

Use of Natural Oil Seeps for Evaluation of Dispersant Application and Monitoring Techniques

By James R. Payne¹ and Alan A. Allen²

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¹Payne Environmental Consultants, Incorporated
1991 Village Park Way, Suite 206 B
Encinitas, CA 92024
(760) 942-1015

and

²Spiltec
19220 N.E. 143rd Place
Woodinville, WA 98077
(425) 869-0988

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Use of Natural Oil Seeps for Evaluation of Dispersant Application and Monitoring Techniques

James R. Payne and Alan A. Allen

Abstract

The natural oil seeps off Coal Oil Point (Santa Barbara), California, release an estimated 100-150 bbl per day of oil to the marine environment. With FY 2002/2003 funding from the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) and invaluable support from NOAA HAZMAT, California Office of Oil Spill Prevention and Response (CA OSPR), the U.S. Coast Guard (USCG), and several other county, state, and federal agencies, permits were obtained from the CA State Regional Water Quality Control Board (RWQCB), the U.S. Fish and Wildlife Service (US FWS), and the National Marine Fisheries Service (NMFS) to use the oil from the Coal Oil Point seeps to conduct a series of dispersant trials that were originally scheduled for August 2003. The purpose of those permitted experiments was to evaluate a recently developed oil-boom/dispersant application technology (NeatSweep) and provide intercalibration of the NOAA UV/Fluorescence-based Scientific Monitoring of Advanced Response Technologies (SMART) Protocols with finite measurements of dissolved aromatics and dispersed oil droplets in the water column.

To prepare for the field experiments, a limited set of laboratory tests with the seep oil were conducted in April/May 2003. Results from those tests indicated that the 11° API gravity seep oil from the Monterey Formation was not amenable to treatment with dispersants (0% dispersion), but similar tests on nearby Platform Holly produced oil (also from the Monterey Formation) indicated a possible dispersion of up to 70%. In compliance with the permits and with assistance from the USCG, NOAA HAZMAT, and the U.S. EPA, a limited set of *in situ* field tests (using a hand-held spray bottle with less than one pint of Corexit 9500) were completed on the seep oils in June 2003 to determine if the earlier laboratory results were an artifact of the seep oil collection and shipment or some other unknown factor. The field tests convincingly demonstrated that the natural seep oils were not amenable to treatment with Corexit 9500, the best available oil-spill dispersant for heavily weathered, and viscous, emulsified crude oils.

As a result of that finding, it was concluded that failing to show any oil dispersion (if the full-scale field tests were implemented as originally planned) could set the use of dispersants as an oil-spill countermeasure back 30 years. Therefore, the original project was put on hold, and several other field options were considered. These included using other natural oil seeps in either California or the Gulf of Mexico, using a spill of opportunity, or returning to the Coal Oil Point area and conducting a limited series of planned spill experiments with an oil more amenable to chemical dispersion. After consideration of these options and several conference calls with NOAA and CICEET project management, it was decided that the scope of work for these other options was so different from the original proposed project, that it made more sense to reduce the scope of the current effort to the preparation of lessons-learned reports and manuscripts on the permitting process. This report documents the research plan, progress made in obtaining the necessary permits, and the results from the limited laboratory and field tests that were completed. It also includes a brief discussion on the limitations of using natural seep oils for oil-spill response research.

1.0 Introduction

Oil-spill dispersants were found by the National Academy of Sciences/National Resource Council (NRC 1989) to be an important component in the arsenal of tools to combat oil spills, and dispersant use is gradually finding wider acceptance and use in many coastal areas (Stoermer et al. 2001; Los Angeles-Long Beach Area Dispersant Subcommittee 2002). Implicit in this slowly developing acceptance, however, is the desire for improved methods of dispersant application and better means of monitoring dispersant effectiveness and documenting potential environmental effects (water-column concentrations and impacts).

This project was designed to utilize the natural oil seeps at Coal Oil Point off Santa Barbara, California to evaluate a recently developed oil-boom/dispersant application technology, NeatSweep, and allow intercalibration of the NOAA UV/Fluorescence-based Scientific Monitoring of Advanced Response Technologies (SMART) Protocols (Henry et al. 1999; Henry and Roberts 2001) with discrete measurements of dissolved constituents and dispersed oil droplets obtained with a Portable Large Volume Water Sampling System (PLVWSS) developed by Payne Environmental Consultants, Incorporated (PECI) (Payne et al. 1999). As such, the results of this effort were intended to provide a better understanding of the effectiveness and effects of dispersant-based oil-spill countermeasures and specifically allow:

- Measurement of the environmental fate of oil spills in real-time or near real-time, and
- Resolution of uncertainties about the long-term fate and effects of dispersant-treated oil.

In addition, this project was intended to introduce spill responders to a new and innovative oil deflection and dispersant application technique that had been shown in OHMSETT tests to significantly improve dispersant application, effectiveness, and efficiency.

2.0 Project Implementation

This project was undertaken as a cooperative effort between two private consulting firms (PECI and Spiltec), the developers of the NeatSweep technology (Elastec American Marine), the Clean Seas Santa Barbara Oil-Spill Response Cooperative, and So Cal Ship Services. In addition, Regional Response Team (RRT) personnel from NOAA, the U.S. Coast Guard, California Fish and Game Office of Spill Prevention and Response (OSPR), and the U.S. EPA, as well as representatives from other state and county agencies were involved as program participants and observers.

As described in the sections that follow, most of the effort undertaken during the first nine months of the period of performance centered around permitting activities, and most of this report will focus on the steps necessary to successfully obtain the necessary permits for the field trial. To allow a better understanding of the scope and nature of the proposed activities and place the permitting process into the proper context, a brief description of the field plan is presented below.

After obtaining the necessary permits from the responsible county, state, and federal agencies, the program plan called for a series of sea trials to be undertaken over a weeklong period (thereby hopefully ensuring a variety of sea states and weather conditions) using the natural oil seeps off Coal Oil Point (Santa Barbara), California. Five vessels were identified and committed to the project, including the 130 ft *Mister Clean*, the 32 ft *Clean Sweep*, and two 21 ft crew boats (all from Clean Seas Santa Barbara) and the 100 ft *OSV/Crewboat* (from So Cal Ship Services). The anticipated field plan for the study was as follows:

- Day 1 – Shakedown field equipment, establish and check communications, and finalize field plan. Measure background hydrocarbon signals in water with SMART & PLVWSS protocols
- Day 2 – Complete 1-2 field trials
- Day 3 – Complete 2-3 field trials (if necessary)
- Day 4 – Weather contingency day
- Day 5 – Decontaminate equipment

Utilizing the equipment and capabilities of Elastec American Marine, Clean Seas Santa Barbara, and So Cal Ship Services, the NeatSweep boom and dispersant application system was to be used to treat several slicks from the natural seeps in the area. With the NeatSweep system (Figure 1), oil from a broad swath of separate slicks at varying thicknesses is concentrated into a band of oil of fairly uniform thickness that then passes through a 3-meter-wide catamaran-like Dispersant Application Zone (DAZ) where “neat” (undiluted) dispersant is sprayed directly on the oil. This reduces the amount of dispersant that is wasted through mis-targeting as often happens with other application methods, and it eliminates overdosing and under dosing.

NEATSWEEP

New Concept in Dispersant Application

Neat Sweep collects a broad swath of oil, funneling the slick into a narrow band where dispersant is applied at full concentration. Neat Sweep is the most efficient dispersant application system available.

- Dispersant is applied 'Neat' (undiluted) for maximum efficiency.
- Concentrates oil into a narrow band of uniform thickness.
- Personnel has virtually no exposure to air borne dispersant mist.
- Ideal for use with vessels of opportunity.



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330 ft.
(100 meters)

Dispersant Application Zone (DAZ)

Figure 1. NeatSweep boom and Dispersant Application Zone (DAZ) configuration during at-sea trials of operational parameters (no oil or actual dispersants employed).

During the field trials, additional boats were to be used to deploy smoke bombs and drogues to mark the treated area, and then a series of transects through the test area were to be run over a 2-3 hour period as described by Payne et al. (1991, 1993) for subsurface water sampling on a continuous basis using the NOAA SMART Protocols. Aliquots of effluent from the UV/fluorescence system were also to be collected and placed on ice for subsequent toxicological testing under a separate contract funded by the Texas General Land Office. Using the results from the SMART Protocol approach as a guide,

discrete 3.5 L PLVWSS filtered water samples (Figures 2 and 3) from 1, 3, and 10 m depths were then to be collected for separate analyses of dispersed oil droplets (trapped on 0.7 μm glass fiber filters) and dissolved components (in the filtered water samples).

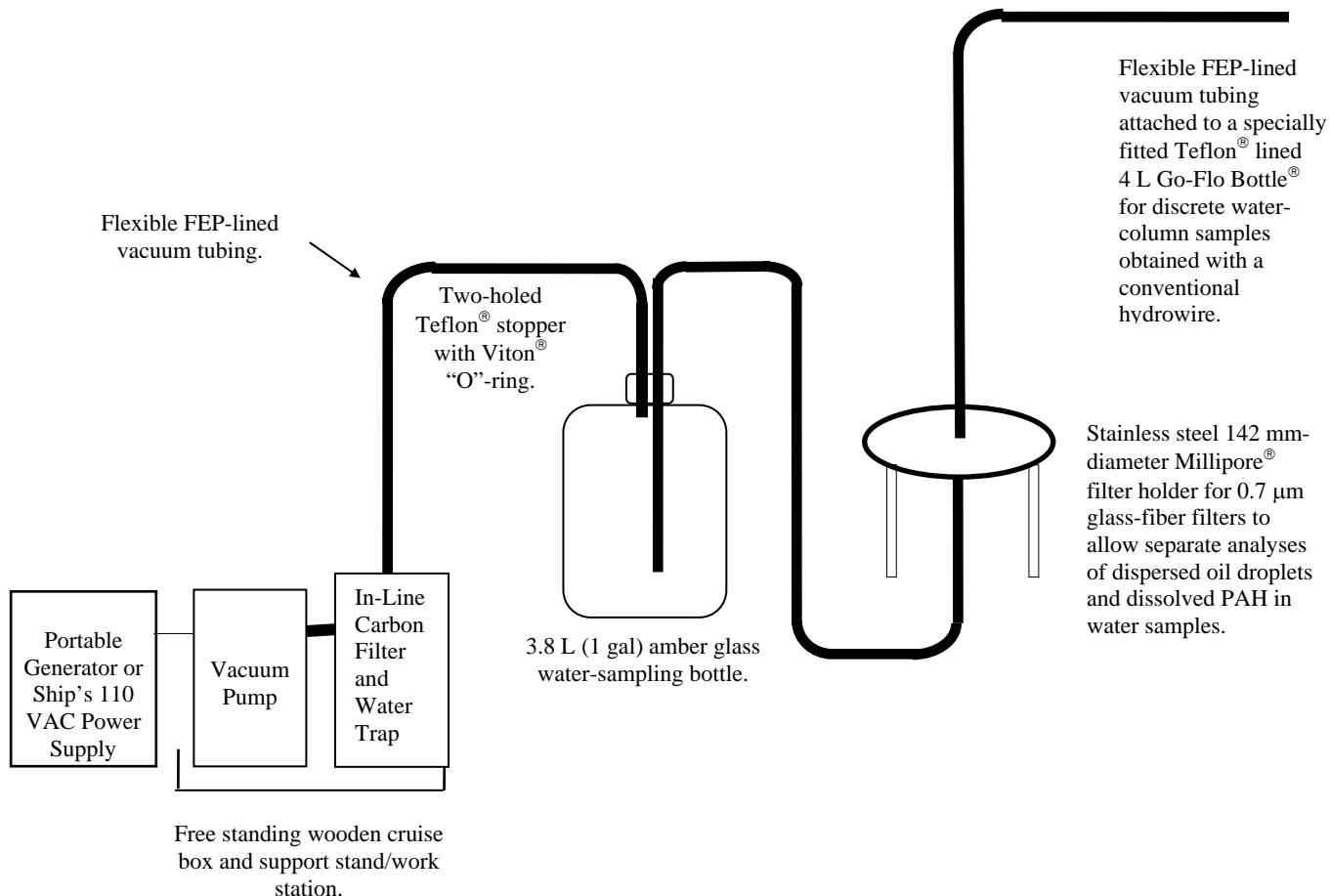


Figure 2. Schematic diagram of PECCI's Portable Large Volume Water Sampling System (PLVWSS).

After collection, the PLVWSS filters were to be frozen and the dissolved-phase samples preserved with methylene chloride for shipment (under full chain of custody) and later extraction and Selected Ion Monitoring (SIM) GC/MS analyses at the Woods Hole Group Environmental Laboratories in Raynham, MA. Extracts from the dissolved- and dispersed oil droplet-phases would have been spiked with internal standards and analyzed for 43 parent- and alkyl-substituted PAH as specified in the Woods Hole Group Standard Operating Procedure, "Analysis of Parent and Alkylated PAHs and Selected Heterocyclic Compounds by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision #1)." Alaska North Slope crude oil and samples of the Coal Oil Point seep oil were also to be analyzed as part of the analysis run sequences to provide compositional reference data for alkylated PAH patterns. The extracts were also to be analyzed for saturated hydrocarbons (SHC) by gas chromatography with flame ionization detection (FID GC) following modified



Figure 3. Use of a conventional 4-Liter Go Flo[®] Bottle connected to the PLVWSS to obtain discrete samples of dispersed oil droplets and dissolved components at different water depths following the 1999 *M/V New Carissa* oil spill off Coos Bay, OR.

EPA Method 8100. The SHC analyses were included in the program to assist in differentiating between dissolved and particulate (oil droplet) sources of hydrocarbons, to assess the overall state of evaporation and biological weathering of the oil, and to provide data on possible biogenic (planktonic) sources, which can introduce background fluorescence in the field.

Ultimately during the data analyses and reporting phase of the project, the results of the UV/Fluorescence measurements from the SMART Protocols were to be compared to the specific component analyses of both the dissolved phase and discrete oil droplets providing the field intercalibration that has not been obtained to date. These data were then in turn to be correlated with the results of the toxicological testing and computer model-based predictions of oil concentrations in the water-column.

3.0 Permitting Activities

Almost before the contract between Payne Environmental Consultants, Incorporated (PECI) and the University of New Hampshire was signed, news of this project had reached members of the California Regional Response Team (RRT). As a result, we were invited to make a presentation describing the project at the 23 October 2002 meeting of the RRT in Alameda, CA.

RRT members in attendance at that meeting included: Heather Parker-Hall, NOAA SSC; Yvonne Addassi, CA Dept. of Fish & Game Office of Spill Prevention and Response (OSPR); Scott Schaefer, Deputy Administrator, OSPR; Mike Sowby, OSPR; Lt. Cmdr. Byron Black, USCG, Chief, Response Branch; Cmdr. Steve Thompson, NOAA Corps, San Francisco Bay Regional Manager; David Peck, Clean Bay, Inc.; and James Hong (representing Patricia Port), U.S. DOI, Office of Environmental Policy & Compliance. PECI prepared a PowerPoint presentation for the meeting and briefed the attendees on the pros and cons of dispersant use and the specific objectives of this CICEET-funded project. The presentation was well received, and the attendees expressed their unanimous support for the project. They then assisted with identification of consultations and permits that would be required to proceed, and a list of action items, including contacts with additional state and federal agencies was

developed. As a result of this meeting and numerous telephone and e-mail communications over the next several weeks, the priorities for contacting these additional agencies and initial contact personnel were organized as follows:

- 1) Regional Water Quality Control Board: discharge permit requirements (Mike Higgins)
- 2) U.S. Fish and Wildlife Service: Endangered Species Act, Essential Fish Habitat, and marine mammals (Greg Sanders)
- 3) National Marine Fisheries Service: Endangered Species Act, Essential Fish Habitat, and marine mammals (Joe Dillon)
- 4) U.S. Environmental Protection Agency: NPDES issues (Bill Robberson/Terry Oda)
- 5) CA Coastal Commission: Federal Consistency with Coastal Zone Management Act (Ellen Faurot-Daniels)
- 6) Santa Barbara County (John Day)
- 7) Channel Islands National Marine Sanctuary (Chris Mobley)
- 8) Plus, various follow-up activities by RRT personnel to obtain letters of support from their respective agencies including the U.S. Coast Guard and OSPR, if possible.

The support of the Regional Water Quality Control Board (RWQCB) and the U.S. Fish and Wildlife Service were identified by RRT personnel as being critical components in the initial stages of the permitting process. As a result, contacts with these two agencies were initiated, and based on their availability and commitment to attend, a second meeting at the Minerals Management Service (MMS) offices in Camarillo, CA was scheduled for 17 December 2002.

During the process of contacting and inviting agency personnel to the 17 December meeting, Dwight Sanders of the California State Lands Commission was contacted, and through telecommunications on 12 December 2002, it was determined that the project would fall under a Category 6 Exemption of the California Environmental Quality Act (CEQA) that eliminated the need for the preparation of an Environmental Impact Report (EIR). The Class 6 exemption comes under Article 19 -- Categorical Exemptions, section 15306 -- Information Collection.

Section 15306 -- Information Collection states:

Class 6 consists of basic data collection, research, experimental management, and resource evaluation activities, which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes, or as part of a study leading to an action, which a public agency has not yet approved, adopted, or funded.

In addition, Dwight Sanders explained that under CEQA, the RWQCB and the California Coastal Commission served as functionally equivalent agencies, and that if we obtained a permit for the project from the RWQCB we would then be in compliance with CEQA.

The attendees at the 17 December 2002 meeting at the MMS offices in Camarillo, CA, included: Mike Higgins, Central Coast Regional Water Quality Control Board; Greg Sanders, U.S. Fish and Wildlife Service; Mohan Dadlani, State Lands Commission; Rob Coller, U.S. Coast Guard, MSO Long Beach; Mike Sowby, CA Dept. Fish and Game, OSPR; Dave Panzer, MMS; Craig Ogawa, MMS; Heather Parker-Hall, NOAA SSC; John Day, Santa Barbara County Energy Division; Libe Washburn, University of California at Santa Barbara, ICEES/Dept. of Geography; Merril Jacobs, Clean Sees Santa Barbara; Alan A. Allen, Spiltec; and James Payne, PEI. Additional state and federal agency personnel who participated in the meeting via teleconference included: Ellen Faurot-Daniels, California Coastal Commission; Allen Mearns, NOAA, Office of Response and Restoration; Mike Delvaney, NOAA RRT representative; Joe Dillon, National Marine Fisheries Service; Mark Helvey, National Marine Fisheries Service; and Allan Ota, U.S. EPA. Before the meeting, a CD containing the PowerPoint presentation describing the project was sent via Federal Express to each individual attending via teleconference, and extra CDs were available to hand out at the meeting. The

evening before the meeting, however, the PowerPoint presentation was modified slightly to include Applied Science Associates (ASA) computer model predictions of dispersant and dispersed oil concentrations that might be expected during the field trials. Those computer-model predictions were of particular interest to Mike Higgins (RWQCB), as they specifically addressed many of his questions regarding dosages and durations of exposure (see below).

As a result of the 17 December 2002 meeting, Mike Higgins concluded that he believed the project could be permitted under the RWQCB General Permit for Discharges with Low Threat to Water Quality (NPDES Permit No. CAG993001, WDR Order No. 01-119), but he specifically requested that we prepare a Technical Report in support of that NPDES Permit that described in detail the nature of the project, amounts of dispersant that might be applied, and modeled concentrations in the water column. He also requested additional documentation on the ASA computer model and that the modeled concentrations be compared to available toxicity data for California species. Finally, he asked that specific concerns raised by the Santa Barbara County Energy Division (also distributed by John Day at the 17 December meeting) be addressed in writing.

