11.3.7

TESORO ALASKA

FIELD SUMMARY REPORT

TESORO — PES-51™

SHORELINE RESTORATION PROJECT

BEACH SEGMENT LA-19A / SLEEPY BAY

PRINCE WILLIAM SOUND, ALASKA

**Conducted in association with the
Alaska Department of Environmental Conservation's
Alaska Hazardous Substance and Spill Technology Review Council
Technology Demonstration Program**

JULY 1993

Tesoro Alaska Petroleum Company, P.O. Box 190272, Anchorage, Alaska 99519-0272 (907) 561-5521 FAX (907) 561-5047

TESORO — PES-51™

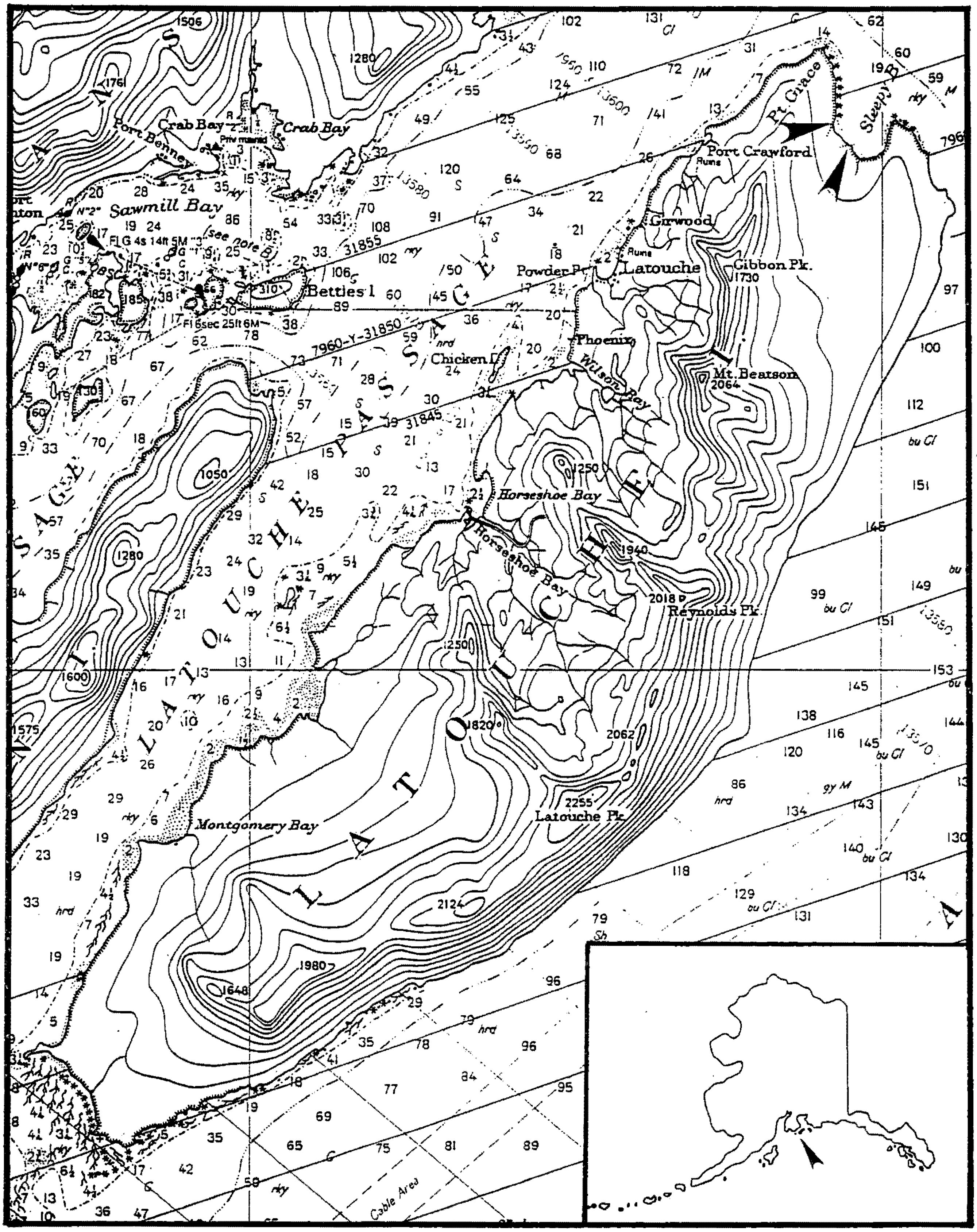
SHORELINE RESTORATION PROJECT
BEACH SEGMENT LA-19A / SLEEPY BAY
PRINCE WILLIAM SOUND, ALASKA

INTRODUCTION

Tesoro Environmental Products Company (TEPCO) and Tesoro Alaska Petroleum Company (TAPCO), both subsidiaries of Tesoro Petroleum Corporation, have successfully demonstrated a new oil spill response and restoration technology incorporating the use of PES-51™, a biological petroleum hydrocarbon cleaning product on a shoreline of Prince William Sound in Alaska.

The PES-51™ Shoreline Restoration Project, conducted July 1-7, 1993, focused on a 120 feet by 150 feet area of Sleepy Bay on LaTouche Island (beach segment LA-19A). The area was severely impacted by the Exxon Valdez oil spill more than four years ago. There had been extensive efforts to clean up the shoreline surface but the existing technology at that time was unable to remove the oil that seeped underground.

LA-19A
SLEEPY BAY
LATOUCHE ISLAND
PRINCE WILLIAM SOUND
ALASKA



PRODUCT BACKGROUND

PES-51™ removes oil from rocky shorelines or other non-porous surfaces. The product is not applicable for removing hydrocarbons directly from water.

Once the PES-51™ is sprayed on or injected, it forms a product/oil mixture which floats to the top of the water during the flushing. The flush waters and oil are trapped or contained within a boomed area and picked up by vacuum, skimming, and/or absorbent pads. Due to the protective protein film left by the product, reimpaction by oil on the treated surfaces is minimized.

PES-51™ is formulated from 100% naturally-occurring components and is biodegradable. PES-51™ is listed in the EPA-National Contingency Plan (NCP) product schedule as a miscellaneous oil spill agent.

1. Sleepy Bay LaTouche Island LA-19A shoreline segment site selection.

2. Baseline sediment and water sampling in boulder/cobble/armor/bedrock beach.

SCIENTIFIC EVALUATION

The selected beach area was subdivided into treatment segments approximately 150 feet long by 20 feet wide — from lower inter-tidal zone to upper inter-tidal zone. Sediment and pore water and oily liquid samples were taken within both the treatment segments and from the adjacent control beach for geochemical analysis. The testing was conducted by University of Alaska, Fairbanks, Environmental Technology Laboratory personnel under the direction of Dr. Mark Tumeo, P.E., Director, and included:

• EPA 418.1	(TPH)
• EPA 5520-C	(Oil and Grease)
• EPA 8260/8270 GCMS	(Hydrocarbon Analysis)
• EPA 602	(BTEX)
• Microbial Analysis	(Total Heterotrophs and Hydrocarbon Degraders, Sheen Screen, and Radiorespirometry)
• Nutrient Analysis	(Ammonium, Nitrate, Nitrite, and Orthophosphate)

At the time of baseline sampling, the treatment beach was contained with a double sea boom configuration. A landing craft was utilized to stage and support pumps, air compressors, and ancillary recovery equipment.

