADCPs will measure currents to determine the major modes of circulation near the outfall. These data can then be used to evaluate the behavior of the wastewater plume and for planning future plume tracking studies.

The project represents a "strategic process study" as defined under the regulatory requirements that govern the Point Loma Wastewater Treatment Plant's discharge of wastewater to the Pacific Ocean (Addendum No. 1 to Order No. R9-2002-0025, NPDES Permit No. CA0107409). Such special studies represent a unique mechanism to focus

monitoring efforts on specific questions as defined in the model monitoring program that was developed for large ocean dischargers in southern California (Schiff et al. 2001).

General Approach

This pilot study is designed to obtain an initial characterization of the thermocline structure and current regime in the area surrounding the PLOO discharge site using both thermistor strings and ADCP deployments. Phase 1 will involve characterizing the dynamics of thermocline structure at the 100m and 60m isobaths, as well as a detailed view of the current regime within and around the outfall. This will provide important background information for Phase 2, which will also attempt to capture a larger scale picture of the complex currents around the tip of Point Loma. Although the City's existing program of quarterly offshore sampling and weekly nearshore sampling shows snapshots of the thermocline in this area, an expanded detailed long-term time series of temperature and current data will be more useful for determining the frequency of shoreward transport of the plume into shallow nearshore waters. This preliminary study will also provide data for future modeling efforts and plume tracking studies as well as to assess the need for long-term real-time monitoring. Field sampling is scheduled to begin in June 2006 with an initial project summary report expected in December 2007.

SIO scientists currently deploy a series of thermistors within the Point Loma kelp bed north of the PLOO. By using similar instruments offshore it will be possible to more fully capture the nearshore dynamics of the physical forcing that influences movement of the wastewater plume. In subsequent phases, these measurements will be used in a model of plume behavior. We plan to use the ocean current data to determine the major modes of circulation around the outfall so that future tow-yo studies of plume behavior can be conducted during periods when these modes are likely to occur. We hope to utilize the data from these studies in a model of plume behavior that can then be coupled to real-time current and temperature data from the vicinity of the outfall (transmitted via telemetry) to determine when conditions might be conducive for plume movement into nearshore waters. The output of the model may show that the plume is highly unlikely to move into shallow coastal waters, in which case a permanent telemetry system may not be necessary.

Study Design

Deployment locations

During Phase 1 of the MOSPS, 2 thermistor strings and 2 ADCPs will be deployed near the present PLOO discharge site at about 100m (**Figure 1**). Of these, 1 ADCP and 1 thermistor string will be initially deployed in tandem (~50m apart) and as close as possible to the active diffuser ports near the current wye structure. The second ADCP and thermistor string will be deployed close to the end of the southern diffuser leg, yet far enough from the diffusers to be outside the area of active plume rise. This initial deployment scheme is intended to observe the effects of the rising plume on vertical

currents and temperature structure of the water column. This information will be useful for determining permanent site locations for long-term monitoring of water column structure and current movement near the outfall. Another consideration for instrument placement is the possibility that turbulence within the rising plume may limit the performance of the ADCPs. For the permanent observation program we plan to use two thermistor strings (for redundancy) and a single ADCP near the 100m discharge site. Additionally, a second set of 2 thermistor strings will be permanently deployed near the original PLOO discharge site at a depth of about 60m. Figure 1 shows the initial placement of these inshore thermistor strings near the end of the original southern diffuser leg – placement of these inshore thermistors may be modified throughout the course of the project.