In response to these requests, we prepared and submitted a formal Technical Report in Support of the Regional Water Quality Control Board General Permit for Discharges with Low Threat to Water Quality on 24 January 2003. A copy of that report was appended in its entirety to our Semi-Annual Progress Report submitted to CICEET on April 30, 2003; however, to ensure the completeness of this report, relevant excerpts (including text, figures, and tables) on Dispersant Applications, Computer Model Predictions of Sub-Surface Concentrations, Dispersant and Dispersed Oil Toxicity, and Responses to Questions and Concerns Raised by Santa Barbara County Energy Division Staff are presented below as sections 3.1.1, 3.1.2, 3.1.3, and 3.1.4, respectively.

3.1 Relevant Sections of the Technical Report in Support of Regional Water Quality Control Board General Permit for Discharges with Low Threat to Water Quality (NPDES Permit No. CAG993001, WDR Order No. 01-119)

3.1.1. *Dispersant Applications*

The National Contingency Plan (NCP) approved oil-spill dispersant, Corexit 9500, will be utilized for the project because it has been shown to be effective on high viscosity low API gravity oils such as those that will be encountered at Coal Oil Point (Fiocco and Lessard 1997; Fiocco et al. 1999). Details of the field trials are presented below:

Dispersant Volume: The application of Corexit 9500 will involve a relatively small volume of dispersant, typically between 25 and 50 gallons per discharge. Over the 2-day period, it is conceivable that 3 to 6 individual discharges (or “dispersant runs”) will be conducted, resulting in the total estimated release of 150 to 300 gallons of dispersant (a maximum of ~ 6 drums).

Project Location: The general region of interest (i.e., where seeps are most active) exists in water depths of typically 40 to 100 feet, approximately ½ to 1 mile offshore, directly south of Coal Oil Point. Because of the variability of wind and sea conditions as well as seepage flow rate, it is difficult to pin down the exact location for each dispersant run. The selection of actual discharge zones each day will involve those areas where natural oil slicks are fairly continuous, heavy in concentration, and at the greatest distances and water depths offshore.

Application Area: The NeatSweep system, consisting of two 300- to 500-ft-long deflection booms and a 10-ft-wide Dispersant Application Zone (DAZ) at its apex, will be towed through the “target slick” at approximately 1 knot (see Figure 1). The leading end of each deflection boom will be towed by a small boat, creating an overall average swath between the boats of 300 to 350 feet (for planning purposes, ~ 100 meters). This configuration will allow the NeatSweep system to sweep approximately 0.7 acre (~ 0.31 hectare) of oiled area per minute. Because each dispersant run will be conducted for no more than 2 minutes, a maximum of about 1.4 acres (~ 5,666 square meters) will be swept during each run. The oil swept from this area will be concentrated and fed back to the 10-ft (3-meter)-wide

DAZ unit. The DAZ, with its 9 dispersant spray nozzles approximately 2 feet (0.6 meter) above the water, will then spray the concentrated oil layer for 2 minutes, resulting in a total area of application about 10 feet (~3 meters) wide and 200 feet (~61 meters) long. The total dispersant application area per run will therefore cover about 2,000 square feet (~183 square meters).

Application Rate: Corexit 9500 is commonly applied to relatively fresh crude oils at a Dispersant-to-Oil Ratio (DOR) of 1:10 to 1:50. Using a DOR of 1:20, for example, a slick with an average thickness of 0.1 mm (i.e., a concentration of about 100 gallons of oil per acre) would require a dosage of about 1/20th of 100 gallons per acre or 5 gallons per acre. Because chemical dispersants are not normally very efficient on heavy crude oils or highly weathered/emulsified oil layers, it is assumed that the effectiveness of chemical dispersion with the natural seep oil will be marginal, at best. And, while dispersion at Coal Oil Point may be less than desired during an actual oil spill, this will not detract from the objectives of this project. A conservative estimate has been established for this effort involving an expected DOR of between 1:5 and 1:15. If the greater performance value of 1:15 is achieved, it is conceivable that for each gallon of dispersant applied, as many as 15 gallons of oil could be dispersed with reasonable effectiveness. Depending upon the results of the initial run(s), dispersant pump rates may be adjusted to achieve a greater level of treatment. As mentioned earlier, however, total dispersant discharge per run will be held at 25 to 50 gallons (i.e., ~12 to 25 gallons per minute). The maximum volume of oil that might be dispersed with a DOR of 1:15 would therefore be approximately 750 gallons (nearly 18 barrels). The chance of actually encountering that much oil in a single 2-minute sweep is extremely unlikely since the entire output of oil from Coal Oil Point is on the order of 100-150 barrels per day or less.

The very low oil concentrations likely to be encountered at Coal Oil Point, even with reduced dispersion performance, strongly suggest that the NeatSweep system will be operated at its lowest practical pump rate. At 10 to 12 gallons of dispersant per minute, the average dosage over the 1.4 acres swept in 2 minutes would be about 14 to 17 gallons of dispersant per acre of oil slick. With a DOR of 1:15, this represents an average oil thickness of about 0.1 to 0.2 mm.

Minimum and Maximum Potential Water-Column Loading: From the above discussions, the volume of dispersant discharged over a given area for each application “run” will be:

Minimum: ~24 gallons (~91 liters) over 183 square meters

Maximum: ~50 gallons (~189 liters) over 183 square meters.

If one assumes a dispersion effectiveness potential (i.e., an effective DOR) of 1:15, it is conceivable that the following total volumes (oil + dispersant) could enter the water:

Minimum: ~24 gallons of dispersant + 360 gallons of oil

Or

~384 gallons (1,453 liters) over 183 square meters

Maximum: ~50 gallons of dispersant + 750 gallons of oil

Or

~800 gallons (3,028 liters) over 183 square meters

3.1.2 Computer Model Predictions of Sub-Surface Concentrations

To estimate potential water-column concentrations of dispersant and dispersed oil droplets/dissolved phase components, we have assumed the maximum dispersant application rates discussed above and assumed the maximum DOR of 1:15 with 100 percent of the oil being dispersed for computer model simulations completed by Applied Science Associates, Inc (ASA).

The computer modeling analyses were performed using a model system developed by Applied Science Associates (ASA) called SIMAP (Spill Impact Model Analysis Package). SIMAP was developed from the oil fates and biological effects submodels in the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME). The NRDAM/CME was

developed by ASA for the U.S. Department of the Interior over a 12-year period, and the NRDAM/CME (Version 2.4, April 1996) was published as part of the CERCLA type A Natural Resource Damage Assessment (NRDA) Final Rule (Federal Register, May 7, 1996, Vol. 61, No. 89, p. 20,559-20,614). The technical documentation for this model is in French et al. (1996a,b,c). The physical fates model estimates the distribution of oil (as mass and concentrations) on the water surface, on shorelines, in the water column, and in the sediments. The model is 3-dimensional, using a latitude-longitude grid for environmental data. Algorithms are based on state of the art published research including spreading, evaporation, transport, dispersion, emulsification, entrainment, dissolution, volatilization, partitioning, sedimentation, and degradation (ASCE Task Committee on Modeling Oil Spills 1996). Oil mass is tracked separately for low molecular weight aromatics (monoaromatics, BTEX, and 2 to 3-ring polynuclear aromatic hydrocarbons, PAHs) which impart estimated toxicity in the model, other volatile components, and non-volatile components. This model has been routinely utilized by NOAA for Natural Resource Damage Assessment (NRDA) activities following numerous oil spills throughout the United States, and several papers have been published on validation studies where field measurements of water column concentrations have been compared to model-predicted levels and oil weathering behavior (French and Rines 1997; French et al. 1997, 1999; French 1998).

For this Technical Report, water column concentrations of dissolved surfactants from the dispersant, discrete dispersant droplets, dispersed whole oil droplets (Total Petroleum Hydrocarbons, TPH), and dissolved total polynuclear aromatic hydrocarbons (TPAH) were estimated as a function of time and distance from the point of dispersant application. The results are presented as a series of latitude and longitude grids showing the horizontal distribution of the different constituents with an insert in each figure showing the vertical (cross-section) distribution through a transect represented on each grid as a dashed red line. A 16 knot wind was assumed for all model simulations, and the wind direction is shown in each figure. Water column concentrations are represented by the different colors shown in the concentration scale boxes within each figure. All concentrations are in units of parts per billion (mg/m^3 or $\mu\text{g}/\text{L}$).

Before presenting those results, however, it is again important to emphasize that all model runs were generated assuming the “worst-case” potential concentrations following dispersant application. Specifically, one should recognize that:

- The very low concentrations of oil at Coal Oil Point will very likely result in actual dispersant plus oil volumes that are at or below the minimum volumes provided above and well below the maximum volumes used for the computer modeling runs.
- The volumes of oil actually treated will have already been released “naturally” to the waters of the Santa Barbara Channel.
- The oil that is treated and dispersed will result in a temporary increase in hydrocarbon concentrations in a very small region below the surface; however, that same oil would have eventually impacted the air (through evaporation), the shoreline (through surface transport), and/or the sub-surface waters (through natural advection and ultimately, biodegradation).
- The volumes of dispersant and oil allowed to mix in the upper few meters of the sea will do so in water depths that are significantly greater than those commonly used for dispersant application in the U.S. and abroad (typically 10 meters).
- The total area over which dispersant is to be applied (assuming 5 runs in two days) represents five 10-ft by 200-ft areas (about $1/4^{\text{th}}$ of a football field).
- The distances offshore where dispersants are to be applied are typically between $1/2$ mile and 1 mile or more. It is practically certain that waters with temporarily elevated hydrocarbon concentrations could not reach shallow near-shore waters.
- While an extremely small portion of pelagic drifters (plankton) could be impacted briefly, neither birds, benthic or shoreline organisms will be impacted by the dispersed oil generated during the tests.

- Even if some of the treated oil remains undispersed at the surface, it will pose no greater threat to any form of life than the original oil had it not been treated.

The results of the modeling runs (assuming 100% dispersant effectiveness) are presented on the following pages in Figures 4 through 27. Figures 4 through 7 show the horizontal and vertical distributions of dissolved surfactants in the water column at 1, 2, 4, and 8 hours after dispersant application, and Figures 8 and 9 show graphical presentations of maximum concentrations for all depths and locations as a function of time. Note that the data in Figure 9 are the same as Figure 8, but the concentration scale is expanded to better show the time-series decay between 1 and 4 hours. Figures 10 through 15 present a similar set of data for finite dispersant droplets in the water column, and Figures 16 through 21 present the data for dispersed whole oil droplets (Total Petroleum Hydrocarbons, TPH). Finally, Figures 22 through 27 present the data for total dissolved aromatics (labeled TPAH, but actually both BTEX and PAH components).

Based on the Applied Science Associates, Inc. (ASA) computer model predictions, maximum dissolved-phase surfactant concentrations of 11-12 ppm may be reached immediately after dispersant applications; however, these concentrations quickly fall to less than 40 ppb in as little as 2.4 hours (Figures 8 and 9). Likewise, the plume of dissolved-phase surfactant components quickly spreads and diffuses, with no material reaching a depth greater than 4 m (Figures 4 through 8). Concentrations of finite dispersant droplets reach higher concentrations (approaching 32 ppm) immediately after application, but they too are reduced due to dilution, mixing, and advective transport to concentrations less than 0.4 ppm in as little as 2.4 hours (Figures 14 and 15). Significant concentrations of finite dispersant droplets are not mixed below a water depth of approximately five meters (Figures 10 through 13), and even then, the concentrations at five meters are estimated to only be between 1 to 10 ppb. Maximum dispersed oil droplet concentrations (TPH) are estimated to approach 540 ppm immediately after dispersant application (assuming an overly optimistic DOR of 1:15 and 100% dispersion), but here again, the concentrations fall off to less than 6 ppm in as little as 2.4 hours (Figures 20 and 21). Maximum depth penetration of dispersed oil droplets may reach 6-8 meters, but the model-predicted concentrations at that depth would only be in the range of 10-100 ppb (Figures 16 through 19). Total dissolved aromatic concentrations (both BTEX and PAH – labeled TPAH in the figures) would only reach a maximum of 450 ppb in the first hour after dispersant application, and then they would drop to less than 70 ppb after 2.4 hours and less than 20 ppb after 4.8 hours (Figure 27). Mixing of these components is predicted to be limited to the upper 3-4 meters of the water column (Figures 22 through 26). In all cases, the extent of vertical mixing is controlled by the wind speed, which in these modeling scenarios was assumed at 16 knots. Higher wind speeds would drive the components to slightly greater depths, but this in turn would result in greater mixing and dilution, so the actual concentrations at depth would be lower than those predicted here.

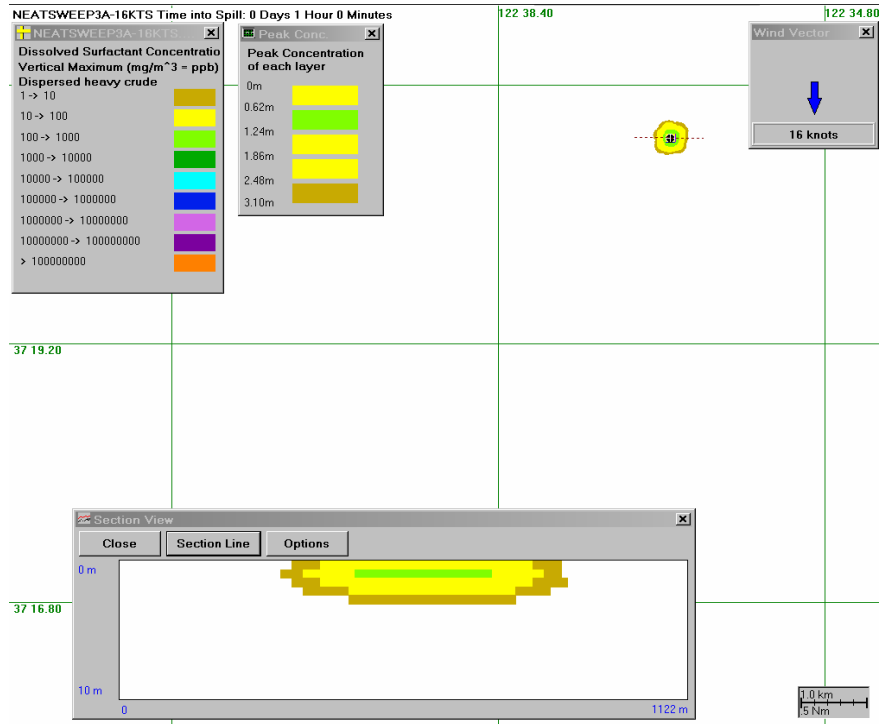


Figure 4. Applied Science Associates (ASA) computer model simulation of dissolved dispersant concentrations (in ppb) in the water column 1 hour after worst-case, 50 gal dispersant application. The black circle represents the point of release and the insert shows the vertical distribution across the transect represented by the dashed red line.

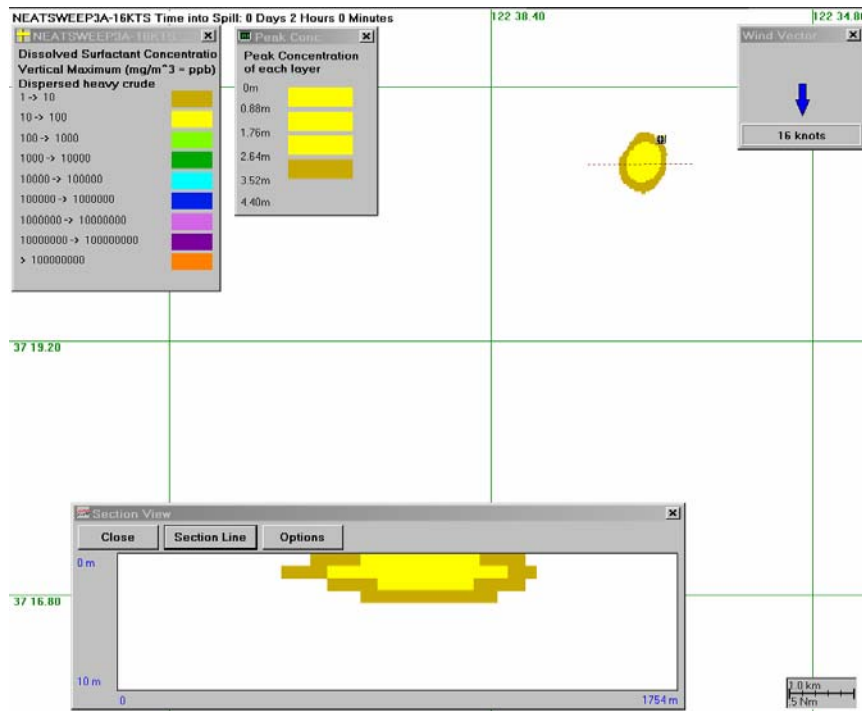


Figure 5. Computer predicted dissolved dispersant concentrations (in ppb) in the water column after 2 hours. The insert shows the distribution with depth.

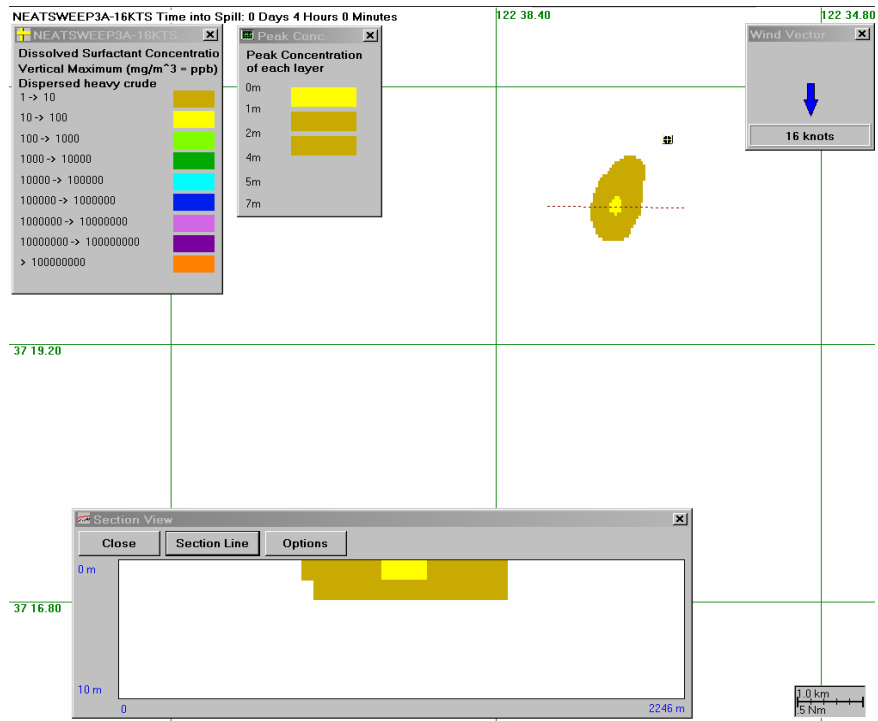


Figure 6. Computer modeled dissolved dispersant concentrations (in ppb) in the horizontal and vertical dimensions 4 hours after a worst-case 50 gal application.