3. Test pit showing subsurface medium-to-heavy residual oil/mousse. Baseline sampling.

4. Boulder area showing residual medium-to-heavy residual oil/mousse. Baseline sampling.

5. Baseline sediment sample collection - University of Alaska, Fairbanks.

6. Air knife testing.

7. Primary and secondary boom deployment at LA-19A treatment site.

8. Pre-treatment subsurface oil reconnaissance.

9. Pre-treatment sediment and water sampling - University of Alaska, Fairbanks.

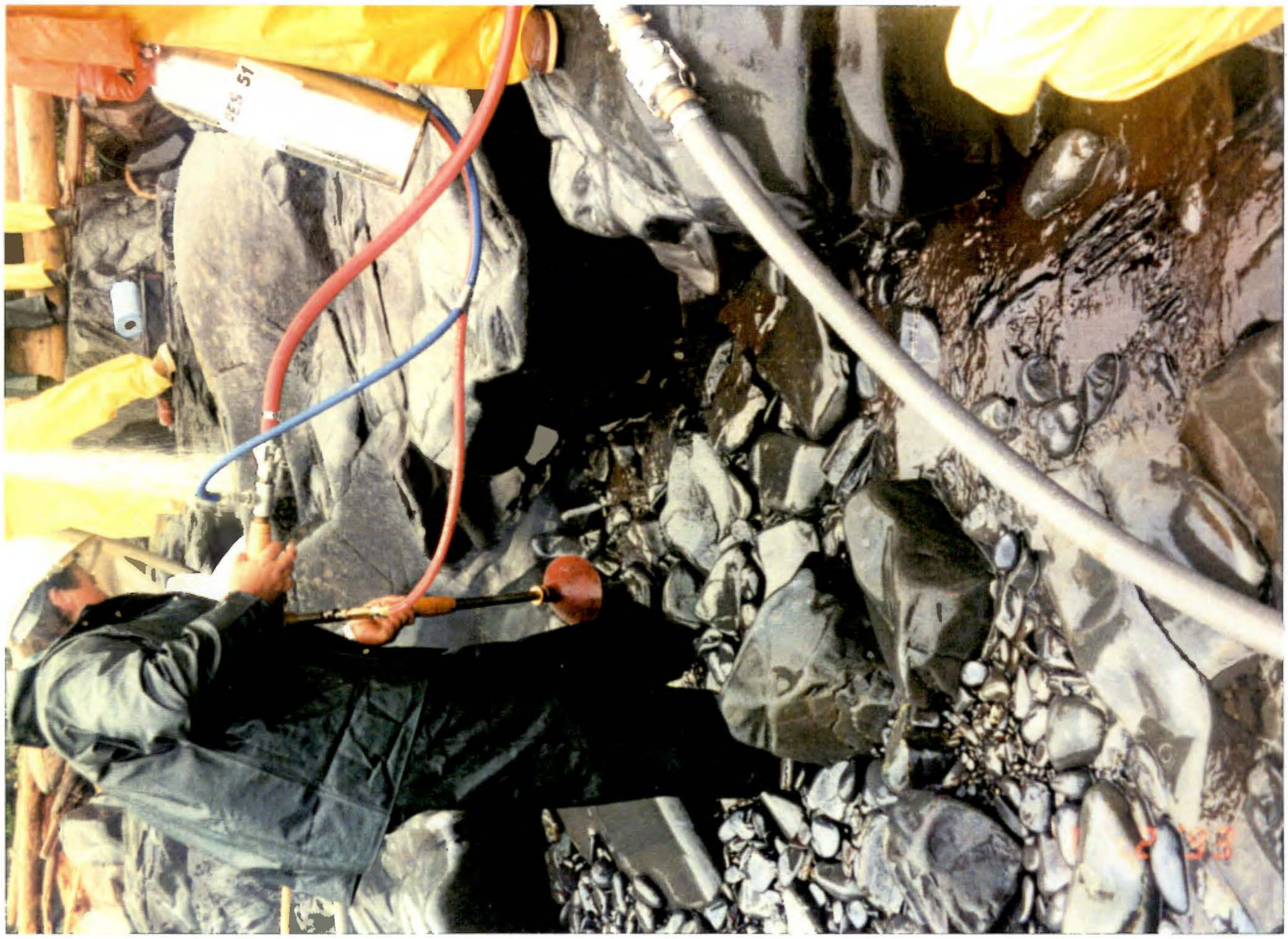
10. Pre-treatment sediment and water sampling - University of Alaska, Fairbanks.

FIELD OPERATIONS - SUBSURFACE TREATMENT

A modified Air Knife/PES-51™ injection system (patent pending) was used for subsurface treatment. The Air Knife system uses 100 psi compressed air to penetrate and agitate the subsurface sediments and boulder areas.

PES-51™ is directly injected either as a liquid or an aerosol into the affected area. Visual confirmation of the product's efficacy was observed immediately. Seawater flushing was used to float the hydrocarbons to the beach surface and transport the oil to the boomed shoreline area for recovery. After 24-48 hours following PES-51™ treatment, seawater flushing continued to lift the hydrocarbons from the subsurface.

Within the treatment beach segment, the majority of residual subsurface hydrocarbons were observed in the middle tidal zone and in boulder areas adjacent to the bedrock outcrops.



11. PES-51™ air knife injection and saltwater flushing. Note oil runoff.

12. PES-51™ air knife injection and saltwater flushing. Note oil runoff.

13. PES-51™ air knife injection and saltwater flushing. Note oil runoff.

14. Brown moussey oil from PES-51™ treatment and saltwater flushing.

FIELD OPERATIONS - OIL RECOVERY

Recovered oil was flushed using ambient seawater (approximately 53-57° F) and was collected using a variety of absorbent pads, pillows, sausage booms, and sweeps in conjunction with the Manta Ray skimmer.

Liquids recovered from skimming equipment were pumped into a 5000 gallon tank staged on the landing craft. The oily liquids were allowed to phase separate and the water was decanted with no visible sheen evident.

Approximately 120 gallons of oily liquids were recovered using the skimmer and a variety of absorbent materials. Twenty-four bundles of pads were utilized in conjunction with 500 feet of sweep and 250 feet of sausage boom deployed for passive recovery.

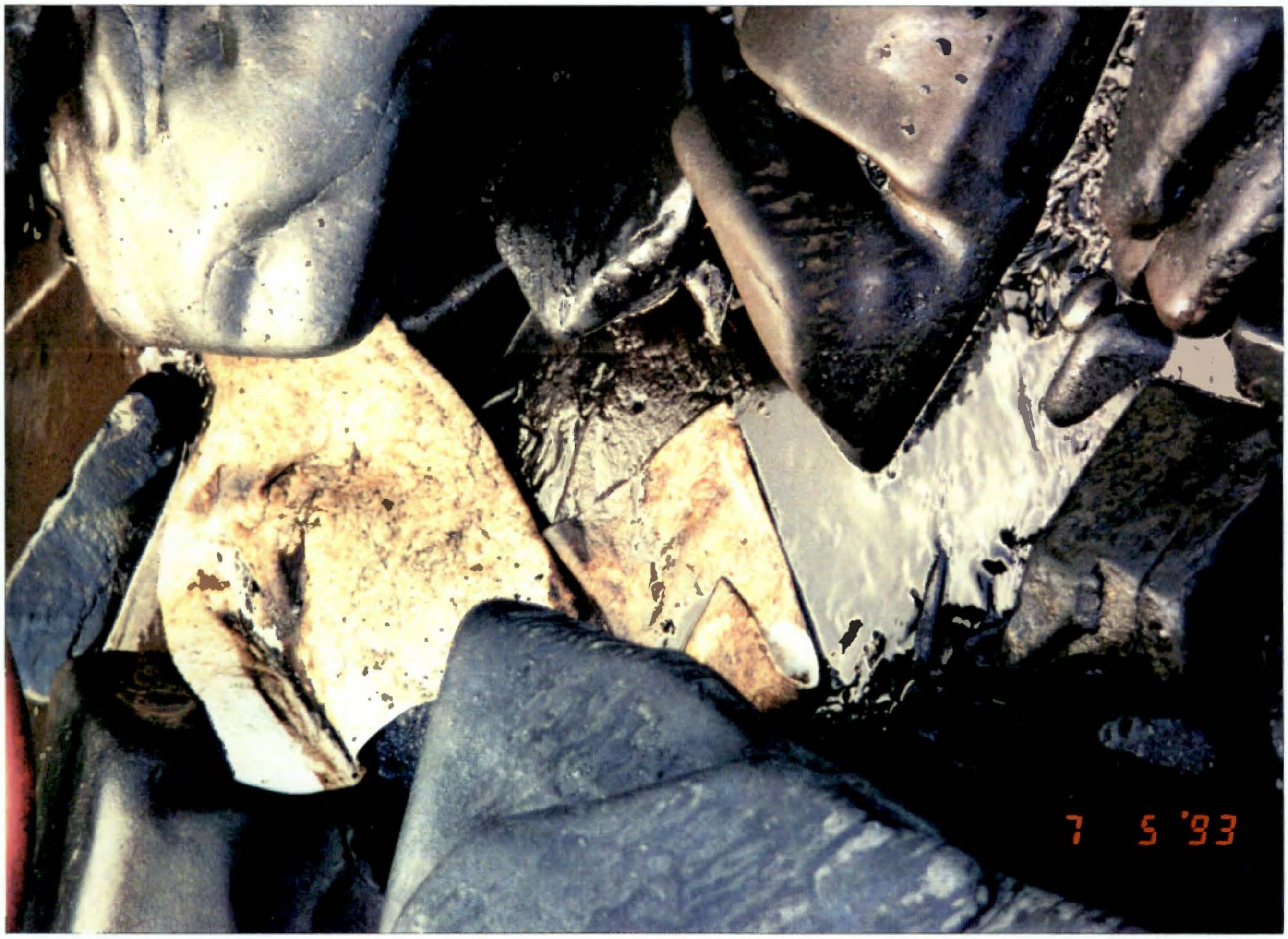
During beach restoration activities, four types of crude oil were observed:

Rainbow sheen

Light brown to rust brown mousse

Dark brown to black crude oil

Black asphaltic tar balls and stringers.