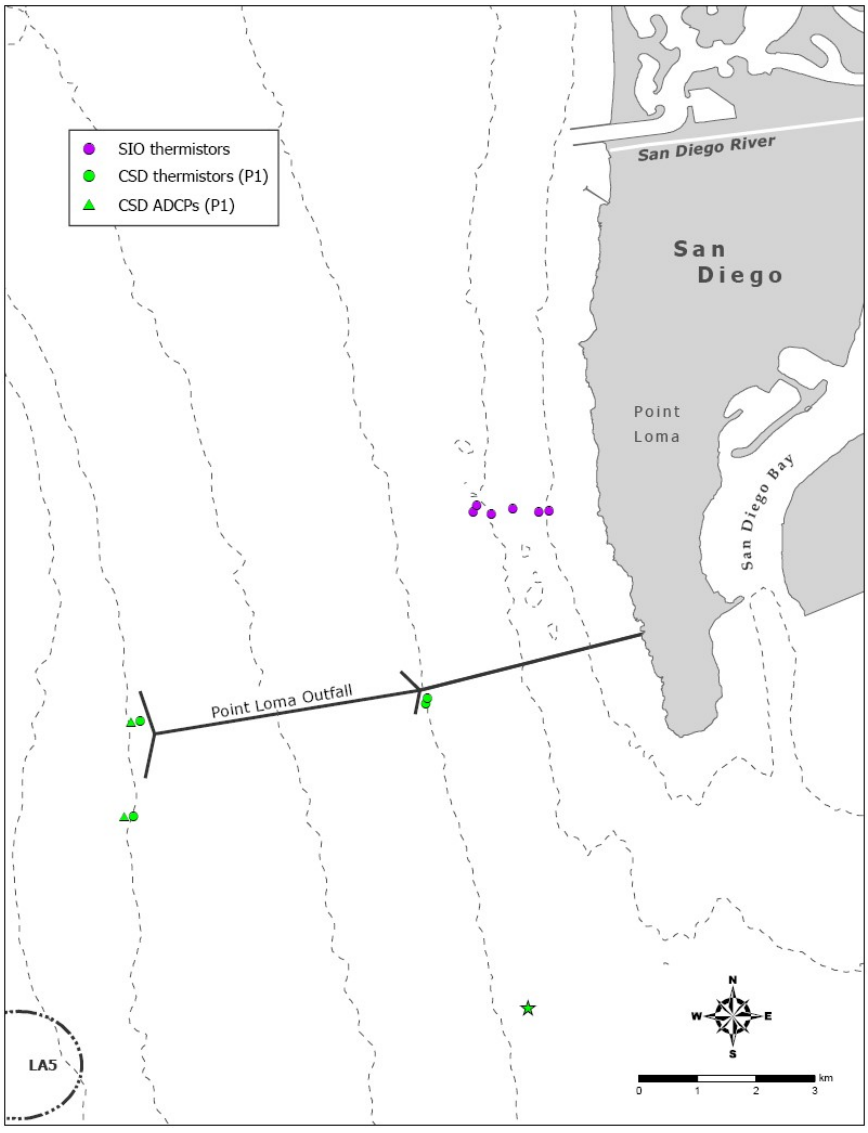


Figure 1. Approximate placement of thermistor strings and ADCPs off Point Loma. The "star" marks the proposed location for redeployment of the second ADCP in Phase 2.

For Phase 2 of the study, the second ADCP will be moved to a strategic location off the tip of Point Loma (see Figure 1). This relocation will enable study of the complex current regime that exists south of this headland (see Roughen et al. 2005).

SIO also maintains thermistor strings in an across shore transect located approximately 2.5 km north of the PLOO at depths of 33m, 21m, 15m, and 8m. Coupling the temperature data sets from the SIO thermistors with the City's planned thermistor strings at 100m and 60m will enable visualization and analysis of temperature structure and dynamics from waters near the outfall to waters within approximately 0.5 km of shore.

Instrument configurations

The ADCPs will be configured to sample in 2m depth bins beginning at ~2m above the bottom and extending to as close to the surface as possible. The accuracy of ADCPs declines with distance away from the instrument. This problem coupled with the noisy near-surface layer complicates current measurements within this shallow depth range. We believe we will be able to successfully resolve currents as shallow as 4m and possibly shallower. Therefore currents will be monitored every 2m, from a depth of approximately 98m at the deep sites to at least as shallow as 4m.

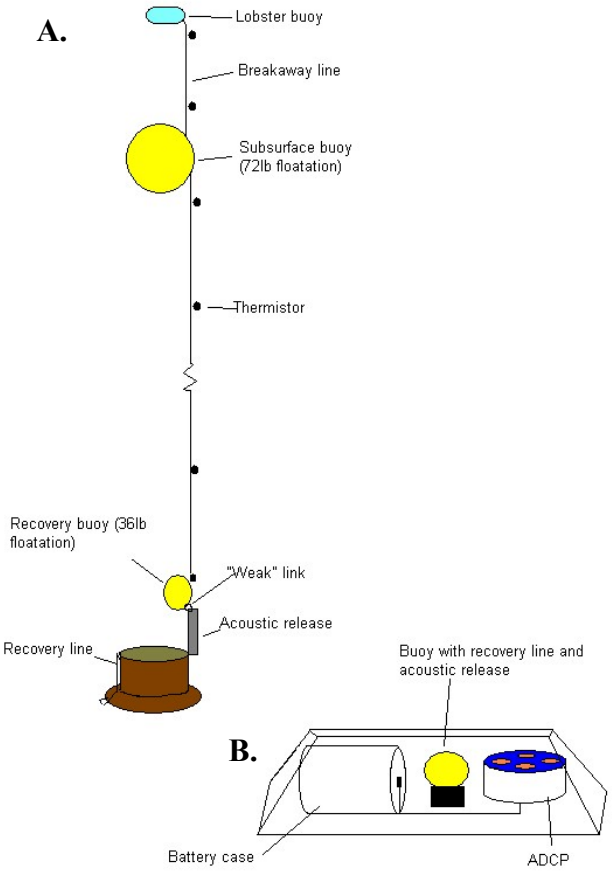


Figure 2. Schematic representation of (A) thermistor string anchor, and (B) ADCP with trawl-resistant bottom mount. Drawings are not to scale.