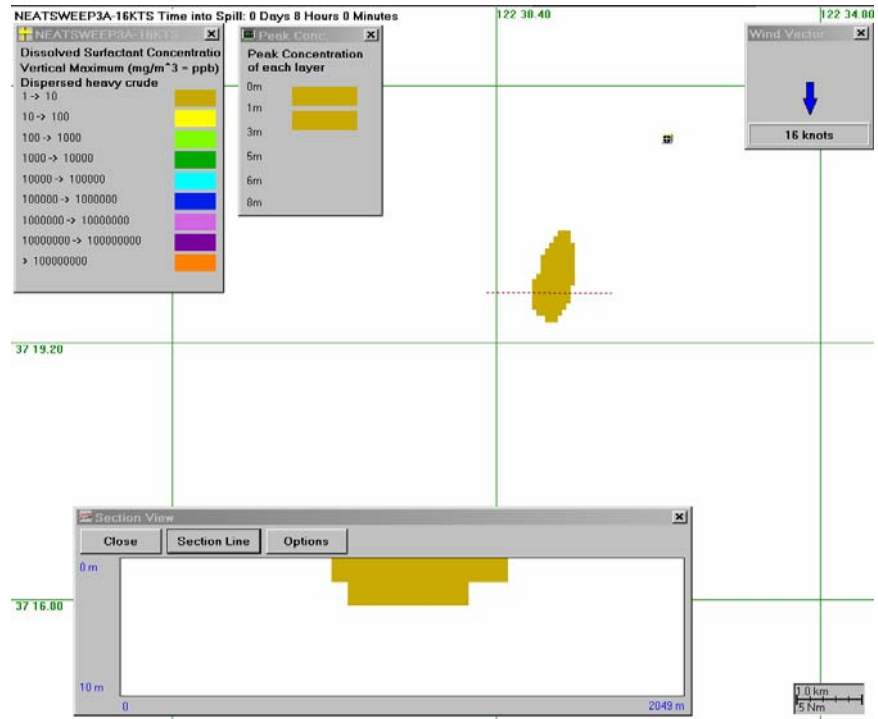


Figure 7. Computer modeled dissolved dispersant concentrations (in ppb) in the horizontal and vertical dimensions 8 hours after a worst-case 50 gal dispersant application.

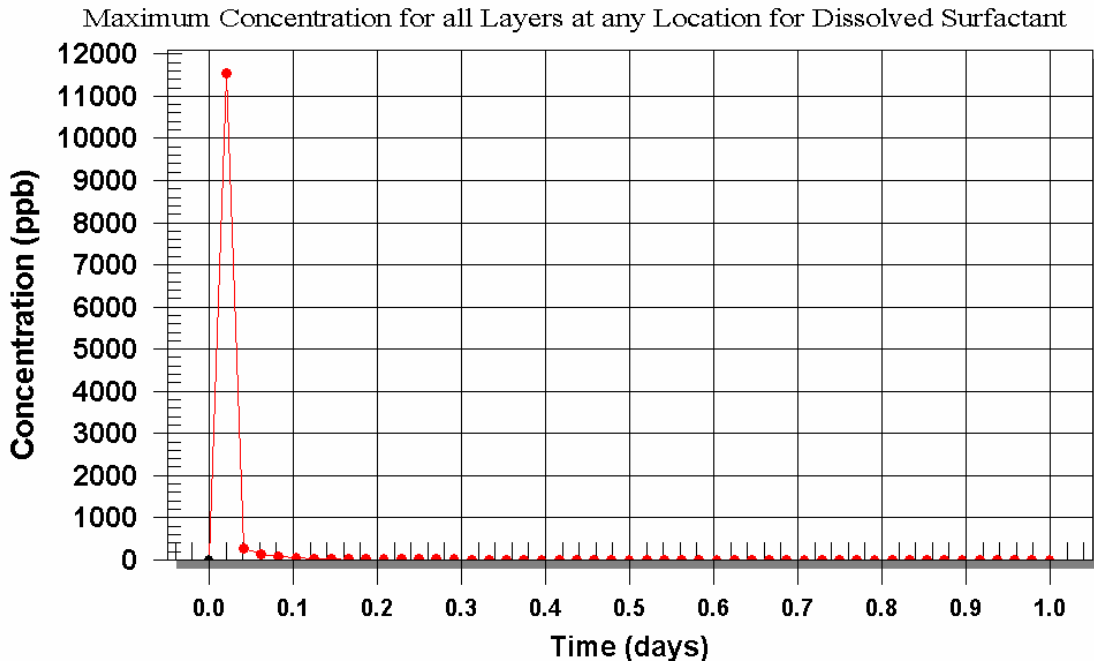


Figure 8. Time-series plot of maximum dissolved dispersant concentration (in ppb) in the water column for all depths and locations.

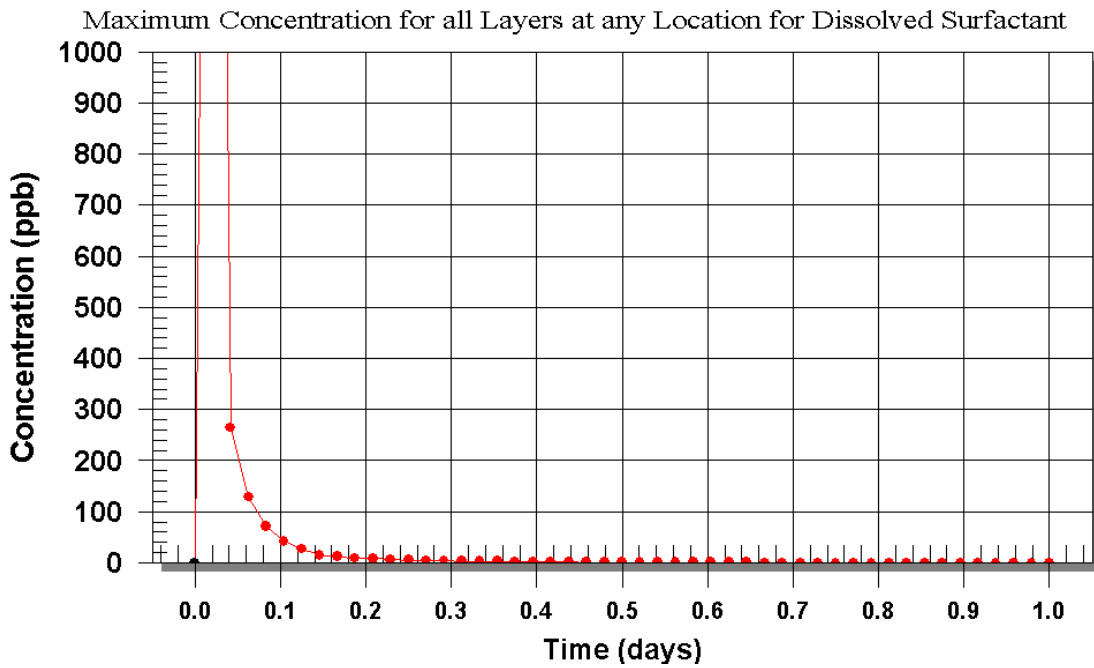


Figure 9. Expanded concentration-scale plot of data from Figure 8 to show decay of dissolved dispersant concentration in the water column over time. Note concentrations are less than 60 ppb in 2.4 hours (0.1 days) and less than 20 ppb in 4.8 hours (0.2 days).

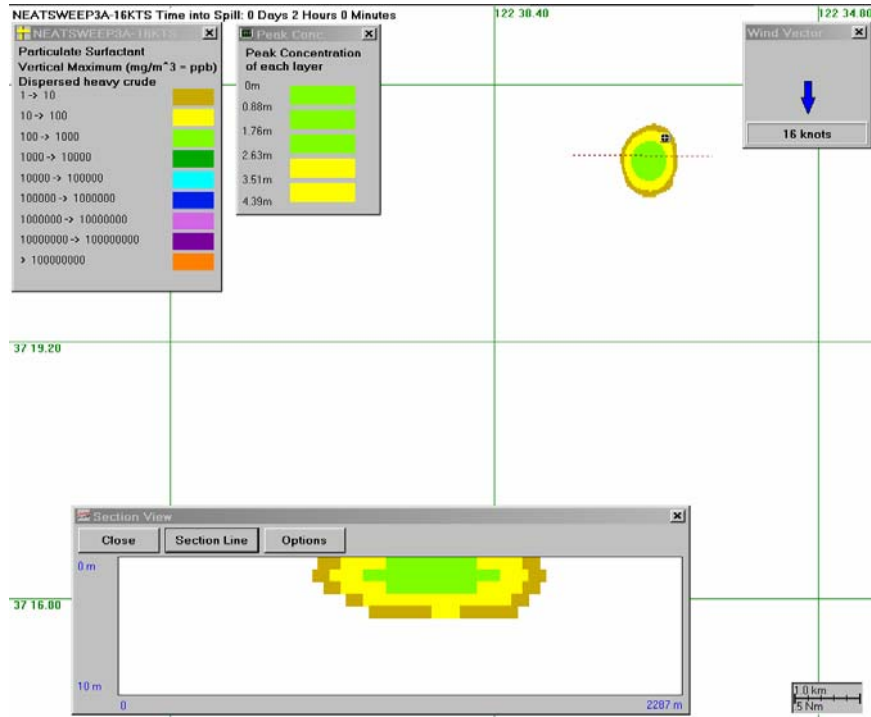


Figure 10. Applied Science Associates (ASA) computer model simulation of droplet-phase dispersant concentrations (in ppb) in the water column 2 hours after worst-case, 50 gal application. The black circle represents the point of release and the insert shows the vertical distribution across the transect represented by the dashed red line.

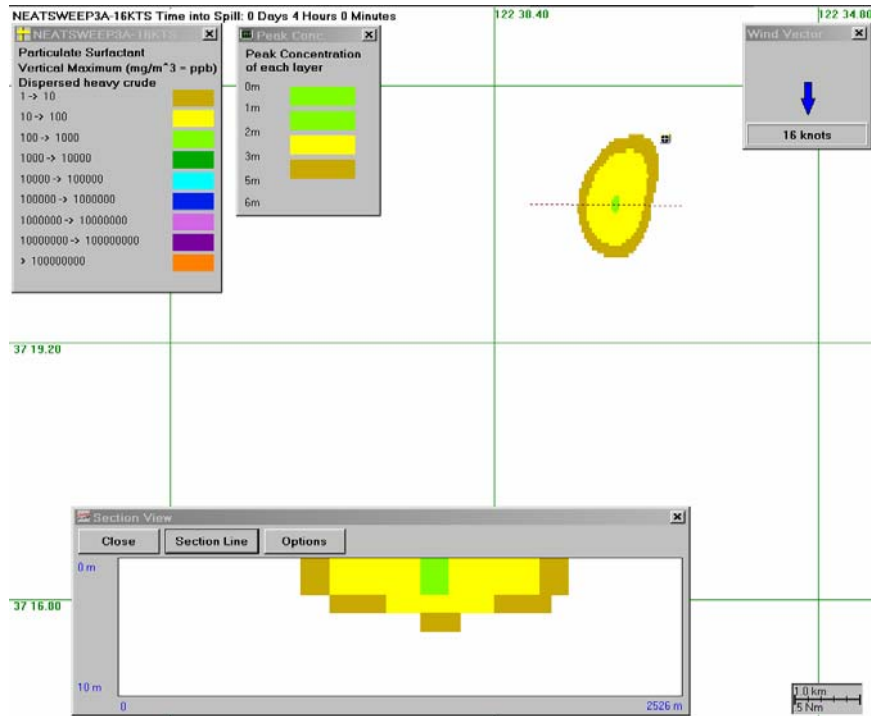


Figure 11. Computer predicted dispersant droplet concentrations (in ppb) in the water column after 4 hours. The insert shows the distribution with depth.

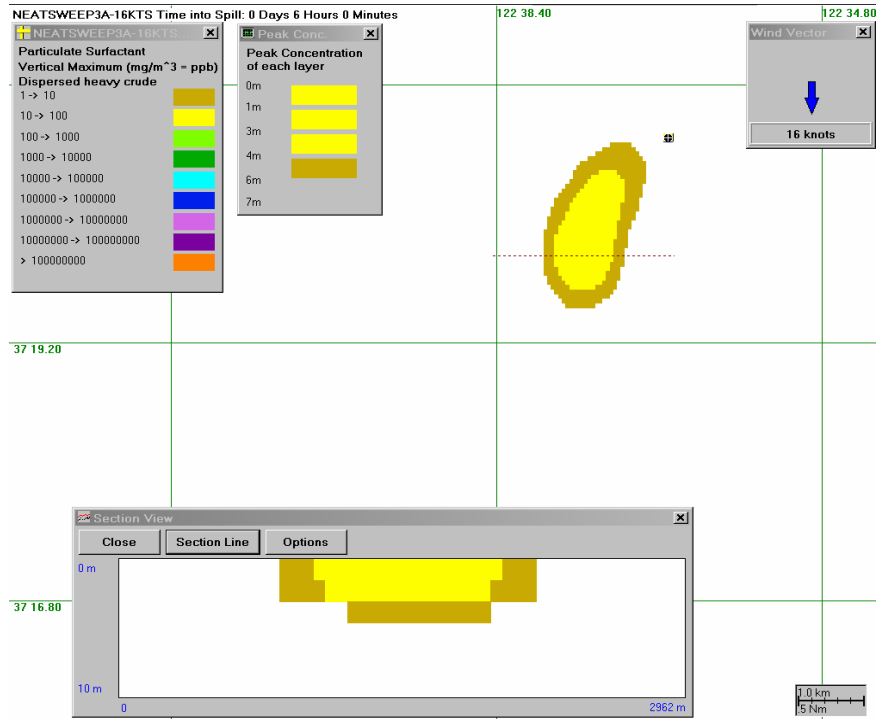


Figure 12. Computer modeled dispersant droplet concentrations (in ppb) in the horizontal and vertical dimensions 6 hours after a 50 gal application.

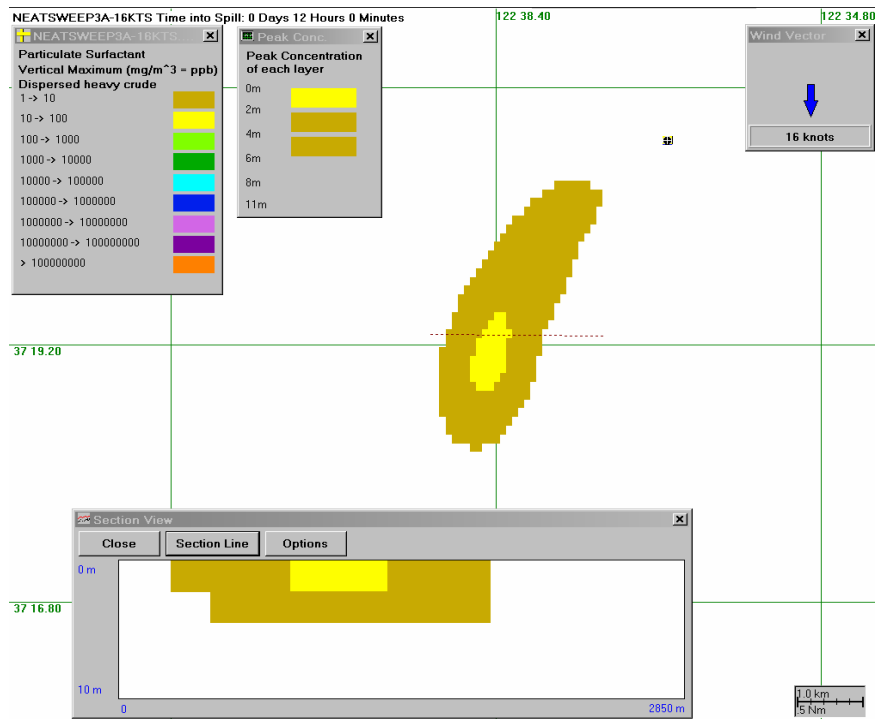


Figure 13. Computer modeled dispersant droplet concentrations (in ppb) in the horizontal and vertical dimensions 12 hours after a 50 gal application.

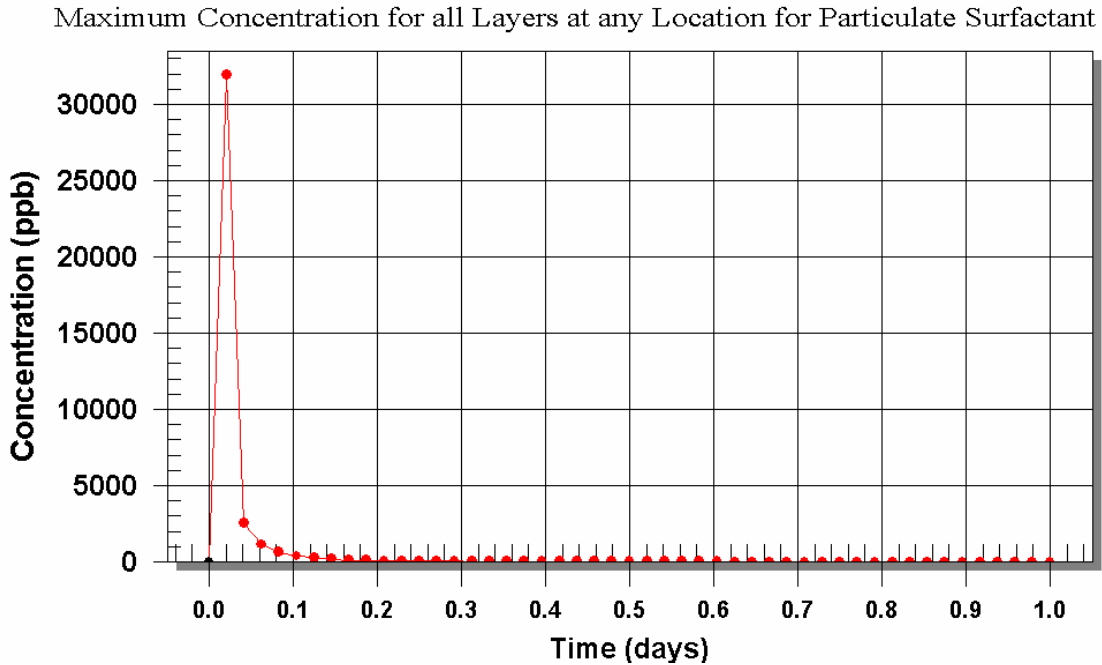


Figure 14. Time-series plot of maximum dispersant droplet concentration (in ppb) in the water column for all depths and locations.