15. Brown moussey oil from PES-51™ treatment and saltwater flushing.

16. Manta Ray skimmer used for recovery.

17. Absorbent boom deployed within primary containment. Note passive recovery.

18. Absorbent pads used to recover flushed oil in boulder crevasses and backwater eddies.

19. Crude oil collecting in boulder crevasses from seawater flushing.

20. Absorbent pads showing tar ball collection.

21. Oil collection using skimmer and pads.

22. Rainbow sheen leaching from up-gradient PES-51™ beach treatment and flushing.

AGENCY OVERVIEW

Representatives of governmental agencies, industry and academic institutions observed the demonstration project. Among them were:

Alaska Department of Environmental Conservation (ADEC)
United States Coast Guard (USCG)
National Oceanic and Atmospheric Administration (NOAA)
Prince William Sound - Regional Citizens Advisory Council
Cook Inlet Regional Citizens Advisory Council (CIRCAC).

The Chenega Corporation, a major landowner in Prince William Sound, provided technical support, field crew services, and project monitoring. Martech, U.S.A., a qualified oil spill response contractor, provided crew and recovery equipment.

The University of Alaska, Fairbanks (UAF) and the University of Texas at San Antonio (UTSA) will continue monitoring for sediment and water quality parameters and for micro-flora recolonization at the treated area through the fall of 1993, with final sampling in the spring of 1994. The Universities will produce a cooperative technical report discussing the field procedures, geochemical analyses, and results of the technology demonstration project. Data will be compared to existing UAF scientific studies in other oil-impacted areas of the Prince William Sound. This report will be available to the public.

23. Seawater flushing with oil pooling in crevasses. Absorbent pad used for recovery.

24. Aerial shot of LA-19A treatment segment. Note sheen at beach waterline.

CONCLUSION

The shoreline restoration project at Sleepy Bay (PWS) confirmed the effectiveness of PES-51™ and associated technologies in removing residual hydrocarbons from previously impacted rocky shorelines. The success of the field project corroborated previous laboratory and smaller scale efficacy demonstrations. The PES-51™ technologies utilized for this subsurface restoration project are directly applicable during immediate shoreline response activities.

PES-51™ has other applications, including use in oil industry operations and maintenance, contaminated soils cleanup and remediation, marine and oil industry tank cleaning, and response/maintenance equipment decontamination.

The Prince William Sound Shoreline Restoration Project was funded by a grant from the Alaska Department of Environmental Conservation's Alaska Hazardous Substance and Spill Technology Review Council (ADEC's HSSTRC) Technology Demonstration Program and Tesoro Petroleum Corporation.

For additional information, the following participants may be contacted.

Project Operation Information:
Steve Rog, Sr. Environmental Manager
Tesoro Alaska Petroleum Corporation
P.O. Box 196272, Anchorage, AK 99519
(907) 561-5521

Product Information:
Bill Sims, President
Tesoro Environmental Products Corporation
8700 Tesoro Drive, San Antonio, TX 78268
(210) 283-2644

Scientific Evaluation Information:
Dr. Mark Tumeo, P.E., Director
University of Alaska Fairbanks
Environmental Technology Laboratory
Rm 363 Duckering Bldg, Fairbanks, AK 99775
(907) 474-6090

Regulatory Overview Information:
Leslie Pearson, Environmental Spec.
Alaska Department of Environmental
Hazardous Substance Spill Technology
Review Council (ADEC's HSSTRC)
P.O. Box 5800, Ft. Richardson, AK 99505
(907) 428-7080

Mike Rudolph, MST1
United States Coast Guard
P.O. Box 486, Valdez, AK 99686
(907) 835-4791

TESORO

Tesoro Petroleum Corporation is a natural resource company engaged in refining and marketing, development and production of natural gas, environmental product sales and services, and oil field supply and distribution.

Tesoro Environmental Products Company (TEPCO) and Tesoro Alaska Petroleum Company (TAPCO) are wholly-owned subsidiaries of Tesoro Petroleum Corporation.

11.3.7

TESORO ALASKA

Letter of Transmittal

To: Exxon Valdez Trustee Council
Restoration Team
645 "G" Street
Anchorage, Alaska 99501

Date: 8/27/93

RECEIVED
1 1993
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL
ADMINISTRATIVE RECORD

Attn: Mr. David Gibbons

Re: PES-51/PWS Mussel Bed Proposal

We are sending the following items:

Date	Copies	Description
July 28, 1993	3 copies	Mussel Bed Proposal
July 1993	3 originals	Tesoro's FIELD SUMMARY REPORTS
July 1993	3 copies	ADEC's FIELD DEMONSTRATION STUDIES
July 1993	3 copies	NOAA's FIELD TRIP REPORT
July 1993	3 copies	USCG's FIELD REPORT
	3 copies	Compendium of PES-51 Aquatic Toxicity Data

These are transmitted:

- ☐ For your information
- ☐ For action specified below
- ☐ For review and comment
- ☐ For your use
- ☐ As requested

Remarks

Letter from TC to Steve Rog under 13.1.2 in admin rec.

By: Steve Rog

Title: Sr Environmental Coordinator

Copies to:

Tesoro Alaska Petroleum Company, P.O. Box 196272, Anchorage, Alaska 99519-6272 (907) 561-5521 FAX (907) 561-5047

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TESORO ALASKA

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645 "G" Street
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Remarks

By: Steve Rog *Steve Rog*

Copies to:

Title: Sr Environmental Coordinator

Tesoro Alaska Petroleum Company, P.O. Box 196272, Anchorage, Alaska 99519-6272 (907) 561-5521 FAX (907) 561-5047

July 28, 1993

Ms. Leslie Pearson
Alaska Department of Environmental Conservation
P. O. Box 5168
Fort Richardson, AK 99505-5168

Dear Leslie:

Pursuant to a recent conversation, yesterday, with the NOAA scientific group in Seattle, I have recomposed my letter and proposal to you of July 15, 1993. The letter and proposal have been edited to more accurately reflect my discussions with the NOAA group.

I apologize for any confusion that my first letter created. It should be clearly understood that NOAA is not a lead agency in this project, nor are they providing any funding. They are only an interested observer in this new technology demonstration project.

If you have any questions or require further explanation, please do not hesitate to contact me.

Sincerely,

Steve Ry for

Dennis C. Owens
Senior Scientist, R&D
Tesoro Environmental Products Co.

cc: John Whitney, AK-NOAA
Ernie Piper, ADEC-Trustees

July 15, 1993

Ms. Leslie Pearson
Alaska Department of Environmental Conservation
P.O. Box 5168
Ft. Richardson,AK 99505

Dear Leslie:

This letter and its attachments are a proposal by Tesoro Environmental Products Co. of Alaska (TEPCO) to the Alaska Department of Environmental Conservation (ADEC) to be included in their Project 93038-Shoreline Assessment, Exxon Valdez Oil Spill Project.

Tesoro is proposing the use of PES-51 as a minimally intrusive manipulative technique for restoring oiled mussel beds in yet to be identified areas from the ADEC survey conducted under this project (a copy of the project is attached). This proposal is made in light of the recent successful use of PES-51 in a shoreline restoration project conducted by the Hazardous Substance and Spill Technology Review Council (HSSTRC) in Sleepy Bay. The HSSTRC project had originally included the treatment of oiled mussels; however, the selected shoreline for treatment did not include any oiled mussels, only newly, immature colonies were present. It should be noted that no acute toxic effects were noted or observed during the HSSTRC project on the mussel populations in the treatment area. Attached as a technical appendix is the recently completed toxicity tests for PES-51 on mussels and oysters, performed by United States Testing Company, Inc. Based upon this project, PES-51 appears to offer an economic and effective method of restoring oil impacted mussel beds.

The proposed treatment will be performed by the Chenega Corporation crew, who has been trained with PES-51 use on the HSSTRC project. This work would be initiated and completed in accordance with the scheduled restoration activities of ADEC Project 93038 from July 15 to September 30, 1993.

We have met, on an informal basis, with the NOAA-Scientific Support Co-Ordination Branch and Bioassessment Team in Seattle, WA to discuss the demonstration of this new technology on oiled mussel beds. They have been copied on this proposal. Their comments will be incorporated into the TEPCO proposal as soon as they are received.

We realize that this unsolicited proposal is of short notice; however, there exist some unique opportunities that should be taken advantage of: 1) the fact that the PES-51 has recently completed successful shoreline efficacy field trails by the HSSTRC, 2) the Chenega Corporation crew is freshly trained in the use of PES-51 and deployment equipment,
and 3) the opportunity to evaluate new technology under field conditions with the overlapping involvement and of ADEC and NOAA on evaluating the shoreline restoration technology that PES-51 represents. This mussel bed restoration project would simply be a continuation of the Tesoro-ADEC professional services contract and yet a part of the Exxon Trustees Restoration Project 93038 and 93036. This test would fulfill the objectives outlined in both the projects with minimal rescheduling and cost to the State of Alaska or the Trustees.