Thermistor strings will have sensors placed every 4m beginning at ~2m above the bottom and extend to near the surface. However, the upper 14m of the moorings will be attached to the main moorings using a weak link because of the risk that large ships that frequent the area may run over the moorings. The use of weak links will ensure that only instruments in the top 14m of the water column would be lost if the mooring were to be run over by such vessels (see **Table 1**). Deployment configuration schematics for both instrument types are shown in **Figure 2**. Each thermistor will be set to sample every 10 minutes, while the ADCPs will sample every 3 minutes. The thermistor strings and ADCPs will be recovered, downloaded, and serviced to remove fouling after roughly 90 days and then redeployed. Recovery dates will be targeted to avoid conflicts with regular quarterly sampling conducted by the City. To facilitate a reasonable field schedule, one thermistor string from each depth and one ADCP will be serviced during each non-quarterly month. This should minimize the number of ship days required to complete servicing activities, and thus allow the greatest flexibility in choosing days with the most appropriate weather and sea conditions for field work.

Table 1. Thermistor heights above the bottom in meters. Breakaway thermistor depths are indicated with an asterisk (*).

100-m contour	60-m contour
2	2
6	6
10	10
14	14
18	18
22	22
26	26
30	30
34	34
38	38
42	42
46	46
50	50*
54	54*
58	
62	
66	
70	
74	
78	
82	
86	
90*	
94*	

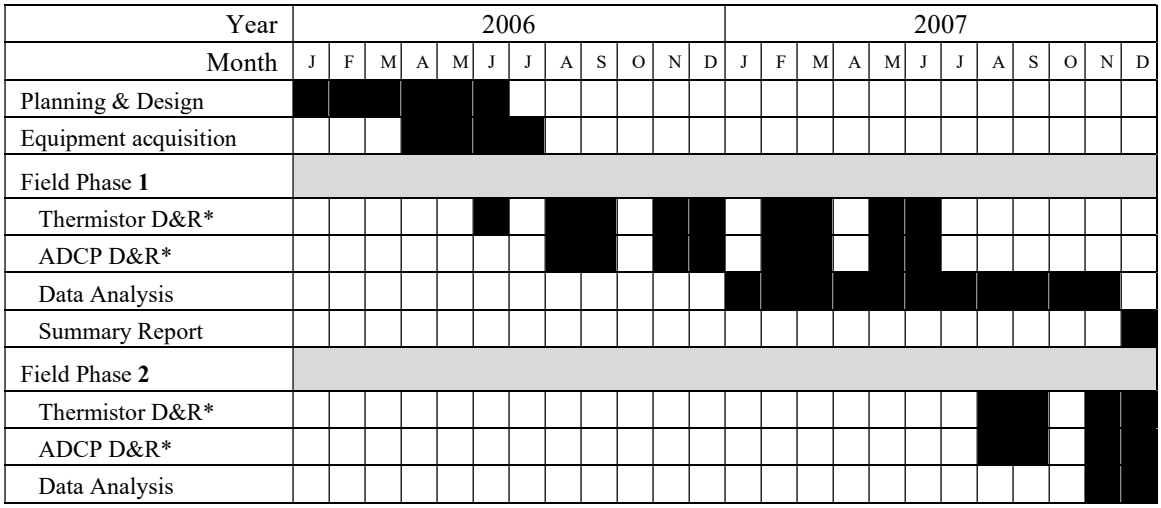
Data analysis

Once downloaded from the instruments, all data will be analyzed using MATLAB software using the same QA/QC controls currently being utilized for the SIO project in order to coordinate activities. Primary data analyses will focus on identifying the major modes of circulation and temperature structure near the PLOO to determine the likely trajectory of the wastewater plume and to identify periods when the plume might encroach upon nearshore waters. Of primary interest will be the dynamics of the temperature structure offshore of Point Loma as it is subjected to high frequency forcing such as internal waves and tides, as well as lower frequency seasonal forcing. Further analyses will be performed in conjunction with SIO.

Project Schedule

It is anticipated that this project will continue for the next several years in order to accumulate sufficient seasonal data. These instruments will continue to provide data as the next phases of the project are undertaken. **Table 2** shows a tentative schedule for Phase 1 and the beginning of Phase 2 monitoring through calendar year 2007.

Table 2. Tentative schedule for Moored Observation Pilot Study for 2006-2007.



* D&R = Deployment & Retrieval

Literature Cited

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