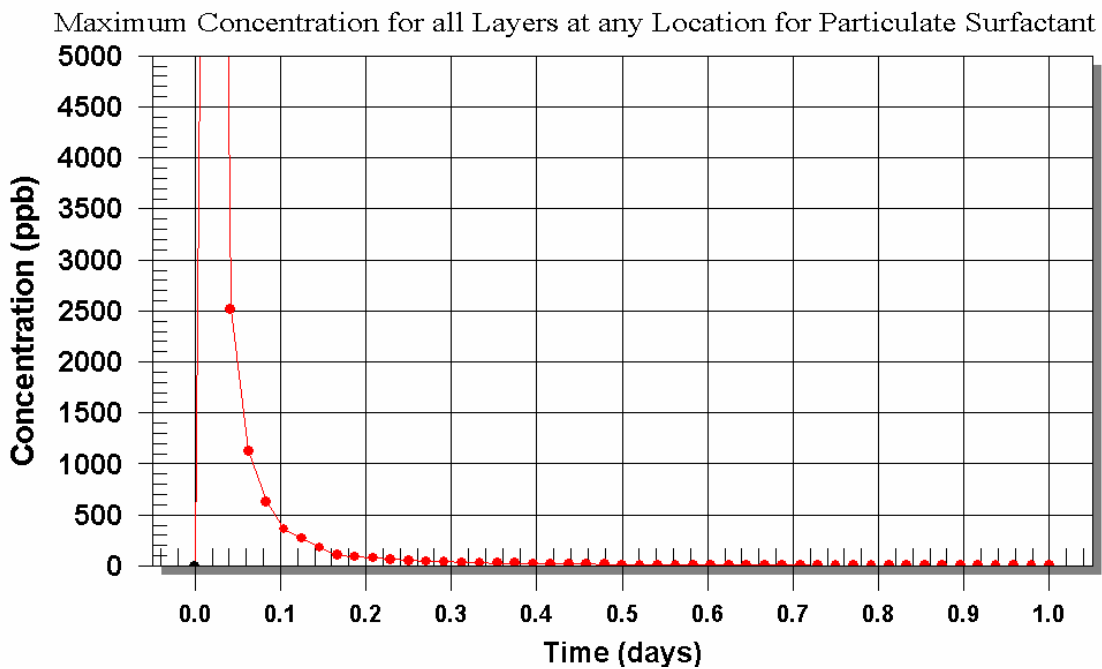


Figure 15. Expanded concentration-scale plot of data from Figure 14 to show decay of dispersant droplet concentrations in the water column over time. Note concentrations are less than 200 ppb in 4.8 hours (0.2 days).

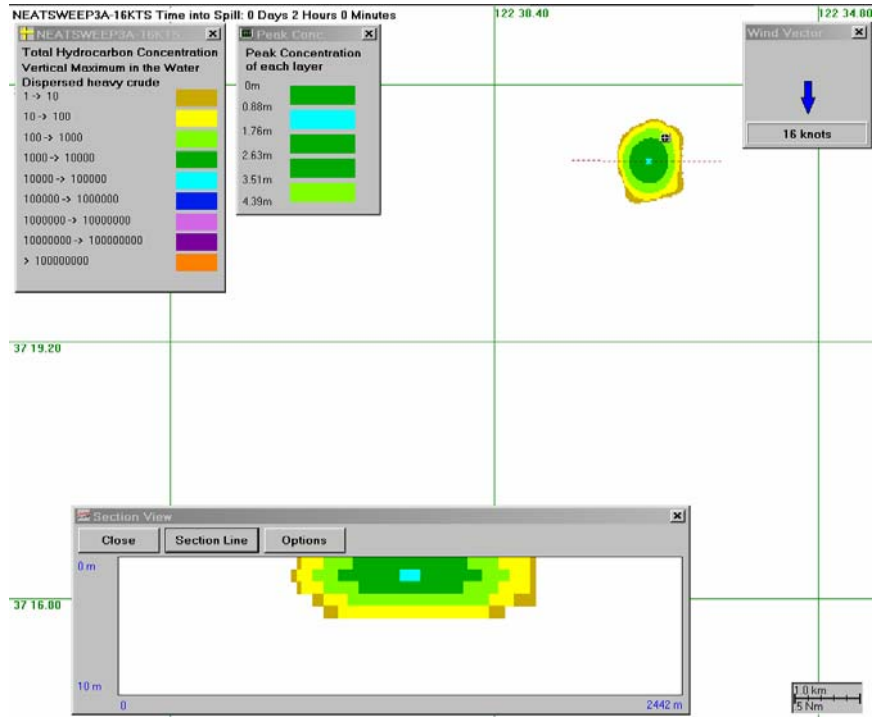


Figure 16. Applied Science Associates (ASA) computer model simulation of total petroleum hydrocarbon (TPH) concentrations (in ppb) in the water column 2 hours after worst-case, 50 gal application of dispersant assuming 100% oil dispersion at a DOR of 1:15 for a maximum 750 gal of oil.

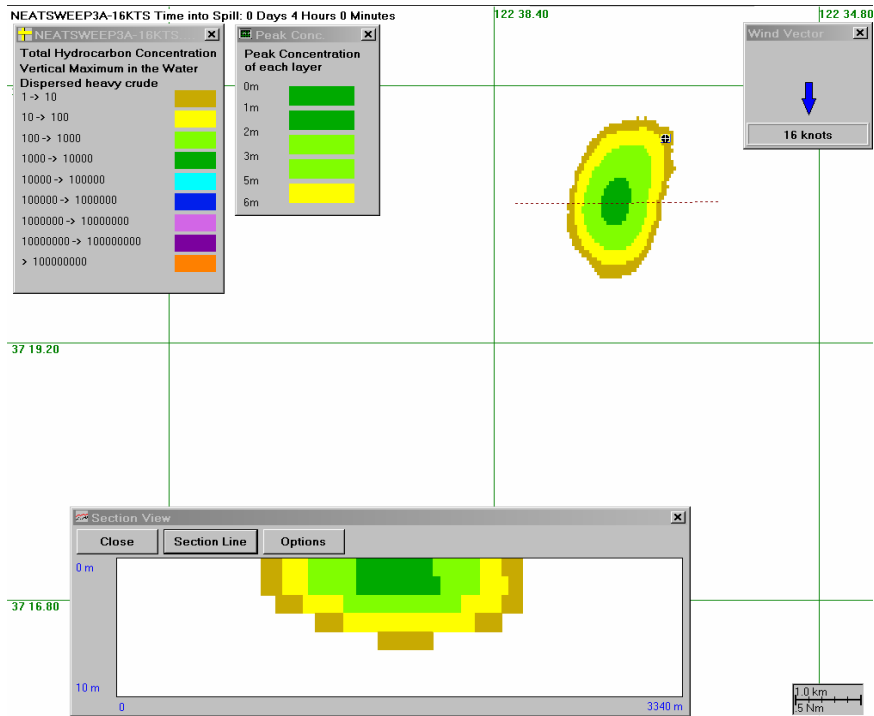


Figure 17. Computer predicted horizontal and vertical TPH concentration profiles (in ppb) in the water column 4 hours after worst case, 50 gal dispersant application.

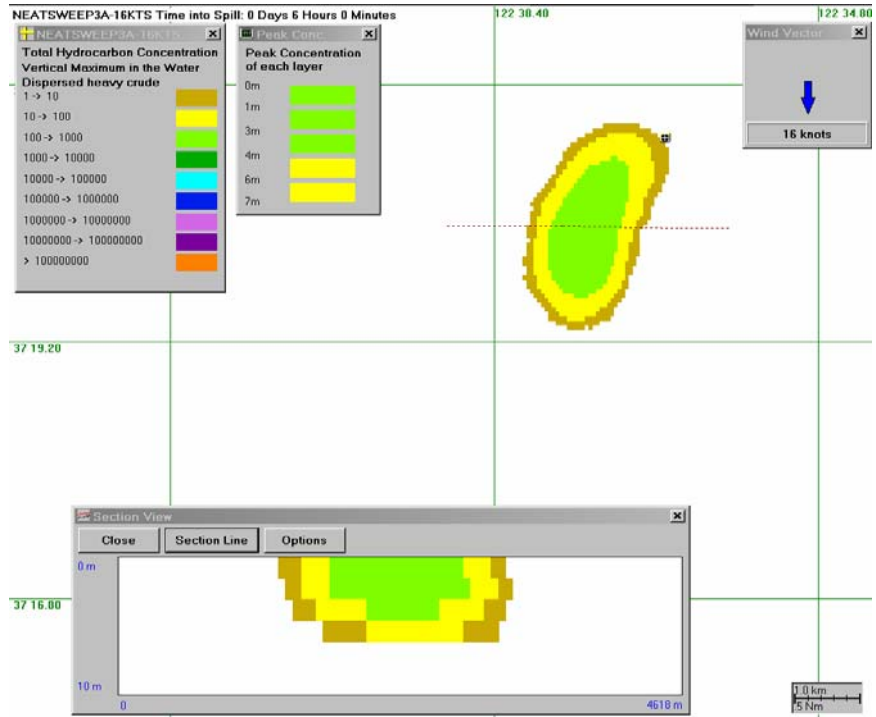


Figure 18. Computer predicted horizontal and vertical TPH concentration profiles (in ppb) in the water column 6 hours after worst case, 50 gal dispersant application. Assumed DOR of 1:15 and 100% dispersion.

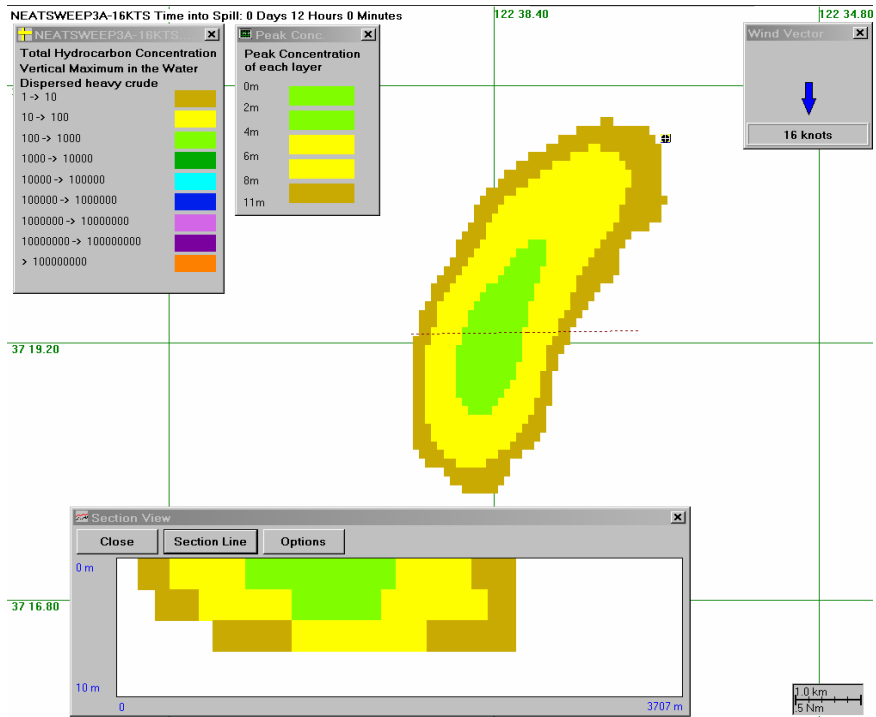


Figure 19. Computer predicted horizontal and vertical TPH concentration profiles (in ppb) in the water column 12 hours after worst case, 50 gal dispersant application. Assumed DOR of 1:15 and 100% dispersion.

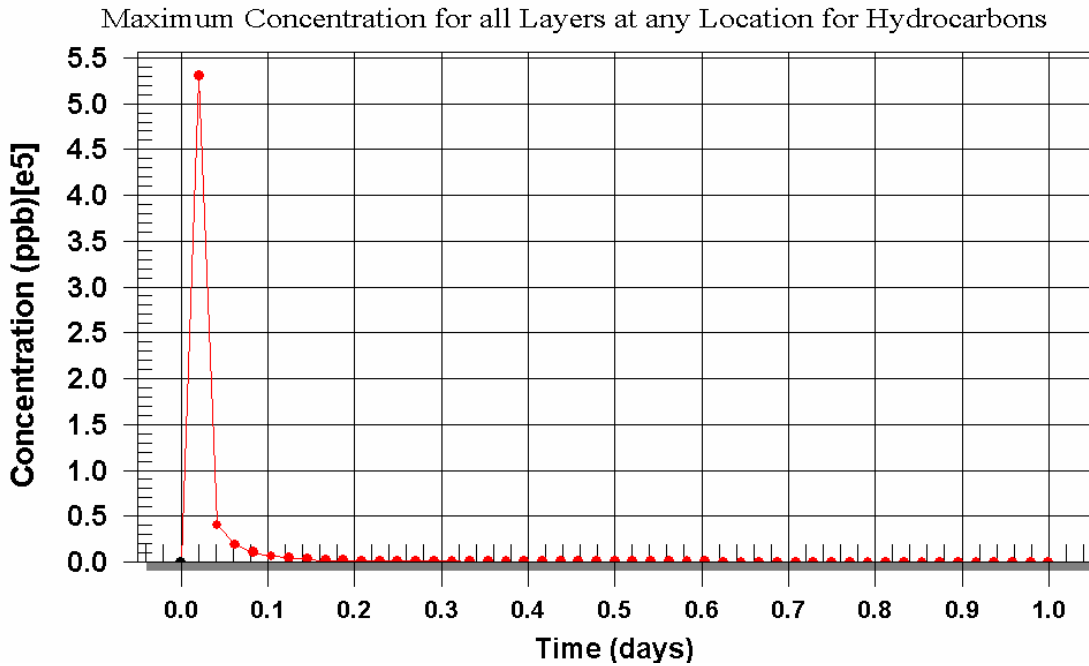


Figure 20. Time-series plot of total petroleum hydrocarbon (TPH) concentrations (in ppb) in the water column for all depths and locations assuming a worst case 50 gal dispersant application at a DOR of 1:15 and 100% oil dispersion.

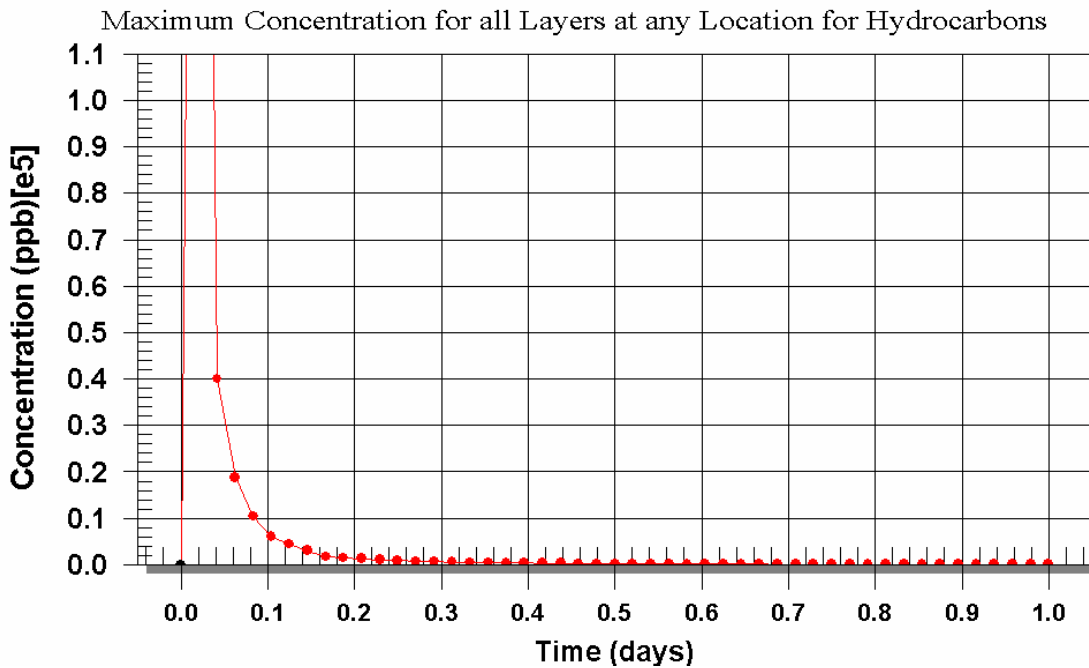


Figure 21. Expanded concentration-scale plot of data from Figure 20 to show decay of TPH concentrations in the water column over time. Note concentrations are less than 4000 ppb (or 4 ppm) in 4.8 hours (0.2 days).

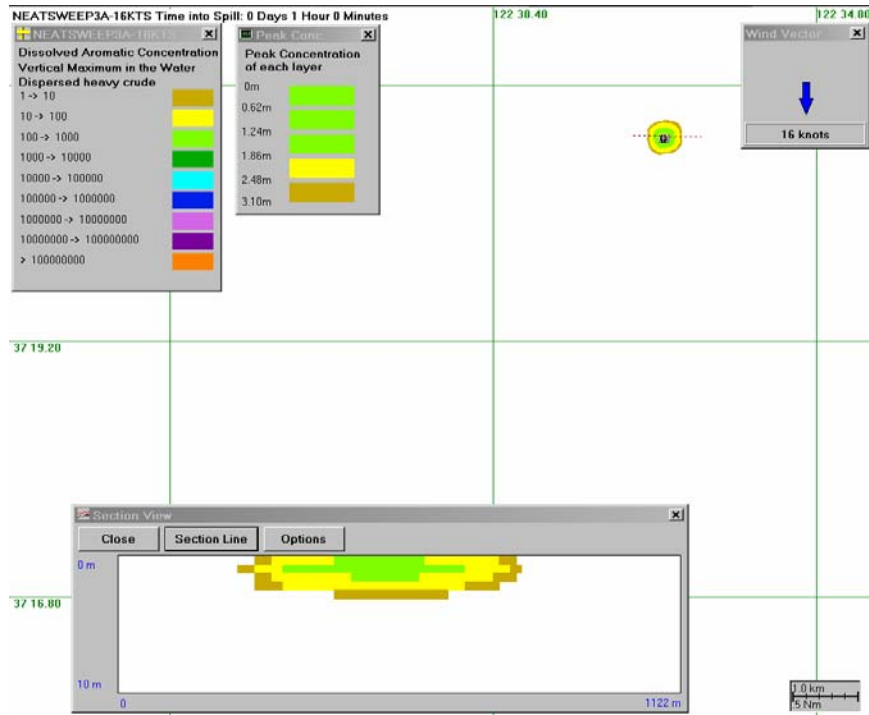


Figure 22. Applied Science Associates (ASA) computer model simulation of total dissolved polynuclear aromatic hydrocarbon (TPAH) concentrations (in ppb) in the water column 1 hour after worst-case, 50 gal application of dispersant assuming 100% oil dispersion at a DOR of 1:15 for a maximum 750 gal of oil.

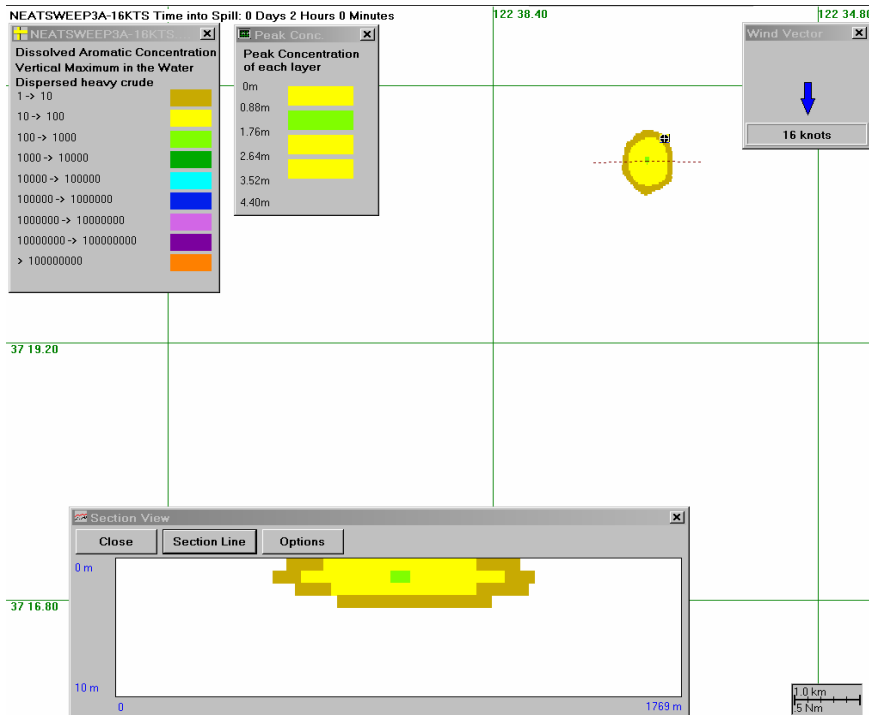


Figure 23. Computer predicted dissolved TPAH concentrations (in ppb) in the water column 2 hours after worst-case 50 gal dispersant application.