I would like to propose a tentative meeting date of the week of July 19, 1993, at our office to discuss this proposal and its merits. Please invite any interested parties that might facilitate the acceptance of this proposal or have direct approval/involvement in it. In the meantime, please do not hesitate to contact me or Steve Rog if you have any questions, or require additional information. We appreciate your time and efforts in this matter.

We look forward to seeing you soon.

Sincerely,

Dennis C. Owens by ASR

Steve Rog

Dennis C. Owens
Senior Scientist,R&D
Tesoro Environmental Products Co.

Steve Rog
Sr. Environmental Mgr.
Tesoro Alaska Petroleum

enclosures

Project Number: 9: 3 Work Order

Project Title: **Restoration Manipulation with PES-51®of Intertidal Oiled Mussel Beds in Prince William Sound Impacted by the Exxon Valdez Oil Spill.**

Project Category: **Restoration Manipulation/New Technology Demonstration**

Project Type: Coastal Habitat

Lead Agency: Alaska Department of Environmental Conservation (ADEC) and Hazardous Substance and Spill Technology Review Council (HSSTRC)

Cooperating Agencies: Trustee Agencies

Project Term: July 15, 1993 to July 15, 1994

INTRODUCTION

Dense clusters of the blue mussel, Mytilus edulis, occur on rocky shores throughout the region impacted by the EXXON Valdez oil spill of March, 1989. Mussels attach themselves to the substrate by secreting byssal threads with their foot. Each mussel produces a number of threads, creating a matrix beneath the mussel bed. This matrix offers considerable shelter from waves, sunlight, and wind for a high diversity of marine invertebrates that inhabit mussel beds. It has been found that liquid oil has persisted in the sediments and organic materials that compose the mussel beds. As mussels are utilized for food by sea otters, harlequin ducks and gulls and are also utilized by residents of Prince William Sound for subsistence purposes, removal of oil from the beds is imperative. These oiled beds also offer the opportunity to evaluate the efficacy of PES-51 on oiled mussel beds which will establish baseline information for future impacts. There is no established best method for removal of the oil from beneath mussel beds. It is important to develop a method of effectively and efficiently removing the oil, while minimizing damage to the mussel bed. Based upon the recently successful PES-51 field demonstration in the Prince William Sound, it is expected that this product and technology will meet the above requirements.

Identified and verified oiled, densely packed mussel beds are located throughout the western and southwestern part of Prince William Sound. The ADEC has surveyed and sampled mussels and sediments from oiled sites along this area. One of these monitored locations will be utilized for the evaluation.

The purpose of this proposal is to work with the ADEC to evaluate the effectiveness of PES-51® in removing oil from an impacted mussel bed and the impacts of the removal treatment on the mussels and the matrix fauna.

WHY

This project will test the feasibility of new technology, a minimally intrusive manipulative technique, to remove oil from beneath oiled mussel beds. It will provide data on the efficacy of PES-51 in removing oil from an impacted mussel bed and the impacts of the removal treatment on the mussels and the matrix fauna.

Since there is no established best method of removal of the oil from beneath mussel beds, appropriate new technologies must be evaluated under field conditions if possible. New techniques for cleaning oiled mussel beds at the time of impact must be developed in order to prevent the possible toxic linkage to injury seen in the mussel consuming species-harlequin ducks, black oystercatchers, river and sea otters, and humans.

HOW

A. Project Management

Project Manager- Mr. Steve Rog
Tesoro Alaska Petroleum
Senior Environmental Manager

Experience: 20 years as an environmental geologist...Currently provides management of all environmental concerns for the retail and marketing division of Tesoro Alaska...He has an extensive working knowledge of the proposed product and the application technology...Rog serves on the Tesoro Oil Spill Response Team as the Environmental Coordinator.

Technology Coordinator- Mr. Dennis C. Owens
Tesoro Environmental Products Co.
Senior Scientist R&D

Experience: 20 years as a corrosion oilfield chemist and microbiologist...Currently provides management of the research and development program for TEPCO...He is one of the product developers and will provide on site expert application of the technology...Owens serves on the Tesoro Oil Spill Response Team as the Technology Coordinator.

Principal Investigator- Dr. Raymond Highsmith
Institute of Marine Science
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks

Experience: He is a full professor at the University of Alaska at Fairbanks and is recognized as a worldwide expert on bivalves found in Alaskan waters.

Work Crew- Chenega Corporation
Martech U.S.A., Inc.

Experience: This crew is freshly trained in the use of the PES-51 from a recent Hazardous Substance and Spill Technology Review Council funded project in the Prince William Sound.

B. Methodology

Scientific Evaluation
A demonstration project mussel bed that has retained oil will be selected in Prince William Sound.

A mussel bed that has not retained oil, as near as possible to the oiled bed, will be used as a control bed. Depending upon the length of the mussel beds, two designs are possible. If the beds are small then the oiled bed should receive treatment on one half and no treatment on the other half. Care will have to be taken to minimize the possibility PES-51® getting into the non-treated side of the bed. Prior to treatment, a minimum of five randomly determined 0.1 m2 quadrat samples will be collected from each side of the bed. A number of mussels will also be specially collected using NRDA sampling methods for submission to a designated laboratory for hydrocarbon analyses. The quadrat samples will be preserved and taken to UAF for processing. In the laboratory, the size and age frequency distribution of the mussels will be determined. This approach will allow determination of pre-and postspill growth rates and recruitment patterns. The matrix fauna will be identified and counted. The un-oiled control bed will also be treated on one half, with pre-treatment sampling identical to that for the oiled bed. It is necessary to treat the control bed because 1) mussels and matrix fauna exposed to chronic oiling for four years may be highly susceptible to injury by the treatment, 2) conversely, those organisms remaining may be extraordinarily hardy or resistant, and 3) the matrix faunas may be different (samples collected during the reconnaissance visit may answer this question prior to the experiment).

The second possible approach would be utilized if the beds were long enough for a randomized block design. A length of 50m would be adequate. The length of the bed would be determined and a random numbers generator used to determine the location of the first treatment block. Six blocks would be established at equal distances apart, using the location of the randomly determined block as the starting point. Three blocks would be treated with PES-51 and three blocks would not be treated in both the control and oiled bed. Every other block will be treated, using a coin toss to determine initial order. As for the previous design, quadrat and hydrocarbon samples would be collected prior to treatment.

One day after treatment, another set of quadrat samples will be collected for on-scene determination of immediate mortality of mussels and matrix fauna. Approximately 10 days after treatment, still another set of quadrat samples should be collected for determination of impacts. Subsequent samples should be collected on a schedule to be determined from the treatment date. It will be particularly important to resample the following summer to evaluate recruitment in the blocks or bed halves relative to oiling and treatment.

Wastes generated during restoration activities will require treatment at approved facilities.

Field Operations - oject Work Plan

After mussel bed selection, the scientific evaluation will be conducted by Dr. Highsmith, UAF. This is expected to take place late July through August 1993. During that time logistical, equipment and crew support services will be procured and scheduled for the September 7-13, 1993, during a favorable tide cycle.

The selected mussel bed will be double boomed and contained prior to the PES-51 treatment. Sea water deluge and flush pumps, air compressors, recovered oil storage tank and equipment and supplies will be staged on a 60 foot landing craft, moored adjacent to or "beached" at the treatment site. Crew support will be provided using a berthing vessel.

The PES-51 treatment will be performed using a modified version of the air knife, pneumo-hydrodynamic system used at Sleepy Bay. For the mussel bed application, the air knives will be pressure regulated to allow for a low pressure, PES-51 and air infusion through the vertical section of oil impacted mussel bed. After the PES-51 infusion, sea water deluge and flushing (low pressure, large quantities), using 6-inch pumps and fire monitors, will be used to move the oil to the double boomed area for collection and recovery. The recovered oil will be collected using a skimmer vessel and different types of absorbent materials (pads, boom, sweeps, etc.). Recovered oil will be pumped to the storage tank for quantification. Excess water will be decanted, as necessary.

ENVIRONMENTAL COMPLIANCE

As in prior product evaluations, permits and notifications will be required by several permitting agencies. All permits will be obtained prior to commencement of field work.

WHEN

July 93'- Two day reconnaissance visit by Tesoro, UAF and ADEC personnel to examine oiled bed and located suitable control beds. Quadrat samples will be collected for mussel growth rate analysis and evaluation of matrix fauna.

July and August 93'- Sample sorting in the laboratory.

September 93'- Conduct one week field demonstration project on suitable low tide and collect post treatment impact samples. Issue preliminary report.

Spring 94'- Resample mussel beds and final report.

COST ESTIMATE

LABOR

Tesoro Project Management	Lump Sum	$ 8,500
Tesoro-Field Crew and Tech Reps	$ 1,750/day x 7 days	$ 12,250
Chenega Corp-Project Mgmt	Lump Sum	$ 3,000
Chenega Corp-Field Crew (6 man)	$ 1,500/day x 7 days	$ 10,500
Martech USA-Project Mgmt	Lump Sum	$ 2,000
Martech USA-Field Crew	$ 1,400/day x 7 days	$ 9,800
Videographer	$ 1,000/day x 7 days	$ 7,000
	SUBTOTAL-LABOR	$ 53,050

SUBCONTRACTOR EQUIPMENT

2 Berthing Vessels	$ 2,000/day x 7 days	$ 28,000
1 Skiff	$ 200/day x 7 days	$ 1,400
1 Landing Craft (60 ft)	$ 2,000/day x 7 days	$ 14,000
1 Skimmer	$ 3,000/day x 7 days	$ 21,000
Fuel (DF #2, U/L Gas)		$ 1,500
2 6-inch Pumps	$ 600/week	$ 1,200
Fire Hose (Estimate)	Lump Sum	$ 500
1 250 cfm Air Compressor	$ 600/week	$ 600
Air Hose (Estimate)	Lump Sum	$ 500
1 5000 gallon Tank	$ 150/day x 10 days	$ 1,500
2 Air Knife Injection System w/Remote Feed	$ 1,000/day x 7 days	$ 7,000
500 LF Containment Boom	$ 12/LF	$ 6,000
Misc Field Supplies		$ 1,500
PPE	$ 30/day x 12 men x 7 days	$ 2,520
Absorbents (Estimate) (Pads, Booms, etc.)		$ 3,000
Oil Disposal AK Pollution Control	5000 gallons @ $2.00/gal	$ 10,000
Mobe/Demobe Freight/Aircharter-Recon		$ 3,500
	SUBTOTAL-SUBCONTRACTOR EQUIPMENT	$103,720

CONSULTANTS

University of Alaska, Fairbanks - Dr. R. Highsmith & UAF Graduate Student		$ 38,600
Lab Testing (GCMS, Oil/Water Analysis)		$ 2,000
	SUBTOTAL-CONSULTANTS	$ 40,600

GENERAL AND ADMINISTRATION

10% of $197,370		$ 19,737
	TOTAL PROJECT COST ESTIMATE	$217,107

PROPOSED CREW LIST

5	TESORO
6	CHENEGA
3	MARTECH
1	VIDEO
2	ADEC
2	NOAA
1	TRUSTEE
1	USCG
2	UAF
2	LANDING CRAFT CREW
6	BERTHING VESSEL CREW
31	TOTAL CREW

SRR

PES-51 Demonstration of Subsurface Shoreline Cleanup of Weathered Exxon Valdez Oil

FIELD DEMONSTRATION SUMMARY

By

Leslie A. Pearson
Alaska Department of Environmental Conservation
Fort Richardson, Alaska

Introduction

Based on the shoreline assessment data collected in 1992 by the Alaska Department of Environmental Conservation's (ADEC)-Exxon Valdez Oil Spill (EVOS) Center, conclusions were made that a significant amount of oil existed on numerous shorelines within Prince William Sound. During the T/V Exxon Valdez Oil Spill, it became apparent that cost effective shoreline cleaning techniques were limited. Many of the existing techniques available today remain labor intensive, expensive and provide minimal results. The State's Hazardous Substance Spill Technology Review Council (Council) is mandated by AS 46.13.100 to assist in the identification of containment and cleanup products for arctic and sub-arctic oil and hazardous substance releases. On March 10, 1993, Tesoro Alaska Petroleum Company (Tesoro) submitted a proposal titled PES-51 Demonstration of Subsurface Shoreline Cleanup of Weathered Exxon Valdez Oil to the Council for review. PES-51, a biosurfactant manufactured by Tesoro Environmental Products Company is a relatively new product which has not been used on a wide scale basis during spill cleanup in Alaska. The proposal was approved by the Council on April 20 with an allocation of $100,000.00 for Tesoro to conduct a field test in Prince William Sound using PES-51.

Project Objectives

Approval of the PES-51 field test was based on a cooperative effort involving Tesoro, the University of Alaska Fairbanks, and the University of Texas in San Antonio. The intent of this project was to:

1. validate the draft Technology Protocol for Chemical Product Use on Spills in Marine Waters of Alaska developed by the Council:

2. determine the effectiveness of PES-51 in removing petroleum contamination from the substrate in the inter-tidal zone;

3. determine the level of petroleum hydrocarbons in surrounding water that result from the application of PES-51; and

4. determine the microbial response to PES-51 treatment of substrate.

Summary of Product Information and Toxicity Test Data

PES-51 was listed on the National Contingency Plan Product Schedule List as a miscellaneous oil spill control agent on September 8, 1992. The composition of PES-51 is biospersan, biosurfactant, d-Limonene and water. In essence the product is composed of bacterial fermentation by-products which are combined with d-limonene to form a biological mixture. When PES-51 is mixed with a hydrocarbon it increases the interfacial tension surrounding the oil molecule without affecting the surface chemistry of the hydrocarbon. PES-51 also decreases the surface tension between the oil/sediment substrate which allows it to float to the surface. The product/oil mixture has a density of less than 1.0 which allows it to float on water. The product is designed to remove oil from contaminated sediments. Petroleum Environmental Services, Inc. prepared a compendium of aquatic toxicity data. The following suite of species were tested:

- * P. promelas (fathead minnow), freshwater
- * M. beryllina (inland silversides), saltwater
- * A. salinas (brine shrimp), saltwater
- F. heteroclitus (killi fish), saltwater
- O. mykiss (rainbow trout), freshwater
- C. gigas (pacific oyster), saltwater
- M. edulis (bay mussel), saltwater

The acute toxicity tests conducted on P. promelas, M. beryllina and A. salinas are required by the State of California for evaluating oil spill cleanup agents (Publication No. 43 of the California State Water Resource Control Board). The following is a summary of the tests performed.

	P. promelas	M. beryllina	A. salinas
PES-51 (24hr/LC50)	810 mg/1	100 mg/1	980 mg/1
(48hr/LC50)	810 mg/1	100 mg/1	840 mg/1
(96hr/LC50)	810 mg/1	100 mg/1	N/A
PES-51 + #6 Fuel Oil			
(24hr/LC50)	>1600 mg/1	>1600 mg/1	>1600 mg/1
(48hr/LC50)	>1600 mg/1	>1600 mg/1	>1600 mg/1
(96hr/LC50)	>1600 mg/1	>1600 mg/1	N/A

Acute toxicity tests were conducted on F. heteroclitus and A. salinas using USEPA NCP, 40 CFR Part 300, Subpart H. Appendix C Revised Standard Dispersant Effectiveness and Toxicity Test Method and USTC Procedure PRO/EPA OIL TOX 121-1. The following is a summary of the tests performed.

	F. heteroclitus (96hr/LC50)	A. salinas (48hr/LC50)
PES-51	1,425 ppm	665 ppm
PES-51/#2 Fuel Oil	5,650 ppm	1,542 ppm
#2 Fuel Oil	5,200 ppm	58 ppm

An acute toxicity test was conducted on O. mykiss using 40 CFR Part 797.1400 "Fish acute Toxicity Test" USEPA 1989; 40 CFR Part 300 Subpart J "Revised Standard Dispersant Effectiveness and Toxicity Test" USEPA 1984, revised 1990; USTC Procedure PRO/FT FISH 224-7 and USTC Procedure PRO/EPA OIL TOX 121-1 methods.

	O. mykiss (96hr/LC50)
PES-51	98 ppm
PES-51/#2 Fuel Oil	500 ppm
#2 Fuel Oil	518 ppm

Acute toxicity tests were also conducted on the larvae stages of C. gigas and M. edulis using "Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of four Species of Saltwater Bivalve Molluscs" E-724 ASTM and Bioassay Procedures for Mollusks, Standard Methods, 14th ed. APHA 1975.

	C. gigas (48hr/EC50)	M. edulis (48hr/EC50)
PES-51	18.7 ppm	9.6 ppm
PES-51/#2 Fuel Oil	127.7 ppb	N/A
#2 Fuel Oil	185.3 ppb	

For detailed product information and acute toxicity data contact Tesoro Alaska Petroleum Company.