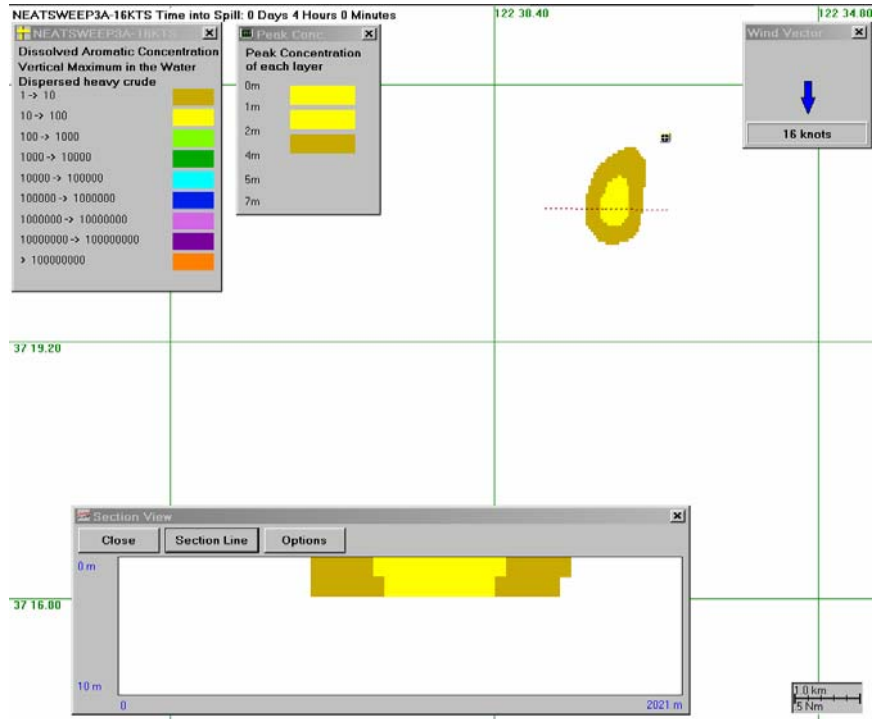


Figure 24. Computer predicted horizontal and vertical dissolved-phase TPAH concentration profiles (in ppb) in the water column 4 hours after worst case, 50 gal dispersant application. Assumed DOR of 1:15 and 100% dispersion.

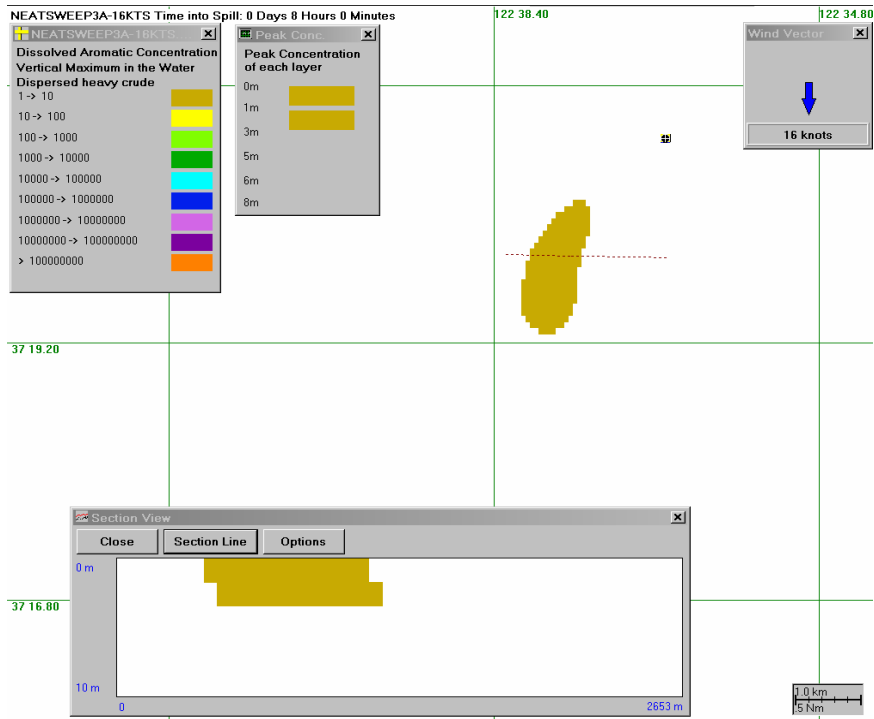


Figure 25. Computer predicted horizontal and vertical dissolved-phase TPAH concentration profiles (in ppb) in the water column 8 hours after worst case, 50 gal dispersant application. Assumed DOR of 1:15 and 100% dispersion.

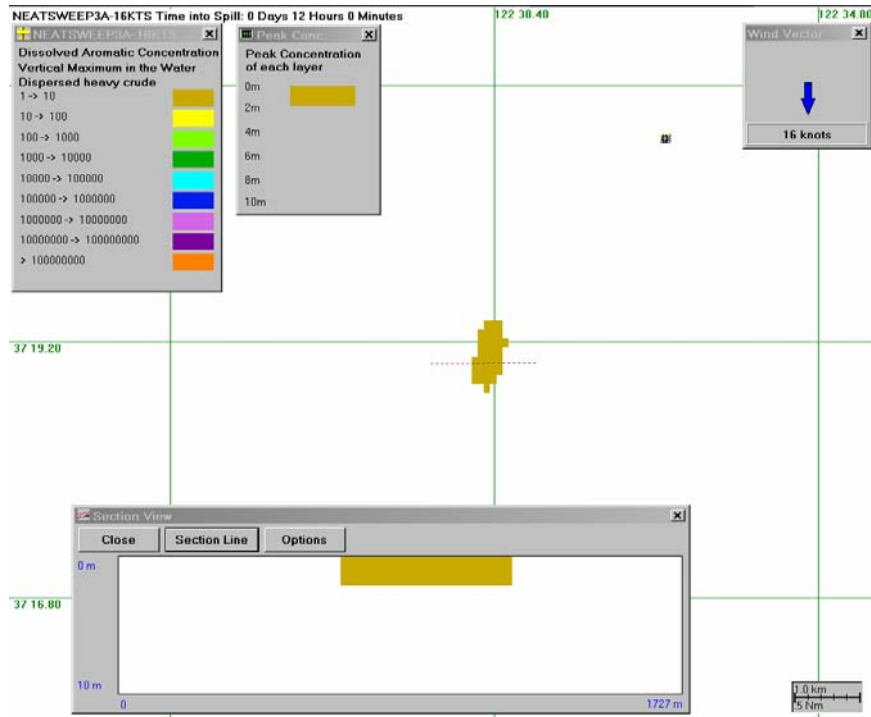


Figure 26. Computer predicted horizontal and vertical dissolved-phase TPAH concentration profiles (in ppb) in the water column 12 hours after worst case, 50 gal dispersant application. Assumed DOR of 1:15 and 100% dispersion.

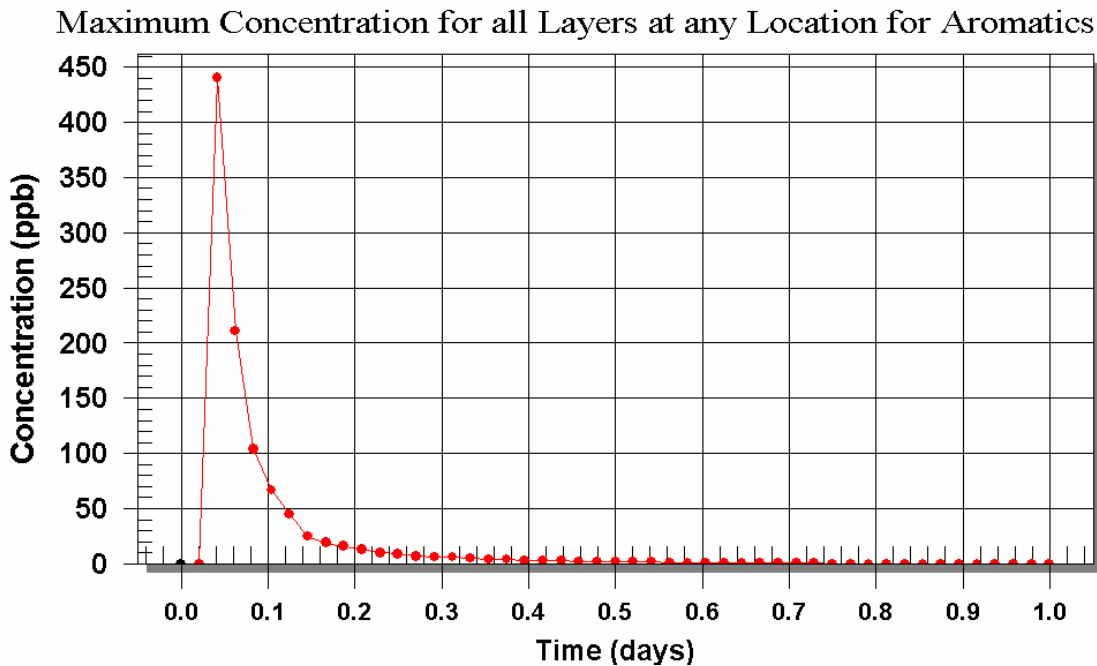


Figure 27. Time-series plot of total dissolved polynuclear aromatic hydrocarbon (TPAH) concentrations (in ppb) in the water column for all depths and locations assuming a worst-case 50 gal dispersant application at a DOR of 1:15 and 100% oil dispersion. Note the concentration is less than 20 ppb in 4.8 hours (0.2 days).

3.1.3 *Dispersant and Dispersed Oil Toxicity*

Numerous studies on the toxicity of oil spill dispersants (including Corexit 9500) and dispersant treated oil have been sponsored by the California Department of Fish and Game -- Office of Oil Spill Prevention and Response (OSPR), and Tables 1 and 2 present data from those studies that are relevant to this project (Singer et al. 1996, 1999, and 2001).

Table 1. Sensitivities of Different California Species and Life Stages to Solutions of Corexit 9527 and 9500 (from Singer et al. 1996 and 1999)

Toxicant/Test	Kelp Forest Mysid (juvenile) LC50 (ppm)	Topsmelt (larva) LC50 (ppm)	Red Abalone (embryo) LC50 (ppm)
Corexit 9527 96 hr exposure	6.2	30.7	1.6
spike exposure	140	83.0	15.9
Corexit 9500 96 hr exposure	no data*	no data*	no data*
spike exposure	158-245	no data*	13-20

* No data are available for these specific tests, but the authors concluded that the toxicity of Corexit 9500 was similar to Corexit 9527 and 9554. Therefore, similar LC50 values are likely.

In comparing the data from Table 1 with the results shown in Figures 4 through 9 and discussed above, it is clear that the predicted dissolved-phase dispersant concentrations will be below levels where significant toxicity was observed with any of the tested California species. When droplet-phase dispersant concentrations are considered, there may be a brief period when concentrations approaching 32 ppm are observed, but these quickly drop off to less than 0.4 ppm in as little as 2.4 hours (Figures 10 through 15). As such, the concentrations might be briefly above levels where effects were observed in the spike-exposure studies with red abalone embryos; however, little impact would be expected with the proposed tests because of the distance from shore, the highly localized nature of the plume, and extensive dilution before any constituents could reach the intertidal zone.

Table 2. Spiked-Exposure Dispersed Oil Toxicity with Fresh and Weathered Oil and Corexit 9500 DOR = 1:10 (from Singer et al. 2001)

Toxicant/Test	Kelp Forest Mysid (juvenile) LC50 (ppm)	Topsmelt (larva) LC50 (ppm)	Red Abalone (embryo) LC50 (ppm)
Fresh Oil	15.5	10.7	11.8
Weathered Oil	> 0.93	> 1.5	No data
Dispersed Fresh Oil	11.6	12.5f	32.5
Dispersed Weathered Oil	15.5	17.6	20.3

From the data in Table 2 and the modeled dispersed oil droplet (TPH) concentrations shown in Figures 16 through 21, it would appear that TPH concentrations immediately after dispersant applications could exceed those where toxicity has been measured in California OSPR laboratory studies. It should be noted, however, that these elevated concentrations would be extremely localized and short-lived. As noted earlier, the treated area will be less than ¼th the size of a football field, and although the dispersed oil plume increases in size with advection and dispersion in three dimensions over time (see Figures 16-19), the actual dispersed oil droplet concentration in the plumes drops to less

than 4 ppm in approximately 5 hours. Furthermore, the predicted TPH concentrations assume 100% oil dispersion at a conservative DOR of 1:15. In actual fact, the amount of oil encountered during the at-sea trials will most likely be much less than the 750 gal used for the modeling simulations, and as shown by the data and references cited below in Table 3, actual measured TPH concentrations in previous at-sea trials and spill-of-opportunity studies are generally in the range of only 7 to 20 ppm, with one study showing measured water-column concentrations around 40 ppm during the first several hours after dispersant application. As a result, we do not anticipate significant water column toxicity due to any of the proposed studies.

Table 3. Measured Total Oil Concentrations at Various Depths from Field Trials and Spill-of-Opportunity Studies (from McAuliffe et al. 1981; Trudel 1998; and Payne et al. 1991, 1993)

Oil Type	Application and Time After Spill	D:O Ratio	Sampling Time After Spraying (minutes)	Concentration at Measured Depth Beneath Slick (ppm)		
				1 m	3 m	9 m
Prudhoe Bay	Aircraft, immediate	1:19	15	40	9	0.9
Prudhoe Bay	Aircraft, after 2 hrs	1:19	7-26	5	4	0.5
Prudhoe Bay	Boat	?	?	21	9	0.4
Prudhoe Bay	None (control)	0	n.a.	n.d.	n.d.	n.d.
Fuel Oil	Aircraft, after 2-4 hrs	?	30-60	18-32	0.8-4	--
Angola Planca	Aircraft, after 12-24 hrs	?	30-120	2-15	2-22	1-4

One of the anticipated outcomes of the proposed dispersant trials will be the opportunity to compare the measured dispersed oil droplet and dissolved PAH concentrations with computer model-predicted values as a function of observed dispersant effectiveness. All of the predicted water-column concentrations in this Technical Report have assumed a conservative, worst-case 100% dispersion effectiveness at a DOR of 1:15, and these tests will be the first opportunity to compare the ASA SIMAP predictions of water-column concentrations under carefully controlled conditions where dispersant effectiveness can be estimated by trained observers. In this regard, it will allow calibration of previous modeling studies of oil behavior and water-column impacts with different assumed (25, 50, and 75 percent) dispersant effectiveness (French and Payne 2001). Also, the ASA SIMAP model utilizes calculated dissolved PAH concentrations to estimate water-column toxicity, and this program will also allow comparison of modeled TPAH values (as shown in Figures 22 through 27) with individual and total PAH measurements. Finally, model-predicted toxicity can be compared against measured toxicity tests completed on grab water samples collected in conjunction with the SMART Protocol UV/fluorescence monitoring activities.

3.1.4 *Response to Questions and Concerns Raised by Santa Barbara County Energy Division Staff*

Environmental Damage Concerns

1. *Even though the planned experiment is small scale, impacts to organisms will occur. As the impacts have been described by Jim Clark (ExxonMobil dispersant expert), you can assume that any organism that gets caught in the dispersed oil plume (before significant dilution occurs) will be killed. There is a lot of evidence that dispersed oil can be toxic, especially in shallow water near shore.*

Dilution begins in minutes after dispersant application due to three-dimensional mixing augmented by dispersive and advective processes. As shown by the modeling data presented in this Technical Report, concentrations of dissolve phase surfactant will never be above levels of concern, and dispersant droplets and TPH will drop below levels of concern within 2-4 hours after each test. Furthermore, the elevated concentrations when they occur will be very localized, and all experiments will be conducted far enough from the shoreline so that shallow nearshore and intertidal effects will be minimized.

2. *How will biotic effects be monitored?*

By GC/MS and FID/GC measurements of dissolved-phase PAH and dispersed, free oil droplets, respectively, and independent toxicity tests of grab water samples collected in conjunction with the SMART UV/Fluorescence measurements.

Permitting/Regulation Issues

1. *It appears that for such an experiment to be done in state waters, an environmental review would be required under CEQA.*

We conferred with the California State Lands Commission regarding CEQA permitting, and they expected that this project would qualify for an Article 19 Categorical Exemption under Class 6 – Information Collection. Class 6 consists of basic data collection, research, experimental management, and resource evaluation activities, which do not result in a serious or major disturbance to an environmental resource. As a result, this project is expected to be exempt from the provisions of CEQA.

2. *Why wasn't this issue discussed at the last dispersants subcommittee meeting? (Neither was it on the agenda of the Area Committee meeting the same afternoon.)*

Notification of Award for the program was made in mid summer 2002, but the contract between CICEET and PECI was not signed until late October 2002. It is possible that the RRT was not aware of the project at the time of the dispersant subcommittee meeting in question.

3. *What permits or permissions by state agencies are required?*

Numerous state and federal agencies are being contacted for the necessary permits for this project, including:

- A Waste Discharge Requirements General Permit for Discharges with Low Threat to Water Quality, from the California Regional Water Quality Control Board Central Coast Region, under Order No. 01-119. NPDES No. CAG993001.
- Consultations are also ongoing with the following agencies:
 - i. California Department of Fish and Game for a Marine Resources Permit
 - ii. The State Regional Air Pollution Control District
 - iii. The National Marine Fisheries Service
 - iv. The U.S. Fish and Wildlife Service
 - v. The U.S. Environmental Protection Agency
 - vi. The Channel Islands Marine Sanctuary Program
 - vii. The County of Santa Barbara Energy Division

- The California Coastal Commission (CCC) for a Federal Consistency Review (if the U.S. Coast Guard or NOAA take the lead as the federal applicant for the CCC permit) or a CCC Coastal Development Permit if the lead applicant is Payne Environmental Consultants, Incorporated (PECI).

Experimental Design Issues

1. *Why conduct the experiment so close to shore, where potential biological damage is maximal? (Why not do it in Spain under real spill conditions?)*

The experiments will be conducted ½ to 1 mile off shore to minimize shoreline impacts. It is unrealistic to attempt experiments such as this “on the fly” at spills of opportunity in international waters, such as the spill in Spain. All of the logistics provided by Santa Barbara Clean Seas and So Cal Ship Services, the USCG, and MSRC, along with the natural seeps available at Coal Oil Point make this the only logical location for the study.

2. *June is a poor time for the experiment, because of likely fog and calm seas.*

June through August is the best window of opportunity given other project constraints and timelines necessary to complete the project on schedule and in time to generate a paper for the 2005 International Oil Spill Conference (abstracts are due in Spring 2004). Also, we have been informed that biological activity in offshore waters is at a minimum during the June-August period (personal communication, Mike Sowby, California Department of Fish and Game, OSPR).

3. *Will you test oil dispersion under a range of sea states?*

Weather permitting; we hope to get a variety of wind and sea states over the two-to-three day period that the experiments will be completed, but of course, there is no way to predict that this far in advance.

4. *How much dispersant will be applied? On how many days?*

As discussed in this Technical Report, a maximum of 50 gallons of dispersant could be applied over each two minute experiment. We hope to complete two runs on the second day of operations and a maximum of three runs on the third (or fourth weather-contingency) day of operations.

5. *The spatial and temporal sampling design seems challenging. Will the sampling design give enough information to extrapolate results to other settings? We would like to see the sampling plan in greater detail.*

Sampling activities after each run will be very complex and will require 2-3 hours and several boats to complete. Details typical of the sampling approach are presented in Payne et al. (1991 and 1993). Additional elements of the sampling plan will be developed with all field participants (Santa Barbara Clean Seas, So Cal Ship Services, MSRC, the USCG, etc.) before project implementation and during the first day of field activities. Changes to the field plan will be incorporated as necessary.

6. *The water sampling device that integrates the water sample over several minutes loses information of variability. Peak concentrations will not be known.*

Peak concentrations will be measured by the UV/Fluorescence SMART Protocols. The PLVWSS will provide 5-minute time integrated samples to calibrate the UV/F measurements.

7. *How will the ambient, baseline concentration of oil and PAHs in the water (prior to dispersant application) be measured?*

Baseline samples will be collected on the first day of the program before any dispersant trials are undertaken and immediately before each test run is initiated. In addition, samples will be collected in control areas that were not treated with dispersants during the actual tests. Samples will be obtained by both the PLVWSS (dissolved PAH and finite oil droplets) and SMART Protocols.

8. *Present knowledge of the fate of seep oil is sketchy. How will you evaluate how much oil is encountered and passes under the Neat Sweep and how much remains on the surface?*

Visual observation by trained observers and video tape documentation.

9. *Will you attempt to disperse slicks of different thickness?*

Probably, but the NeatSweep boom and DAZ arrangement will concentrate the oil to the optimal thickness as described in this Technical Report.

10. *How will slick thickness be measured and the appropriate spray rates determined in real time?*

Slick thickness will be estimated by trained observers and spray rates adjusted between 10-25 gal/min as appropriate to obtain optimal results.

11. *Will wave energy and currents be measured/monitored?*

If possible. Currents can be estimated with drogues, which will be deployed during the field experiments (see Payne et al. 1991 and 1993), and sea state will be recorded by USCG or other trained personnel on an hourly basis.

12. *Is the experimental plan being reviewed by objective, non-invested parties (peer review)?*

Yes. This project and experimental design were subjected to independent peer review by university and government scientists as part of the proposal review and competitive award process.

Can Results Be Extrapolated?

1. *Many factors in the experiment are variable, including currents, vertical mixing, and oil characteristics. The seep slick oil is probably very different than Santa Barbara crude extracted on local platforms or other oils likely to be spilled in the vicinity, such as Alaska crude or fuel oils carried by container ships. With so many variables, can the experiment lead to extrapolable results? Have the limits of extrapolation been explicitly examined?*

We are not trying to see if the seep oil is dispersible and extrapolate to other oil types. The objectives are to evaluate the NeatSweep approach under real world conditions and intercalibrate SMART UV/Fluorescence data with discrete measurements of dissolved/dispersed oil droplets quantified by GC/MS and FID/GC techniques. These data will then be compared to computer-model predicted estimates of dispersed oil concentrations and independent toxicity measurements.

2. *Are the oil characteristics of the seep slicks known?*

Yes, and as low API gravity oils they are not particularly good candidates for chemical dispersion. Nevertheless, their presence avoids the issue of artificially introducing oil into U.S. and state waters in order to complete the dispersant trials.

3. *Corexit 9500 is being used. Only 9527 is inventoried locally. Why will the test be conducted using a product other than the one likely to be applied in the local area?*

Corexit 9500 was formulated to be used on lower API gravity oils and higher viscosity weathered crude oils and emulsions (Fiocco and Lessard 1997; and Fiocco et al. 1999). Corexit 9527 may not disperse enough of the seep oil to provide the concentrations and data desired to achieve other program objectives.

4. *How will results be used to inform decision making?*

The field tests and intercalibration data will extend our knowledge and confidence in the SMART protocols and introduce field response personnel to two of the most recent improvements in oil spill technology: a totally new approach for the application of dispersants (NeatSweep) and a relatively simple, though efficient, technique for the separate measurement of dissolved hydrocarbons and oil droplets following the application of dispersants (PLVWSS). The primary focus of our data analysis effort will be to correlate total PAH concentrations (from GC/MS analyses) and total petroleum hydrocarbon (TPH) burdens (from FID GC analyses) with the continuous UV/Fluorescence data obtained from the SMART Protocol readout generated during the field exercise. By separating the dissolved-phase and particulate (oil droplet) components from the total PAH and TPH measurements, we will be able to quantify the importance of the physical state of the components contributing to the fluorescence signal, and thereby provide additional data that may help to tie field measurements to

potential toxicological effects. These data can then be used to help field-calibrate the SMART Protocol readings to actual oil concentrations in the water-column in future spill events, particularly if the PAH composition of the spilled oil is known (or can be measured after the fact). Ultimately, these are the data that will be required to address concerns about organism exposure and potential short-term toxicological impacts from dispersant use.

The results from these studies will initially be available as quantified data in NOAA/CICEET reports that will include narrative descriptions of the methods, results, and conclusions as well as tabulated and graphical data comparing the measurements from the SMART UV/Fluorescence system and the discrete dissolved-phase and particulate phase PAH concentrations. Ultimately, the results from the study will be published in International Oil Spill Conference/AMOP Proceedings, and the peer-reviewed literature. In addition, the operational characteristics and efficiency of the NeatSweep system as well as the utilization of the SMART Protocols will be documented (with photographs and video tape) for dissemination to NOAA, U.S. Coast Guard, and other Oil Spill Cleanup Cooperative personnel.

5. *Will any diffusion/dispersion plume model be tested in conjunction with the concentrations measured?*

Yes, the Applied Science Associates (ASA) SIMAP model has been used in the preparation of this Technical Report, and additional modeling runs at different dispersant effectiveness values will be completed to compare model predictions to measured concentrations of dissolved PAH and dispersed oil droplets (TPH) and the results of independent toxicity analyses.

Dispersant Delivery Method Appears Inappropriate

1. *The Neat Sweep system can only be used for relatively small areas, due to its 100 m wide capture capability. One of the advertised advantages of dispersant use is that large areas can be covered rapidly with aerial applications.*

The NeatSweep system avoids problems of dispersant drift and missing the target, herding, and overdosing/under dosing, which can occur with aerial applications. The NeatSweep system also minimizes potential personnel exposure to the dispersant, and it allows the localized control necessary to complete the experimental approach described in this Technical Report.

2. *With Neat Sweep, the oil must first be contained before it is dispersed. Under circumstances where the oil is contained, it should be recovered rather than dispersed.*

NeatSweep does not contain oil – it simply deflects and concentrates oil for release into the Dispersant Application Zone. Recovery of contained oil from the sea is problematic. Even under the best of circumstances, only 15-20% recoveries are generally obtained, and that approach requires barges or other storage tanks to hold recovered oil/water mixtures.

Concerns About Project Purpose

1. *The experiment moves us a step closer to approval of nearshore dispersant use without adequate understanding of impacts of public acceptance of the tradeoffs. It will prematurely establish a precedent for dispersant use.*

The purpose of these experiments is to provide the very data that are needed to allow a better understanding of the impacts of dispersant use.

2. *Concern was voiced that the experiment is driven by commercial interests and an agency agenda to promote dispersants, rather than by its scientific merits.*

The principle contractor (PECI) for this project has no commercial tie with any commercial interests associated with dispersant manufacture or applications systems. The president of PECI was a member of the 1985-1989 National Research Council Committee on the Use of Chemical Dispersants to Combat Oil Spills (NRC 1989), and the experiments outlined in this Technical Report are a direct

outgrowth of over 20 years of research on oil spill behavior and impacts, two spill-of-opportunity dispersant studies conducted in conjunction with NOAA, CA Dept. of Fish & Game/OSPR, and the USCG, and the results of successful trials of NeatSweep testing at the MMS OHMSETT wave tanks in Leonardo, New Jersey.

3. *How does the experiment fit into the dispersant outreach program of the Area Committee?*

Results will be widely disseminated to scientific and lay members of the public and the Area Committee for incorporation into area-specific dispersant use plans.

Bottom Line Questions

1. *Will the experiment have sufficient scientific value to justify the expected biological impacts, where value is measured in terms of: a) quantifiable technological progress in spill dispersant delivery and monitoring which can be extrapolated to real-world dispersant applications, and b) increases in understanding the biological impacts of dispersant use?*

Yes. Because of the limited volumes of dispersant that will be used, there will be very little biological impact, and yet, this project will demonstrate a new and improved dispersant application technology, allow quantification of UV/Fluorescence SMART Protocols against finite GC/MS measurements of dispersed oil droplets and dissolved-phase components. Furthermore, these same chemical measurements will be correlated with toxicity assessments on water samples collected at the same time, and both the chemistry and toxicity data will be quantitatively compared with computer-model predictions of dispersed oil behavior and PAH toxicity.

2. *Are there other options or experimental designs that would be less damaging to the environment and more informative?*

No. The natural oil seeps at Coal Oil Point are the ideal place to undertake this study with the resources of the response cooperatives and state and federal agencies that have expressed a commitment to this project.

3. *Is the timing appropriate, considering that the case for dispersant use has not yet been effectively made to the Santa Barbara public?*

This project will develop information and data that will be directly relevant to the task of informing the Santa Barbara public about the pros and cons of dispersant use and the most expedient application systems available at this time.

3.2 Receipt of RWQC District Approval

As a result of the Technical Report submission for the NPDES Permit for Discharges with Low Threat to Water Quality described in Section 3.1, and the receipt of a PECI check for \$400.00 for the NPDES permit fee, Mike Higgins informed us that as of 24 January 2003, we were in compliance and could proceed with the project subject to a final RWQC Board review in Watsonville, CA on 16 May 2003. The project was placed on the agenda for that meeting, and Mike Higgins presented his staff review (based on our Technical Report) to the formal Board at that time. The Regional Board concurred with the RWQCB staff report on the project as covered under the Low Threat to Water Quality NPDES Permit, and the project was approved based on our discussions and formal submissions.

3.3 Additional Agency Involvement and Permitting

Two additional action items and a significant development that came out of the 17 December 2002 meeting in Camarillo were: (1) that the Santa Barbara County Air Pollution Control District (APCD) be contacted to determine if they needed to issue a permit

for (additional) boat exhaust emissions generated during the test; (2) a request from Bill Robberson (U.S. EPA) for a two-page briefing paper on the project that he could route through his agency to ensure that additional EPA permits were not required; and (3) the tentative commitment by the U.S. Coast Guard to take the lead as the U.S. Federal agency in preparing Endangered Species Act and Critical Habitat consults for the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

PECI contacted Mr. Peter Cantle of the Santa Barbara County Air Pollution Control District on 18 December 2002, and Jim Payne discussed the project with him in detail. During that discussion, Mr. Cantle stated that he did not believe that an APCD permit would be necessary, but he requested a detailed written description of the project to present to his agency. He then stated that if a permit was required, he would let us know. In response to Mr. Cantle's request, a detailed project description was e-mailed to him on 18 December 2002. In response to Bill Robberson's request for a briefing paper for the EPA, PEGI prepared a two-page summary project description, and it was e-mailed to him on 23 December 2002.

On 28 February 2003, we were informed by Heather Parker-Hall that Lt. Cdr. Byron Black had received authorization for the U.S. Coast Guard to take the lead as the federal agency responsible for preparing Endangered Species Act and Critical Habitat consults for the U.S. Fish and Wildlife Service (U.S. FWS) and the National Marine Fisheries Service (NMFS). PEGI provided input to and reviewed sections of those documents prepared by Heather Parker-Hall (NOAA SSC) and Tim Holmes (USCG), and copies of those consults are appended to this report as Attachments 1 and 2. They were submitted to the respective agencies under U.S. Coast Guard letterhead on 18 April 2003. The National Marine Fisheries Service notified the U.S. Coast Guard in a letter dated 16 May 2003 that they were in concurrence with the USCG position that the proposed tests would not result in any adverse impacts on any of the listed species or habitats under their purview, and that we could proceed with the project. Concurrence from the U.S. Fish and Wildlife Service took a little longer, but on 29 May 2003, NOAA and the USCG received a fax indicating that the USFWS also agreed that there were likely to be no adverse affects to the listed species or critical habitats under their control.

With letters from both the NMFS and USFWS stating that those agencies concurred with the USCG position that a formal consultation under Section 7 of the U.S. Endangered Species Act was not necessary, the USCG (with assistance from NOAA and PEGI) began preparations to get the final approvals required from the California Coastal Commission (CCC). Based on instructions from Ellen Faurot-Daniels of the CCC, the USCG submission of their Federal Consistency Determination needed to address several areas under Section 307 of the federal Coastal Zone Management Act to ensure the project's consistency with the California Coastal Management Program. The Coastal Act issues that needed to be addressed included:

Recreation -- Coastal Act section 30220 – Would the location of the week-long test interfere with offshore recreational users such as boaters and recreational fishermen?

Water Quality -- Coastal Act section 30231 – What are the chemical contents of the dispersants and what would the potential effects to water quality be? Would the dispersant be applied in doses small enough that it can be found consistent with 30231?

Marine Resources -- Coastal Act section 30230 -- What are this project's potential effects to marine resources? Also, address any findings by USFWS and/or NMFS.

Commercial Fishing -- Coastal Act section 30234.5 -- What commercial fishing, if any, occurs at the project area and what would the projects impacts be? Are there any California Department of Fish and Game Marine Resources Region Permits required?

Air Quality -- Coastal Act section 30253(3) -- Does the project require an air permit from Santa Barbara County's APCD? What are the projected emissions from the boats, and does the APCD require a permit for such activity. As a related issue, does the lead CEQA and/or NEPA agency require any mitigation measures or offsets (even if the APCD does not have permit jurisdiction)?

Much of the information required to answer these questions was available in other documents that had already been prepared for the other agencies discussed above; however, some additional data on recreation, commercial fishing, and any California Department of Fish and Game permits needed to be obtained. Dr. Mike Sowby of California Department of Fish and Game Office of Spill Prevention and Response (OSPR) confirmed to Heather Parker-Hall that no California Department of Fish and Game (Marine Resources Region) permits were required, and Craig Fusaro (USCG) was contacted to confirm that posting a Notice to Mariners a few weeks before the project would be sufficient to cover any issues regarding commercial fishing and recreational activities in the study area. On 6 June 2003, the USCG submitted their Federal Consistence Review for the proposed study to the California Coastal Commission, and a copy of that letter (along with the National Marine Fisheries Service and U.S. Fish and Wildlife Service concurrence letters) is included with this report as Attachment 3. Attachment 4 is a copy of a 28 May 2003 letter from the State of California Department of Fish and Game OSPR interim administrator that states their support of the proposed field program. A copy of the OSPR letter was also forwarded by that agency to the California Coastal Commission for use (if necessary) in securing the CCC's approval for the project.

The final step of the permitting process was for Ellen Faurot-Daniels and other CCC personnel to prepare a Staff Report based on the 6 June 2003 USCG Federal Consistency Review for presentation to the full California Coastal Commission Board at their July meeting in Petaluma, CA. The proposed project was assigned a CCC docket number and scheduled for the July meeting; however, as discussed below, it ultimately was withdrawn from consideration after a limited series of field tests on 12 and 13 June 2003 demonstrated that the seep oil was simply not dispersible.

4.0 Additional Agency Support and Planned Involvement in the Field Program

Several subsets of numerous state and federal agencies expressed interest in participating in the program during their involvement in the permitting process. Specifically NOAA HAZMAT requested that a vertical profile of water column structure (temperatures and salinities) at one-meter resolution and possibly current meter and tide data be collected to support computer-modeling efforts that they would like to complete in support of the project. NOAA HAZMAT also requested that wind speed and direction data be collected along with wave height and directional information. Both NOAA HAZMAT and Applied Science Associates, Inc. (ASA) planned on modeling the dispersant scenarios and comparing the computer-model-predicted data with the chemistry and oil profiles measured by the fluorescence protocols and selected grab samples. In addition, the Texas General Land Office (through Robin Jamail) committed to providing personnel and sampling equipment to collect discrete water samples (after passing through the UV/fluorescence unit), refrigerating them, and then completing subsequent toxicity assays at Texas A&M University. Also, Alan Humphrey (U.S. EPA Edison, New Jersey) volunteered the use of UV/Fluorescence units and personnel to operate them (as well as divers and videotape equipment) to document the subsurface plume behavior. Representatives from each of the agencies involved in the permitting process also planned on attending the full-scale field demonstration as observers.

One area where extramural agency support was readily needed (but not yet obtained) was helicopter or fixed-wing aircraft support. In several discussions with project and RRT personnel, the need for synoptic oversight of field activities (as provided by air observations) has been considered. Air operations were critical in previous spill-of-opportunity dispersant trials (Payne et al. 1991, 1993), and such support in this program was deemed to be extremely important if it could be obtained. Because of budget limitations, there were no provisions for aircraft support included in the original field program; however, the possibility of U.S. Coast Guard, National Marine Fisheries Service, Minerals Management Service (MMS), or NOAA helicopter or fixed-wing air support was being considered as we got closer to the planned full-scale field trials in the late July or August timeframe.

5.0 Laboratory Studies and Field Reconnaissance Efforts to Evaluate Seep Oil Behavior and Dispersability

In the original proposal for this project, and in all the project descriptions generated throughout the permitting process, we emphasized that the seep oils off Coal Oil Point were probably not the best candidates for chemical dispersion but that we hoped they would be sufficiently dispersible to achieve the program objectives. The Coal Oil Point site was selected because of the large volume of oil released, the extensive area covered by surface slicks, and the fact that we would not have to purposefully spill or introduce any oil into the environment (a factor that would have exacerbated the already complicated permitting process by several orders of magnitude). No dispersant tests had been completed with the seep oils, but based on the low API gravity of many of the produced oils from the area, S.L. Ross (2002) concluded that most of the produced oils would probably be poor candidates for successful treatment by dispersants. To evaluate the true potential for the seep oils to be successfully dispersed, Santa Barbara Clean Seas personnel collected two seep oil samples from the water surface near the most active seeps in early May 2003, and those samples along with a sample of produced oil from Platform Holly (closest to the seeps) were forwarded to James Clark (ExxonMobil Research and Engineering) for laboratory testing of dispersant

effectiveness with Corexit 9527 and Corexit 9500. The tests were performed in mid May by Ken Becker at Nalco Chemical in Sugarland, TX.

Mr. Becker used the EXDET dispersant effectiveness procedure (described in Attachment 5) and reported that he was unable to get the semi-solid seep oils to even flow or spread out on the water surface used for the test, let alone disperse. He also tried heating the samples and premixing them with Corexit 9580 (up to 50% dilution) before adding the dispersant without any success. In a telephone conversation with Jim Payne on 19 May 2003, he described the seep samples as nothing more than tarballs (containing 35% water and 6% silt), not fluid oil, and he suggested that the seep oil surface slick be resampled (if possible) to get a better sample of fresher oil for additional testing. He stated that if the seep oil collected in a fairly fresh oil film, it may be just liquid enough to disperse, but if it was anything like the tarball samples he had received, that the chances of a good dispersant demonstration were “slim and none.” He did, however, obtain fairly good dispersion with the 20.5° API gravity Platform Holly produced oil sample as shown by the data in Table 4, and based on those results, we concluded that something must have happened to the seep oil sample during collection to cause it to emulsify or form a semi-solid sludge that wasn’t representative of most of the surface oil out there.