Site Description and Oil Characteristics

Shoreline sub-segment LA-19A is located at Sleepy Bay on the north end of Latouche Island in Prince William Sound. A shoreline assessment survey was conducted Ernie Piper, Diane Munson and Marianne Profita, ADEC-EVOS, on June 3. The sub-segment is approximately 300m in length with a moderate to high energy level and is composed of large boulders and cobbles with large grain sand particles filling the interstitial spaces. A long, low schistose outcrop is the boundary that separates sub-segment LA-19A from LA-20C. The oiling summary indicated that asphalt and oil residual sediments were found throughout the mid-intertidal zone (MITZ) to the upper intertidal zone (UITZ). Within the boulder-cobble interstitial spaces oiling occurred in distinct patches and was characterized as asphaltic, saturated oil residual and mousse which often extended subsurface. Twenty one pits were dug with an average depth of 27.9 cm throughout the sub-segment. Sub-surface oiling characteristics ranged from oil-filled pores, high-moderate-low oil residual, oil film and no oil. The northern portion of the sub-segment was selected as the test area. The size of the test area was 60m x 48m. The remaining portion of the sub-segment was designated the control zone for the test.

Treatment History

On July 3, 1989 treatment of LA-19 commenced. Throughout the course of the 1989 season, physical treatment techniques observed by ADEC shoreline monitors consisted of the following:

1. Hand wiping
2. Cold and warm water header hose flood
3. Cold water/high pressure
4. Warm/Hot water, medium pressure wash
5. Hot/steam water, high pressure wash
6. Omni booms

Bioremediation treatment was applied to LA-19 with approximately 220 ga. of Inipol and 948 lbs. of Customblen. LA-19 was demobilized on September 14, 1989 with gross contamination still remaining throughout the segment.

During the 1990 treatment season approximately 21 days were spent at LA-19. Mousse and oil contaminated soils were removed using only manual techniques. Customblen was applied in the upper intertidal zone (UITZ) and behind boulders where concentrations of oil exist.

On May 2, 1991 a multi-agency shoreline assessment team evaluated the oiling conditions at LA-19A. Manual pickup and bioremediation treatment recommendations were made to remove the easily accessible asphalt between the boulders. The Technical Advisory Group (TAG) evaluated the recommendations and decided that no treatment should take place during the 1991 field season. Although shoreline assessment data from 1991 and 1992 indicated a significant amount of surface and subsurface oil on LA-19A no treatment had been applied since 1990.

PES-51 Field Demonstration

Prior to initiating the field demonstration Tesoro obtained the following permits:

1) a "license to enter" from Chenega Corporation;
2) cultural resource clearance from the Alaska Department of Natural Resources (DNR)- State Historic Preservation Office (SHPO);
3) Land Use Permit from DNR; and
4) an "Authorization for Use" from the Alaska Regional Response Team (ARRT).

Due to the sites close proximity to an anadromous stream, resource constraints were placed in effect whereby the experiment had to be conducted prior to July 15 or after September 1.

Subcontracts were established with the University of Alaska Fairbanks to provide scientific support, Chenega Corporation who provided six laborers and two vessels, Martech USA for 3 laborers, a landing craft and oil spill response equipment. TCS Video was also contracted to provide video and photo-documentation throughout the experiment.

On July 1, the field team and equipment departed from Whittier to Chenega via the M/V Outer Limit. On July 3, I joined up with the field team in Chenega to provide agency oversight and assistance. Throughout the duration of the experiment representatives were present from the U.S. Coast Guard- MSO Valdez, National Oceanic and Atmospheric Administration, University of Alaska Fairbanks, Prince William Sound Regional Citizens' Advisory Council, Cook Inlet Regional Citizens' Advisory Council, Cook Inlet Spill Prevention and Response Inc., Chenega Corporation and Tesoro. The field test was completed and demobilized on July 7.

Description of Operation

A cold seawater deluge system was assembled at the UITZ. This system was not utilized due to the deficiency of pumping capabilities. An alternative deluge system consisting of three 2 inch lines equipped with adjustable fire nozzles were used to deluge the treated sections of beach with cold seawater. The temperature of the seawater ranged from 11.5 to 13.9 degrees centigrade.

A primary containment boom was strung from an anchor point position above the high tide line. Within the primary containment boom a secondary containment boom was attached from anchor points positioned immediately outside the anchor points from the primary containment boom. Polypropylene sorbent booms were attached to hinge areas within the secondary containment boom. The landing craft was positioned to the southside of the boomed treatment area.

Tesoro purchased and modified two air knife injection systems for the experiment whereby air and product would be introduced into the contaminated substrate. Three hoses were attached to the air knife. The primary hose was attached to a compressor with an output of 120 psi. at the compressor and approximately 80-100 psi at the knife. Another hose provided air to pressurize the canisters of PES-51. The final hose attached the PES-51 canister to a trigger which injects the product into the substrate through the air knife.

The test area was worked in a north-south direction beginning at the low intertidal zone (LITZ). The air knife was manually worked into the substrate. As air was injected into the substrate, fine grained consolidated material would be loosened which aided towards increasing the knifes depth of penetration. PES-51 was then injected into the substrate thereby complexing with the subsurface oil. A cold seawater flush was applied to the work area which floated the mobilized oil to the waterline.

A test was conducted using the same principles described above but eliminating the injection of PES-51. The air injection and cold seawater flood didn't effectively mobilize the subsurface oil.

In areas where the shoreline material was comprised of small boulder, large cobble, gravel and sand, a depth of penetration ranging from 30-45 cm could be achieved. When air was injected into this type of substrate it was not uncommon to see area of 1 m in diameter rise. Air bubbles then percolated to the surface. The addition of PES-51 mobilized the entrained material which then released oil globules.

During pre-treatment sediment sampling, the University personnel marked areas of high oil concentration. These "hot-spots" were generally located within the large boulder areas of the test zone. When treatment was applied to the "hot-spots" mousse was released and flowed steadily towards the waterline emitting brown-rainbow-silver sheens. Asphaltic flecks were also observed within the water.

After the first couple days of operation observations were made of tarry rings around some of the large boulders. Residual oil was transported back onto the substrate during the tide cycle creating the rings. The tar rings were quickly removed when PES-51 was applied using a hand wands then followed by a cold water flush. The PES-51 has a unique property whereby when it's applied to the surface material an enzyme film remains. The film prevents oil from re-adhering to the material. The film has a retention time of approximately 96 hours. The retention time can be reduced by prolong exposure to ultraviolet rays and walking on the area treated.

The total amount of PES-51 used during the experiment which included decontaminating the containment booms was approximately 165 gallons.

Oil Recovery Methods and Estimate

During the operation polypropylene sorbent pads, sweeps and sausage boom was used to absorb floating product on the water and found within the interstitial spaces between boulders. The sorbent product was extremely effective. I believe the PES-51/oil mixture increased the absorbency ratio. I would recommend a study be conducted to further examine the effects of PES-51/oil mixture and sorbent effectiveness.

Twenty-four bails of polypropylene sorbent pads, 500 ft. of sorbent sweep and 250 ft. of sausage booms were used during the five day operation. A total of 120 ga. of oil/product mixture was recovered using a Slickbar Flexible Manta Ray skimmer.

Protocol Validation

One of the objectives of this project was to validate the draft Technology Protocols developed by the State's Hazardous Substance Spill Technology Review Council. The protocols are designed to provide a mechanism to screen chemical and bioremediation products prior to a spill event. Tesoro met the requirements of the *"Preliminary Review of Information on Chemical and Bioremediation Products for use on Marine Spills in Alaska"* (Attachment 1) and had also met the requirements up to Step 5 of the *"Protocol for Chemical Product Use on Spills in Marine Waters of Alaska"* (Attachment 2). Step 5 of the *"Protocol for Chemical Product Use on Spills in Marine Waters of Alaska"*, deals specifically with acute and chronic toxicity tests on marine biota. The Council is presently re-evaluating the specific toxicity tests found within the protocol and have proposed to utilize standard species rather than Alaska specific species. The toxicity data provided by Tesoro was provided to the Council. It was determined that the data sufficiently satisfied the requirements of Step 5 of the protocol.

Step 6, "Spill of Opportunity" test plan was developed by Tesoro and submitted to the Council as their project proposal for funding approval in March. The proposal was approved by the Council at their April meeting. Tesoro fulfilled all of the requirements found within Step 6 of the protocol prior to the field test.

The draft protocols are currently being re-written based on observations obtained from the field test. Additional information such as permit requirements, containment and cleanup requirements, and work site requirements will be added to Step 6 of the protocol. The protocols are proposed to be finalized by September 1, 1993 for the Councils review and approval.

Recommendations

One of the major limitations of the field test was the lack of pumping capacity to provide a thorough cold seawater deluge to the test site. The oil recovery methods were effective although in the future, I would recommend the use of a more efficient skimming system. I would also encourage experimental tests to be conducted during the early fall rather than the summer period so that the higher tidal cycles and winter storms be used to accelerate the natural degredation of the treated substrate.

Conclusion

PES-51 has proven itself to be one of the most promising shoreline cleaners on the market today. The air/PES-51 injection system was extremely effective at removing weathered subsurface oil throughout the five day experiment. The shoreline selected for the test was one of the most difficult types to effectively treat as indicated in the treatment history section of this report. Surface oil remained at LA-19 following the treatment. Subsequent reports from ADEC-EVOS personnel have indicated that through tidal and storm cycles the surface oiling is degrading.

During any future oil spills, I would encourage the application of PES-51 as an immediate shoreline response technique. Considerations on the use of PES-51 should be made towards designated sacrificial beaches prior to oil impact. This would greatly reduce the entrainment of oil to a shoreline. I would also encourage additional test be conducted using PES-51 on a variety of shoreline substrates to determine the potential limitations of the product.

PROTOCOL FOR CHEMICAL PRODUCT USE ON SPILLS IN MARINE WATERS OF ALASKA

1. Scope

1.1 This protocol covers the development of laboratory test data which describes the performance of chemical products used to remove oils and other compatible fluids from marine waters at a controlled test facility.

1.2 This protocol involves the use of specific test oils which may be considered hazardous materials after testing is completed. It is the responsibility of the user of this protocol to procure and abide by the necessary permits for disposal of the used test substance. These permits are to be obtained from the appropriate Federal, State and Local Authorities.

1.3 This protocol does not address all of the safety problems associated with its use. It is the responsibility of the user of this protocol to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ADEC-QA-006/88 Guidelines for Preparing Quality Assurance Project Plans

2.2 EPA 600/4-85/013 Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms

2.3 40 CFR Part 300.900 The National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule"

2.4 E 729-80 ASTM Standard Practice for Conducting Acute Toxicity Tests with Fish, Macro invertebrates, and Amphibians

2.5 Alaska Department of Labor: Occupational Safety and Health Standards-Hazardous Waste Operations and Emergency Response.

2.6 21 CFR Part 182, 184, 186; FDA Generally Regarded as Safe List.

3. Summary of Method

3.1 The chemical product shall be tested in a certified laboratory with a controllable test environment. Controlled test variables include testing substance properties and thickness, water and product temperatures, testing period and toxicity tests of specific index species for Alaska. It is essential that the product parameters are monitored, measured, sampled and recorded during the test period.

3.2 The chemical product will be tested using established standard methods, where applicable, and specifically developed test for performance factors.

4. Significance

4.1 This protocol will determine a criteria that may be used to balance product performance and net environmental benefit for the State of Alaska. The types of criteria considered include: efficiency, efficacy, toxicity and risk analysis.

5. Toxicity Tests

5.1 Acute and chronic toxicity testing will not be required if the proponent of the chemical product can provide documentation which supports its listing on the Food and Drug Administrations-Generally Regarded as Safe List and that the chemical constituents of the product are below acute and chronic toxicity for the index species listed in 5.3.

5.2 Acute and chronic toxicity tests shall be conducted using American Society of Testing Materials (ASTM) or U.S. Environmental Protection Agency (USEPA) methods.

5.3 Conduct comprehensive laboratory toxicity tests using the product mixed with specified test substances provided by the state in temperature controlled seawater to evaluate the potential for acute and chronic toxicity for marine biota representative of various taxa:

5.3.1 acute toxicity test (96-hr) with pink salmon (<u>Oncorhynchus gorbuscha</u>)

fry or smolt;

5.3.2 acute toxicity test (96-hr) with the epibenthic amphipod Rhepoxynius abronius;

5.3.3 chronic estimator test (7-day) with Pacific herring (Clupea) or silversides (Menidia);

5.3.4 kelp sexual reproduction toxicity test (7-day) with the brown alga Laminaria; and

5.3.5 a 96-hr algal growth test with Skeletonema.

5.4 Conduct laboratory tests with product and solid-phase mixture with oil to determine the acute toxicity (96-hr) with Rhepoxynius abronius.

6. **"Spill of Opportunity" Testing Plan**

6.1 "Spill-of-Opportunity" is defined as:

6.1.1 A spill where there is no identifiable responsible party and/or the responsible party is not capable of controlling, containing and cleaning up the spill.

6.1.2 A spill where there is a responsible party and the proponent has entered into a legal agreement to test the product. Documentation of this agreement must be included in the Testing Plan.

6.2 A general approach using the document Guidelines for Preparing Quality Assurance Project Plans, ADEC-QA-006/88, the proponent of a product will provide a plan for sampling and testing to evaluate effectiveness of the product in a real spill response.

6.3 A health and safety section must be included in the test plan. This section shall include:

6.3.1 Photocopy documentation that personnel are adequately trained to perform hazardous waste operations and emergency response as stated in the ADOL Occupational Safety and Health Standard, Subchapter 10.

6.3.2 Description of the protective clothing and equipment to be worn by personnel during the operation.

6.3.3 Describe and site specific medical surveillance requirements.

6.3.4 Establish decontamination procedures for personnel and equipment.

6.4 Proponent will specify what types and amount of spilled substance his proposed technology would be used on.

6.5 Proponent will specify in the test plan:

6.5.1 Types of affected environment (terrestrial, marine rocky shoreline, sandy substrate, wetland marshes, etc.) the product will be applicable for use.

6.5.2 The location or region of Alaska for cost effective mobilization and product use.

6.5.3 Contact phone numbers for emergency notification, call out and mobilization.

6.6 The proponent will submit the protocol information packet to a third party (ie. environmental consultant, professional engineer) for review.

6.6.1 The third party will evaluate the packet to determine if the proponent has met the requirement within the protocol.

6.6.2 The third party will provide a letter to the proponent indicating the results of the review and a copy of the letter and proponents protocol packet will be submitted to the Hazardous Substance Spill Technology Review Council.

6.7 The Hazardous Substance Spill Technology Review Council and Department of Environmental Conservation will rank the proponents product testing proposal by type and region.

6.8 The Department of Environmental Conservation will notify the proponent of their ranking for product testing on a spill-of-opportunity.

PRELIMINARY REVIEW OF INFORMATION ON CHEMICAL AND BIOREMEDIATION PRODUCTS FOR USE ON MARINE SPILLS IN ALASKA

1. Scope

1.1 This preliminary review of product information, provided by the proponent for state review, will assist in determining the products use as a cleanup or response method for marine spills.

2. **Significance**

2.1 The preliminary review procedures will determine whether the product should proceed towards the implementation of the Protocol for Bioremediation and/or Chemical Product Use on Spills in Marine Waters of Alaska.

3. **Definitions**

3.1 *LC_{50}*- median lethal concentration

3.2 *EC_{50}*- median effective concentration

3.3 *oil, oil liquid, chlorinated solvents*- substantially water-immiscible organic liquids (limited water solubility) as well as liquids containing dissolved solids. These substances may either float, sink, or be dispersed.

3.4 *product*- that which is listed on the National Oil and Hazardous Substance Pollution Contingency Plan, Part 300, Subpart J, "Use of Dispersant and other Chemical Product Schedule".

3.5 *efficacy*- power to produce effects or intended results.

3.6 *risk analysis*- potential human health and product/spill material mixture impact to a suite of species from various taxa.

3.7 *recovery rate*- the volume of substance recovered by the product per unit of time.

4. Product Information

4.1 Physical and chemical data, as well as formulation characteristics and previous use of the product must be provided. This includes:

4.1.1 exact biological and chemical composition;
4.1.2 application rate;
4.1.3 application method;
4.1.4 mode of cleansing action and efficacy;
4.1.5 history of use in Alaska and other areas; and,
4.1.6 environmental fate and persistence.

4.2 Published product and chemical database information from a credible literature search for the evaluation of chemical components, and product formulation must be provided. This includes:

4.2.1 physical, biological and chemical properties of constituents, including data and other information used to support the application for product listing in the National Contingency Plan's Product Schedule List;

4.2.2 potential toxicity or bioaccumulation of product for humans, marine mammals, birds, other wildlife and aquatic resources, including results of any acute or chronic toxicity tests performed on the product method;

4.2.3 certification that the product does not contain carcinogenic, mutagenic, teratogenic, pathogenic or hazardous substances according to toxicity characteristic leachate procedures;

4.2.4 description and results of any tests performed in a laboratory or field study on fresh or weathered oil/oily liquid and chlorinated solvents that documents the proposed mode of action of the product or that the method enhances biodegradation;

4.2.5 an indication that proposed use of the product can comply with all applicable federal, state, or local laws and regulations;

4.2.6 an analysis of potential ecological effects; and, 4.2.7 a statement of corporate or organization qualifications, including previous experience with hydrocarbon degradation, observed results, personnel resources and capabilities.