Table 4. Dispersant Effectiveness with Platform Holly Produced Oil (with the EXDET Procedure)

Test # Product	DOR	Water	Oil Sample	(X), % Oil Dispersed	(X/4) Average
1. Corexit 9500	1: 10	Syn. sea	P/F Holly	75	74
2.				73	
3.				74	
4.				74	
5.	1:25			70	74
6.				74	
7.				73	
8.				78	
9.	1:50			32	40
10.				34	
11.				56	
12.				38	
13. Corexit 9527	1:10			72	70
14.				70	
15.				69	
16.				69	
17.	1:25			71	70
18.				67	
19.				74	
20.				70	
21.	1:50			42	48
22.				54	
23.				50	
24.				47	

Notes:

1. Procedure

- Standard shake time (15 min.), sample size (1 mL), shake intensity (6 mm).
- Dispersant added to surface of oil on the water.
- DOR for dispersant to oil ratio.

The EXDET procedure classifies percent oil dispersed as >80% excellent, 60-79% good, 45-59% average, 30-44% poor, and < 29% unsatisfactory, so we were encouraged by the “good” results with the specific gravity 0.9307 g/mL Platform Holly produced oil, which is obtained from the Monterey Formation. Because the seep oils also are derived from the same formation, we hoped that the samples sent back for the laboratory tests were not representative and that they must have been altered during collection. To verify this hypothesis, we decided to attempt a small field trial with the freshly surfaced seep oil during a reconnaissance cruise and planning meeting at Santa Barbara Clean Seas on 12 and 13 June 2003.

The objectives of the meeting at Santa Barbara Clean Seas in Carpinteria, CA were to:

- Plan the actual full-scale field operations and logistics support
- Review & confirm status of permits
- Visit oil seep locations
- Assess feasibility for dispersion of seep oil
- Confirm personnel & equipment needs
- Identify remaining tasks & assign responsibility for completion
- Determine exercise dates

Personnel in attendance included: Jim Payne (PECI) – Project Director and Science Coordinator; Alan Allen (Spiltec) – Co-Project Director and Operations Coordinator; Rick Gill (SB Clean Seas) – Field Operations Section Leader; Jeff Cantrell (Elastec American Marine) – NeatSweep Operations; Alan Humphrey (U.S. EPA) – SMART Operations; Peter Jensen (ExxonMobil) Dispersant Application; Jeff Dabe (USCG) – Permitting, Public Relations, and Field Operations; Ken Wilson (CA F&G OSPR) – Environment, Permitting & Field Operations; Craig Ogawa (MMS) – Field Operations & (possible) Helicopter Support); Sonny Lanham (SoCal Ship Services) – Vessel Support; and Ira Leifer (UCSB) – Seep Specialist and Advisor. Heather Parker-Hall (NOAA) – Permitting, Environment & Technical Advisor also participated via teleconference during the preparations and planning session.

During the morning of 12 June 2003, we completed an overview of the project scope and discussed personnel assignments and field communications issues at Clean Seas Headquarters; however, during the discussions it became clear that Santa Barbara Clean Seas management would not allow any test spraying of the dispersant Corexit 9500 from their vessels (even in limited quantities, i.e. < 1 L) during the site reconnaissance because permission for the full-scale tests had not yet been obtained from the California Coastal Commission. The CCC had received all the necessary letters and the Determination of Federal Consistency from the USCG, but they had not yet acted on those documents and given us the final authorization to proceed.

During several lengthy telephone exchanges between Heather Parker-Hall (NOAA), Jim Payne (PECI), and Ellen Faurot-Daniels (CCC), it became clear that the CCC could not authorize test spraying in any quantity until the full Board meeting scheduled in July, and Santa Barbara Clean Seas did not want to do anything that would jeopardize their standing with the CCC. In fact, they would not even allow us to take any dispersant on their vessels for the site reconnaissance scheduled that afternoon. Both Ken Wilson (CA F&G OSPR) and Craig Ogawa (MMS) had considerable experience with the CCC and their involvement in offshore drilling and production operations, and they both agreed that Santa Barbara Clean Seas was well advised to avoid running afoul of the CCC. As a result, we all agreed to leave

the dispersant samples behind and simply observe and collect surface oil samples for later testing back at the Clean Seas offices after the cruise. It was acknowledged, however, that this approach might not provide the necessary information on *in situ* slick behavior with Corexit 9500, and that we still might not know if the collection process somehow affected the rheological properties of any samples that were obtained.

Using a Seep Map provided by Ira Leifer, the project team visited several seep areas off Coal Oil Point and University Point to the east during the afternoon of 12 June 2003. Santa Barbara Clean Seas personnel and vessels, along with additional vessel support from Clean Coastal Waters, provided transportation to the seep areas. Figure 28 presents the representative appearance of the surface slicks as encountered in numerous areas near Coal Oil Point.

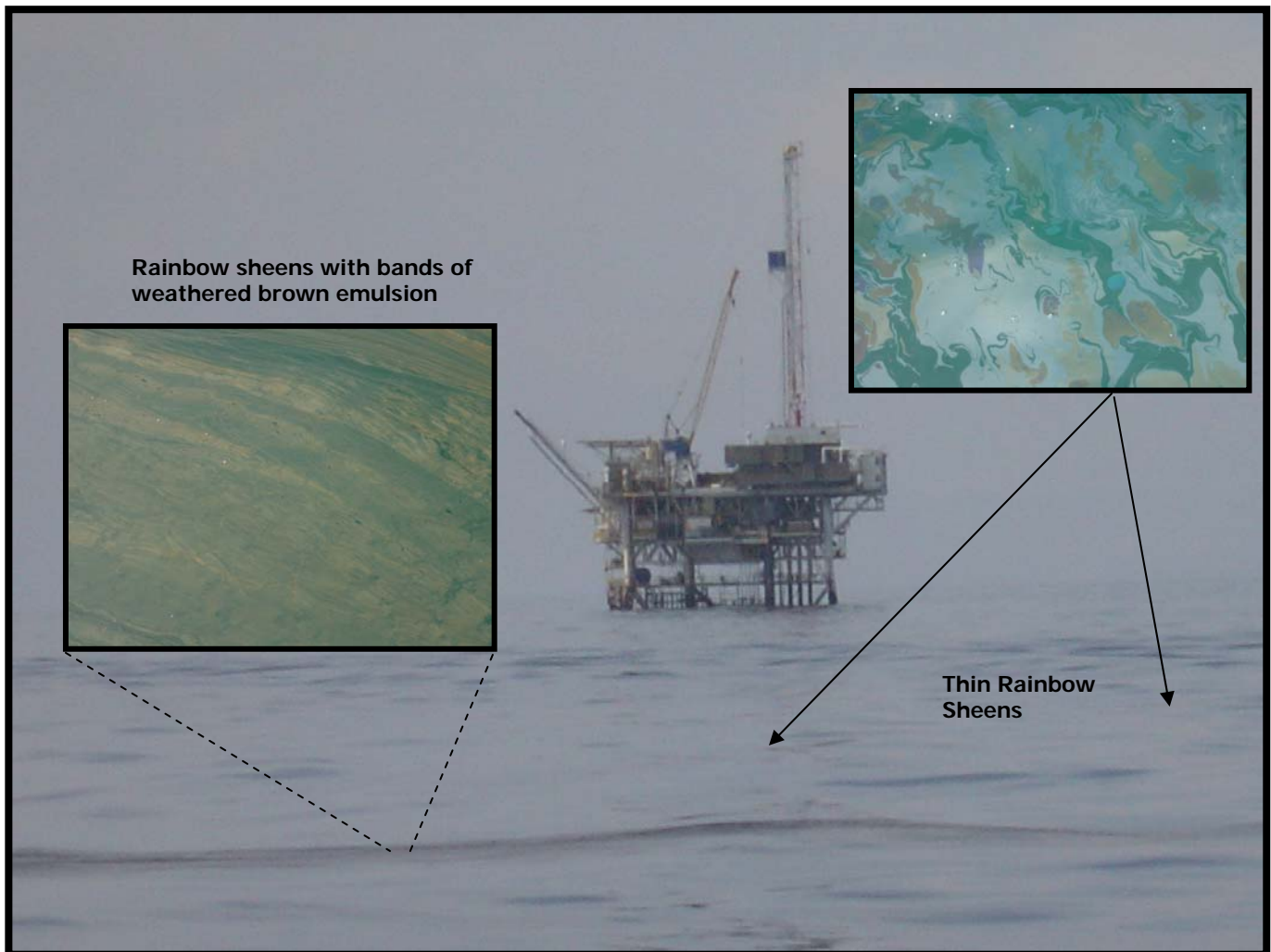


Figure 28. Appearance of the surface slicks east of Platform Holly on 12 June 2003.

The surface oil was wide-spread, and in some areas covered essentially 80-100 percent of the water surface, while in other areas there was clear open water. When discrete oil droplets (approximately 0.5-1 cm in size) were observed to reach the water surface, two different types of behavior were observed. If the oil droplet came up in clear water, it would persist as a finite oil droplet for several seconds (there were no winds and the water was flat calm), and

then it would burst, spreading out into rainbow and silver sheens. If a submerged oil droplet came up under an existing film of silver sheen, it would persist for 30-40 seconds and then spread slowly to form a thicker brown patch of oil (maybe 8-10 cm across) surrounded or trapped within the sheen.

Elsewhere, we observed that if the silver or light brown oil films were disturbed by the wake of the boat (or a boat hook used to break up the oil film), that it did not flow back into the disturbed area (like most fresh oils), but instead folded over onto itself to form a thicker plastic film or agglomeration. This agglomerated material would no longer flow and instead behaved like the plastic wrap used to cover food or bowls of leftovers before placing them in a refrigerator for storage. Figure 29 shows the *in situ* generation of these thicker agglomerates at the edge of the bow-wake from the boat as it traveled at only 1-2 knots through a continuous oil film.

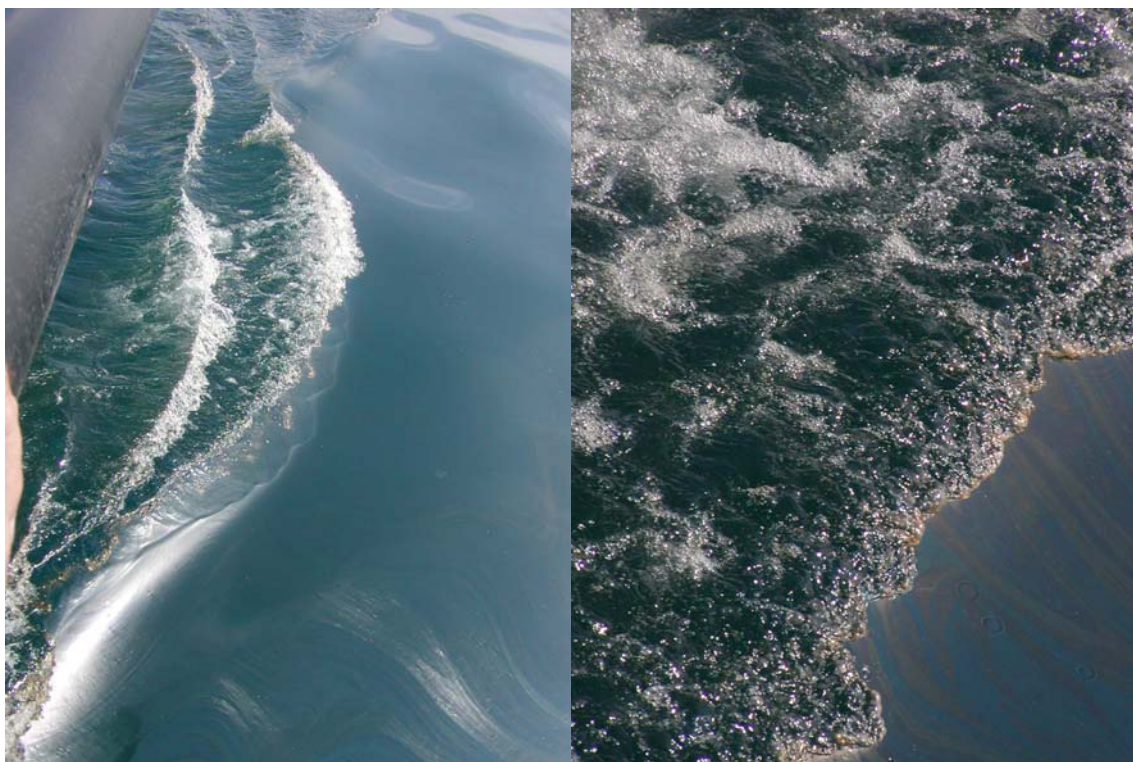


Figure 29. Behavior of surface oil film after minor disturbance with the boat wake. Note the waxy appearance of the undisturbed film in the photograph on the left and the generation of the thicker oil accumulations at the edge of the bubbles in the figure on the right. Once these thicker agglomerations were generated, they would no longer flow or behave like fluid oil.

Because of these very unusual rheological properties, we observed mosaic patterns or composites of everything from freshly surfaced oil to emulsified mousse in areas less than two-to-three feet across (Figure 30). Upon attempting to collect the thinner sheens in screw-cap jars for later testing back at Clean Seas, we were extremely disappointed to observe that simply lowering a jar into the water to allow only the thinner surface sheens to flow into the jar caused them to fold up, agglomerate, and emulsify very much like the disturbed oil films at the edge of the boat wakes shown in Figure 29.



Figure 30. Mosaic pattern of freshly surfaced oil (silver sheen), slightly thicker rainbow sheen, finite oil droplets and gas bubbles (entrapped in the thicker brown oil film), and freshly generated mousse in an area less than two feet across.

Another element of the reconnaissance cruise completed on 12 June 2003 was to observe the behavior of the oil after attempts were made to herd or corral it with a pair of booms in a manner analogous to the boom arrangement needed for the NeatSweep array (see Figure 1). For this effort, Clean Seas provided a small, sorbent V-boom configuration (with open apex) to observe seep oil behavior as the oil is deflected and released from the V-boom. Two vessels were used to tow two 30 ft lengths of sorbent boom through the slick (Figure 31) to see if the oil would stick irreversibly to the boom or flow through the opening as needed for the NeatSweep operation.



Figure 31. Attempt to simulate the NeatSweep boom arrangement to determine if the oil would stick irreversibly to the boom or flow through the opening at the apex.

As shown in Figure 31, much of the oil passed through the opening during the test run and didn't stick to the boom, and it was noted that there was minimal disturbance and mixing of the oil into the water column when the system was towed at ½ to 1 knot. However, at higher speeds the oil mixed into the turbulent eddies along the boom and at the open apex. Most oil remained at or near the surface; however, the nearly neutral density of the oil allowed some of it to slip below the surface. In several instances the oil coming out through the opening appeared to be very emulsified (Figure 32), but it was impossible to determine from the observation boat if this was caused by boom-wave induced emulsification during the towing operation as described above and observed in Figure 29, or if tow boat operators simply entrained a mixture of primarily emulsified oil during the towing operation.

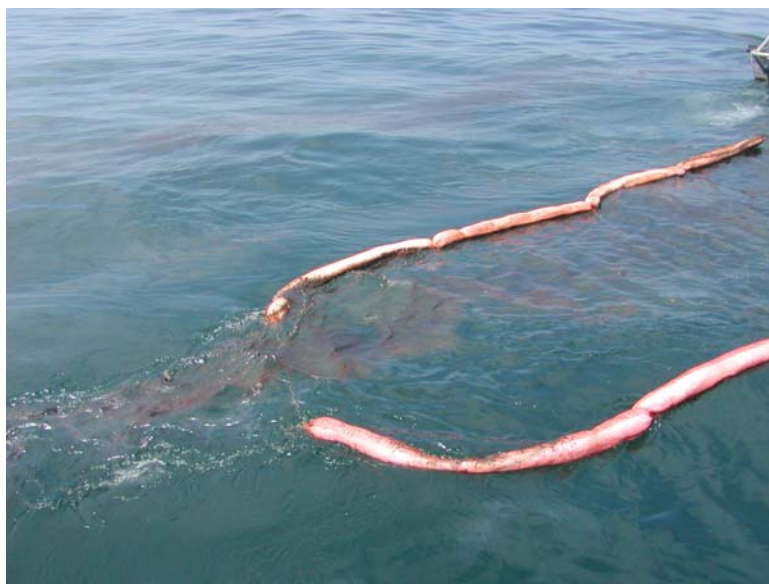


Figure 32. Is the oil emulsified due to the turbulence as it passes through the open apex of the boom array or simply a collection of heavily emulsified accumulations during the towing process? It was impossible to say from our field observations and examination of available photographs taken at the time.

At the termination of the 12 June 2003 reconnaissance cruise, everyone returned to the corporate offices of Clean Seas Santa Barbara to go over the days observations and plan for additional activities the following day, if possible. An attempt was made to treat the collected samples with Corexit 9500, but the dispersant wouldn't even penetrate the emulsified material when it was physically massaged in by hand, let alone enhance any dispersion when examined with a modified shake-flask test. Likewise, we still could not reach agreement as to whether or not our observations back at the office were due to anomalies (primarily emulsification) introduced during sample collection or if the results would be different if the dispersant were sprayed directly on the freshly surfaced oil while it was still a sheen or film before it had emulsified. As a result, it was concluded that the only way to know for sure was to conduct a limited *in situ* spray trial at sea.

As discussed above, Clean Seas would not allow any dispersant testing from their vessels without final CCC authorization, so in another flurry of teleconference calls and e-mails between project participants and Heather Parker-Hall (NOAA), Robert Coller (USCG, Assistant Chief LALB Port Operations), and Merry Goodenough (USCG, Chief,

Environmental Law Branch) the issues of liability and authority with regard to the CCC and the Coastal Zone Management Act were again addressed. As a result of these deliberations, Merry Goodenough wrote an e-mail late in the afternoon of 12 June 2003, which stated:

Heather,

Per your request, I have looked into the issue as to whether an agent of the Coast Guard, i.e., acting on the behalf of the Coast Guard, would be liable for spraying a very small amount of dispersant into navigable waters.

The three laws that would be primarily applicable would be the National Environmental Policy Act (NEPA), the Coastal Zone Management Act (CZMA), and the Clean Water Act (CWA). Our agent is safe on all three laws for the following reasons:

- 1. NEPA is a federal responsibility. According to CG Headquarters, the use of dispersants under the National Contingency Plan have functionally complied with NEPA. I have a copy of the opinion in my files.*
- 2. Under the CZMA, we have made a negative determination under the CZMA regulations that there is no direct or indirect impact to the coastal zone with the application of such a small amount of spray. Again, it is a federal action that triggers compliance. We have complied. Moreover, there are no enforcement provisions under the CZMA.*
- 3. Under the CWA, the Water Board has permitted the discharge, and has no concern about the water quality issues. Again we are in compliance with Federal Law.*

By the way, it is comforting to know that folks are very concerned about the protection of the environment. Usually, I am on the other side of the fence in these legal discussions.

Merry Goodenough

*U.S. Coast Guard
Chief, Environmental Law Branch
MLC Pacific (Legal), Bldg. 54-C
Alameda, CA 94501*

Armed with the above legal opinion from the Chief of the USCG Environmental Law Branch, Heather Parker-Hall then contacted Robert Collier at the Marine Safety Office LALB, and he made arrangements through the Chief of the Group Ops LALB to have USCG Station Channel Islands send a boat up to Santa Barbara harbor on the morning of 13 June 2003 to take Alan Allen (Spiltec), Alan Humphrey (U.S. EPA), and USCG QM2 Jeff Dabe (from MSD Santa Barbara) back out to the Coal Oil Point area to conduct a limited series of meso-scale *in situ* tests with Corexit 9500 at sea.

The rest of the afternoon of 12 June 2003 was used to plan the logistics, procedures, and personnel/equipment needs for a full-scale dispersant application program with the NeatSweep (most likely in mid-August 2003) should the small, hand-spray trials scheduled for the following day show promising results.

On 13 June 2003, Alan Allen, Alan Humphrey, and QM2 Jeff Dabe traveled aboard the USCG Motor Life Boat (No. 47275), driven by Justin Lass, to the seeps off Coal Oil Point. Slicks that were comparable to those observed the day before were photographed during and after treatment with a hand-spray application of Corexit 9500 (Figures 33 and 34).



Figure 33. Appearance of fresh surface oil at Coal Oil Point during initial hand-spray application of Corexit 9500 on 13 June 2003.



Figure 34. Immediate herding of surface oil after application of Corexit 9500.

Within seconds of dispersant application, the treated oil was herded into discreet string-like globules (Figure 35). When these were mechanically disturbed with a paddle or boat hook, the globules would break up and remain as visible particles within the upper few feet of the water column. There was, however, no visible cloud of fine droplets or murky water characteristic of successful chemical dispersion in the water column at or near the treated oil for periods of upwards of 15-30 minutes.

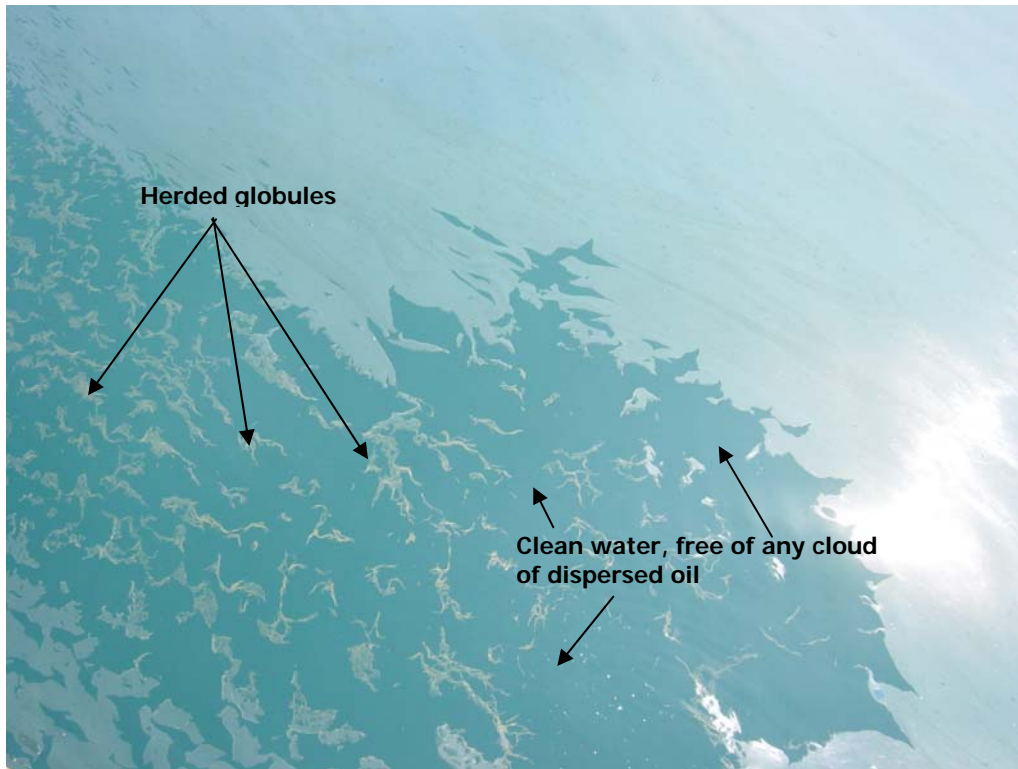


Figure 35. Treated stringers of herded oil observed on the water surface after mechanical agitation following treatment of thin surface slicks (from Figures 33 and 34) with Corexit 9500.

As shown in Figures 36 through 38, dispersant was applied over several different seep locations (i.e., the Seep Tent seeps off Platform Holly, Coal Oil Point Seeps, and the La Goleta Seeps), and over slicks representing very thin sheens, moderately thick layers (100^{ths} to 10^{ths} of a mm), and thick weathered patches (2 to 5 mm).

In all cases, Corexit 9500 was unable to disperse the natural seep oil. The only effect, even after waiting 10 to 15 minutes, was a herding of thin films into thicker string-like globules that would break up and mix as irregular particles of neutrally buoyant material in the upper few feet of water.

Based on the results obtained with the meso-scale tests, it was concluded by all parties on-board the USCG Motor Life Boat (Alan Allen, Spiltec; Alan Humphrey, U.S. EPA; and Jeff Dabe, USCG) that it did not seem feasible to conduct a dispersant application program at Coal Oil Point that would support the objectives of the project. The NeatSweep system could be

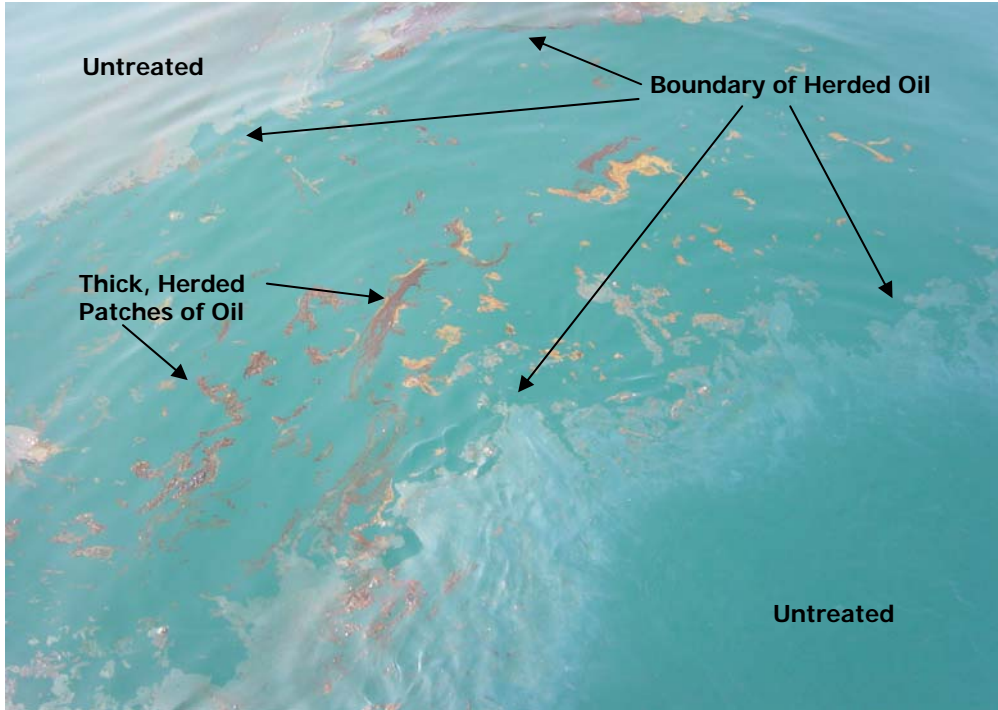


Figure 36. Appearance of fresh thin slick 15 minutes after treatment with Corexit 9500.



Figure 37. Testing on heavier, naturally accumulated patches of oil. Some patches were created by earlier winds and resulting convergence zones; other from the splashing effects of water off the sides of the boat.

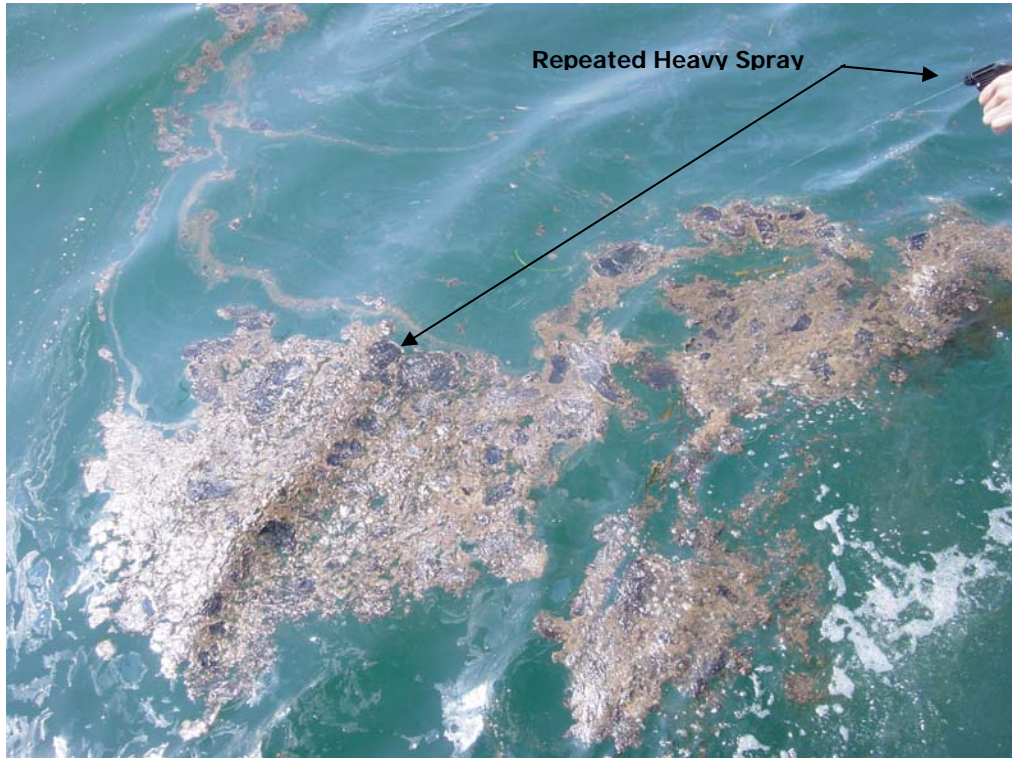


Figure 38. Repeated heavy spray application to the thicker emulsified oil patches shown in Figure 37. No dispersion was observed even after 10 to 15 minutes. The only observed effect was herding of thinner oil patches into string-like globules.

used to demonstrate a unique way to apply dispersants; however, there would be little, if any, chemically dispersed oil following application. Therefore, it would have been nearly impossible to test and evaluate the protocols and equipment on properly dispersed oil within the water column.

Heather Parker-Hall contacted Alan Allen during the limited field trials, and after the day's activities were completed, he debriefed her on the observations. She was in 100 percent agreement that we shouldn't go forward with the project if we knew it was not going to work. Alan Allen then talked with Rick Gill (Clean Seas Santa Barbara) and Jim Payne, and it was agreed that while the project probably shouldn't continue as originally planned, the results to date could be a nice stepping stone towards doing the project with a good target oil. It was hoped that a postponement until a good dispersible target oil could be used would allow us to complete the objectives that we originally set out for the project, whereas, they just simply could not be met with the natural seep oil present at Coal Oil Point.

6.0 Alternatives to Dispersant Testing at Coal Oil Point

The field tests described above convincingly demonstrated that the natural seep oils were not amenable to treatment with Corexit 9500, the best available oil-spill dispersant for heavily weathered, and viscous, emulsified crude oils. As a result of that finding, we concluded that failing to show any oil dispersion (if we proceeded with the full-scale field tests as originally planned) could set the use of dispersants as an oil-spill countermeasure back 30 years.

Therefore, the original project was put on hold, and several other field options were considered. These included using other natural oil seeps in either California, Alaska, or the Gulf of Mexico; using a spill of opportunity; or returning to the Coal Oil Point area and conducting a limited series of planned spill experiments with an oil more amenable to chemical dispersion.

In addition to the natural oil seeps in the Coal Oil Point area, there are a number of other seeps in Southern California (elsewhere in the Santa Barbara Channel and in Santa Monica Bay); however, compared to Coal Oil Point, the rates of oil seepage at these other locations were reported to be at least five times lower (Allen et al. 1970; Mikolaj et al. 1972). In addition, these other seeps are considerably further offshore (Mikolaj et al. 1972). As a result, we concluded that the slicks would likely be further spread out and that the amount of oil on the surface would not be sufficient to provide the volumes required to yield the necessary encounter rates for the NeatSweep system. In addition, most of these other seeps are believed to be derived from the same Monterey Formation, and as such, it was highly likely that the oil would have similar properties to the slicks encountered off Coal Oil Point. We did not have gas chromatographic (GC) characterization data for the Coal Oil Point seeps, but Payne et al. (1978) had characterized the hydrocarbon fingerprints in intertidal mussels (*Mytilus californianus*) exposed to the oil at Coal Oil Point and found the capillary GC profiles to be mostly unresolved complex mixtures (UCMs) with no resolved n-alkanes, and only a few isoprenoid compounds present above the UCM. With no resolved components below Kovats Index 1300 (n-C₁₃) (Kovats 1958) and the other chromatographic features described above, the GC profiles from the exposed mussels clearly suggested that the seep oils had undergone significant weathering and microbial degradation (Payne et al. 1984; Kennicutt 1988) before coming ashore. Because of the close proximity to shore and the estimated transit time of less than one day in many cases (Allen et al. 1970), it seemed most likely that this weathering occurred during the migration of the seep oils through the overlying sediments. This extensive weathering, no doubt, contributed to the non-dispersible rheological properties observed in the seeps at Coal Oil Point, and we expected similar behavior in the oils from the other seeps, if sufficient volume could have been encountered.

Becker and Manen (1989) completed an extensive literature review and identified 29 oil seepage areas in the coastal regions of Alaska. Unfortunately, however, none of the confirmed seeps were subtidal, but ranged in distribution from just above the low tide datum on a beach face, to inland sites that could influence the marine environment through input via freshwater streams. Clearly, none of these seeps would be amenable to the testing protocols required for this program, so further activities in Alaska were not considered.

There are numerous well-characterized oil seeps in the Gulf of Mexico (Kennicutt et al. 1992; Sassen et al. 1994; Whelan et al. 2001); however, most of the seep oils also exhibit extremely degraded chromatographic profiles similar to those described above for the intertidal mussels collected at Coal Oil Point, Santa Barbara, California. The degradation of the oils in the Gulf of Mexico was largely believed to be due to biodegradation in the near surface sediments, or in chemosynthetic communities, which formed as extensive mats at the sediment-water interface. As a result, we ruled out most of the previously characterized seeps in the Gulf of Mexico as possible candidates for dispersant experiments due to anticipated problems with the rheological properties of the heavily degraded oils. The one exception to this trend, was a recently discovered seep approximately 80 km south of the Louisiana coastline in water depths ranging from 60-75 m (Sassen et al. 2003). The oil from this seep appeared to be relatively unaffected by biodegradation, in contrast to the heavily biodegraded hydrocarbons that characterized most of the other known Gulf of Mexico seep sites.

Unfortunately, the flow rate from this seep was described as episodic, and as such, there was no guarantee that a surface slick of sufficient size and volume would manifest itself for the NeatSweep application and follow-on (sampling) activities. In addition, the distance from shore, would significantly hamper operations (particularly helicopter support – Payne et al. 1991, 1993) such that we believed it would be extremely difficult to conduct the program as originally envisioned and described in this report. Finally, the generous donation of ship time by Clean Seas Santa Barbara was an implicit feature of the originally proposed program that make it economically feasible given the program budget, and no such provisions had been made with any of the Gulf Coast oil-spill clean up cooperatives. As a result, the notion of trying to utilize natural oil seeps for undertaking the planned program was eventually scrapped, and we instead returned to the idea of possibly undertaking a planned spill at the Coal Oil Point location.

By building on the momentum generated from the permitting efforts and logistics planning described in this report, we saw great value in pressing forward in an attempt to get the necessary permits for a research spill. We believed that the most practical approach to achieving the original program objectives could include three planned and fully permitted experimental releases of Alaska North Slope (ANS) crude oil in federal waters, 3-5 miles farther offshore from the original proposed site. ANS crude oil was selected as the "target" oil because it is known to be dispersible with either Corexit 9527 or 9500. It also represents over 50% of the oil currently shipped along the California coastline (S.L. Ross 2002) making the results of the planned tests directly relevant to oil spill response planning in near-shore California waters. The total volume of oil needed for the three proposed tests was estimated at ~21 bbl, less than 14% of the volume of oil discharged daily from the natural seeps in shallower water off Coal Oil Point.

After consideration of all these options and several conference calls with NOAA (Dr. Robert Pavia) and CICEET project management (Dr. Richard Langan) throughout the latter part of June 2003, it was decided that the scope of work for these other approaches was so different from the original proposed project, that it made more sense to reduce the scope of the current effort to the preparation of a lessons-learned report and manuscripts on the permitting process. This report represents the final product from the compilation of lessons-learned, and an abstract and manuscript are being prepared for presentation at the 2005 International Oil Spill Conference (IOSC). These will be submitted to the IOSC selection committee later in the spring and summer of 2004. With regard to the idea of undertaking a planned research spill at Coal Oil Point, that too was considered to be out of scope with the originally proposed and funded effort; however, we were invited to prepare and submit a proposal for consideration of such a project as part of the 2003/2004 CICEET Funding Cycle.

Towards this end, we submitted a preliminary proposal to CICEET in July 2003 for a two-year effort. The objective for the first year of this new project was to obtain the necessary permits for conducting the experimental spills. We anticipated a minimum of one year for the permitting process based on the level of effort described in this report to obtain the permits for experiments with the natural oil seeps at Coal Oil Point and on information gathered from the EPA Revised Interim Application Guidelines for EPA Permits to Discharge Oil for Research Purposes (EPA 2001). If the necessary permits were obtained, we then proposed to complete the three planned spills in the second year of the project. As in the program described in this report, we intended to focus on the evaluation of the NeatSweep dispersant application technology and intercalibration of the NOAA SMART Protocols with finite measurements of dissolved-phase constituents and dispersed oil droplets in the water column. Assuming a start date of December 1, 2003 and a full year for permitting activities, the proposed field tests

could have been undertaken in spring 2005. Based on anticipated weather conditions in the Coal Oil Point area; however, we proposed to delay the field tests until the early summer (June/July 2005) timeframe. Based on the Section 7 Consults prepared by the USCG and NOAA for the U.S. FWS and NMFS for the natural oil-seep tests, this is also a period of fewer potential conflicts with endangered species and critical habitat issues. GC/MS laboratory analyses were scheduled to be completed within 1-2 months of sample collection. This would have allowed data analyses and report writing during fall 2005, with a final report submitted by December 31, 2005. This schedule was intended to make the results available for publication at the 2007 International Oil Spill Conference.

Unfortunately, our preproposal was not selected for full proposal submission and further consideration of funding. CICEET received preproposal requests totaling more than \$5.7 million from numerous respondents, and with only about \$700,000 available for project funding, the review panel concluded that investing \$95,000 for the permitting aspect of our proposed project was too risky. We were informed, however, that NOAA has indicated that in the near future, they will seek a permit for a controlled intentional spill, and if successful, they will invite proposals for spill response research. If that situation does develop, there may still be an opportunity to undertake the expanded planned spill program as described above sometime in the future.

We would like to thank all involved parties and agencies for their interest and support of this project over the last year and a half. We literally could not have accomplished what we did had it not been for your continued encouragement, suggestions, and assistance while contacting the appropriate agencies. Needless to say, we were very disappointed that our latest CICEET proposal to proceed with the permitting of a planned research spill was not funded, and we honestly believe that every effort should be made to promote planned at-sea experimental spills for response testing, training, and research. Unless someone picks up the gauntlet and moves this concept forward, there will never be any more at-sea experimental spills conducted in U.S. waters, and options for enhanced oil-spill response, and efforts to protect the environment will suffer accordingly.

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