4.3 Proponent must provide acute (96 hr. LC_{50} or 96 hr. EC_{50}) toxicity test reports on the product utilizing quality assured, flow-through or static-with-replacement testing procedures and the test species; mysids (Mysidiopsis sp.), and larval mussels (Mytilus sp.) or larval oysters (Crassostrea sp.).

4.3.1 The quality assurance procedure will involve simultaneously testing and determining the toxicity of a control toxicant of known toxicity along with the product.

5. Summary

4.1 The state will make a decision, based on the preliminary product review, whether to proceed with the implementation of the Protocol for Bioremediation and/or Chemical Product Use on Spills in Marine Waters of Alaska.

SRR

Trip Report
Observations of PES-51 Application in Prince William Sound
July 1-4, 1993

Debbie Payton and John Whitney
Hazardous Materials Response and Assessment Division
National Oceanic and Atmospheric Administration
Seattle, Washington and Anchorage, Alaska

Background
Tesoro Oil Company is marketing a product, PES-51, for the removal of hydrocarbons from beaches. They proposed, to the State of Alaska's Hazardous Substance Spill Technology Review Council (HSSTRC) to apply PES-51 to a portion of beach in Sleepy Bay (LA-19A) that had subsurface oil bound to the sediments. Tesoro received funding from HSSTRC for a test application and pre- and post-monitoring of the area. They requested approval from the Alaska Regional Response Team (ARRT) for application (though it is not clear that there is any requirement for such approval). The ARRT, through Mark Miller, requested that HAZMAT review and comment on the test plan. Tesoro invited NOAA and other agencies to observe the test.

Objectives
Tesoro's stated objectives were to
1) test the effectiveness of PES-51;
2) look at the levels of hydrocarbons in the water resulting from the application; and
3) look at the microbial response to PES-51 treatment.

Our objectives for observing the test were to
1) make qualitative observations of effectiveness;
2) note the application procedure and logistics requirements;
3) observe beach type of both test and control areas; and
4) note any obvious acute effects to organisms.

Both John Whitney and Debbie Payton made qualitative observations. In addition, the Coast Guard sent an observer from Marine Safety Office Valdez, MST Mike Rudolph, and the Alaska Department of Environmental Conservation (ADEC) sent Leslie Pearson to observe. On one of the days a representative from the Regional Citizens' Advisory Council (RCAC), John Hayes, also observed the application.

Pre-Application Observations (see drawing)

Test beach

Biota. The lower-mid intertidal area had good coverage of yellow-brown fucus attached to the rocks, numerous seastars, mussels, limpets and a few nucella, anemones, isopods, and small minnow-like fish were occasionally observed in the water. In the mid-intertidal area mussels, barnacles, limpets, and littorines were present. In the upper intertidal area there were barnacles and littorines.

Beach type. The test area was bordered to the west by a large bedrock outcropping and on the east by an number of large boulders. The area between the large boulders and bedrock outcropping was mostly small boulder to large cobble overlaying bedrock or gravel, with some scattered large angular boulders throughout the area.

Oiling. Very little surface oil was seen in the area. On the extreme east and west sides of the test area, heavy oiling was seen behind and between some of the large boulders. In some of these boulder areas with standing water, a sheen was observed on the water. Subsurface oil was seen in an approximately 3 m wide swath in the upper intertidal area (in zone 4 - see map) across the whole test area. Some of the boulders and cobbles had oil staining in the form of non-flaky black spots. Oil staining could also be found on the cobble and pebble in the upper storm berm.

Control Beach

Biota. The lower-mid intertidal area and the mid intertidal area were similar to the test beach. There were fewer barnacles and littorines in the upper intertidal area.

Beach Type. The western portion of the control beach was large boulders, fading to smaller boulders and cobble to the east. Boulder and cobble size decreased eastward across the control beach to medium-sized cobble over pebble.

Oiling. Very little surface oil was seen. The surface oil that was found was on the extreme western portion of the beach (the eastern side of the test beach), behind large angular boulders. There did not appear to be a swath of subsurface oiling in this area, though some patches were found at approximately the same level of the beach.

Application Method

A 135'x120' area of the beach was selected for the test site (see map). The area was surrounded by two hard booms, one in front of the other. Absorbent boom was placed abutting sections of the hard boom (we observed three applications, the first - no absorbent boom, the second - absorbent boom behind portions of the first hard boom, the third - absorbent boom half in front, half behind portions of first boom). A clamshell-shaped skimmer was placed in the eastern portion of the inner boom (Man-O-Ray), oil and water were skimmed into a storage tank on-board the landing craft. After gravity separation, the water was pumped back into the Sound. Air knifes were attached to a 2-gallon can of PES-51 and to compressed air. The knives were at about 150 psi. The proposed cold water deluge system did not work so cold water low-pressure flushing from two firehoses (2-3" diameter) was used. The PES-51 was injected, via the knifes, into the sediment at depths that looked to be a few inches to almost a foot (this does not include how far down the air may have penetrated). The first applications were done in the upper tidal area on the eastern 50' of beach (no sampling prior/post). The following applications were done in a pattern that went from the lower beach area (zone 2), parallel to the water and then up the beach to the next zone. Most of zones 5 and 6 were untreated when I departed.

The area to be treated by PES-51 was sometimes wetted first, the PES-51 injected, then the area flooded. At other times, the PES-51 crew was ahead of the water and the injection was done, followed anywhere from a few seconds to minutes later by the fire hose flushing. Injection sites were random (mostly dictated by where injection could be done due to the large boulders); flow rate of product was not controlled. The average application rate (over three applications) was 1 gallon/170 square feet. The first application we observed was done on a falling tide. Subsequent applications were on a rising tide. Prior to observations, approximately three to four gallons of PES-51 were applied during an equipment shakedown, this shake-down was mostly concentrated on the upper eastern quarter of the test area.

Sampling

The University of Alaska at Fairbanks (UAF) was contracted to sample the sediment, water column, and micro-biota prior to, during, and after the testing. They had been to the test and control beaches in June and done sampling. During the first part of the test they had two persons on-scene to conduct the sampling, Mark Tumeo and Tamara Venerator. Tamara was going to stay through the entire testing period.

The UAF team divided the beach into six zones, each 20' deep. Zone 1 started at the lower intertidal; zone 6 ended approximately 20-25' seaward of the upper storm berm. In each zone they collected a composite sediment sample from five places randomly spaced along the zone. The microbiology sample was a composite from all 30 holes. In addition, there were some "hot spots" that sediment samples were taken from. Water samples were collected as a composite from three places just offshore of the middle third of the zone, six inches below the surface. On the control beach UAF collected composite sediment samples from five places along zones 2, 4, and 6; the microbiology sample was a composite from all 15 holes, and water samples were again collected offshore.

During this testing period, the first samples were to be collected immediately prior to application, with another suite of samples just after the complete test. Water samples were to be taken after each application. Due to communication problems, samples were not taken for the "shake-down" and the eastern upper beach application (19-20 gallons), but were taken after the subsequent zonal applications.

Observations

Weather:

It rained intermittently during the testing period, winds were mostly out of the N to NE at 5-10 knots when PES-51 was being applied. A storm on the night of July 2 resulted in breaking off and stranding of fucus in the upper tidal area. No applications were conducted during stormy weather.

Application:

In general, the product was quite effective at liberating oil from sediments. As long as water was kept on the area where application had been made, surface sheens and free-floating brown/black oil could be seen.

During and immediately after application, strong citrus smells were in the area. By the following day, there was no smell of citrus except in the few "hot spot" areas. In these areas, if you turned rocks over you could smell limonene.

During the application, if you put your hand in the oily/water/PES-51 mixture, oil did not stick to your hand, what did stick was easily wiped off. Similarly, the mixture was not sticking or adsorbing onto the rocks (this was attributed to a biologically derived lipid/saccharine protein put into PES-51 specifically to keep it from sticking). By the next day, the oil would stick to your hand, as normal oils do.

The amount of surface oiling significantly increased after the first application (and all subsequent ones that I saw). This was probably due to the fact that the product was working well, but there were insufficient quantities of water to get the oil off the beach and into the water where it could be collected in the boom.

I documented and watched a patch of mussels in the lower intertidal and saw no obvious changes. The only obvious biological impact was the displacement of littorines, probably just from the pressure.

Light sheens filled the inner boom area within approximately one hour of the application (July 4). Some of the sheen entrained and moved to the east during all applications. Very little brown/black oily product was in the boom area (it was spread too thin by then).

Absorbent pads worked very well in absorbing the oily mixture.

For up to at least two hours after the application of PES-51, re-introduction of water liberated more oils/sheens. Since surface oiling was increased because of the previous application, it was hard to tell whether the PES-51 was still having any cleaning effect on the next morning with the introduction of plain water.

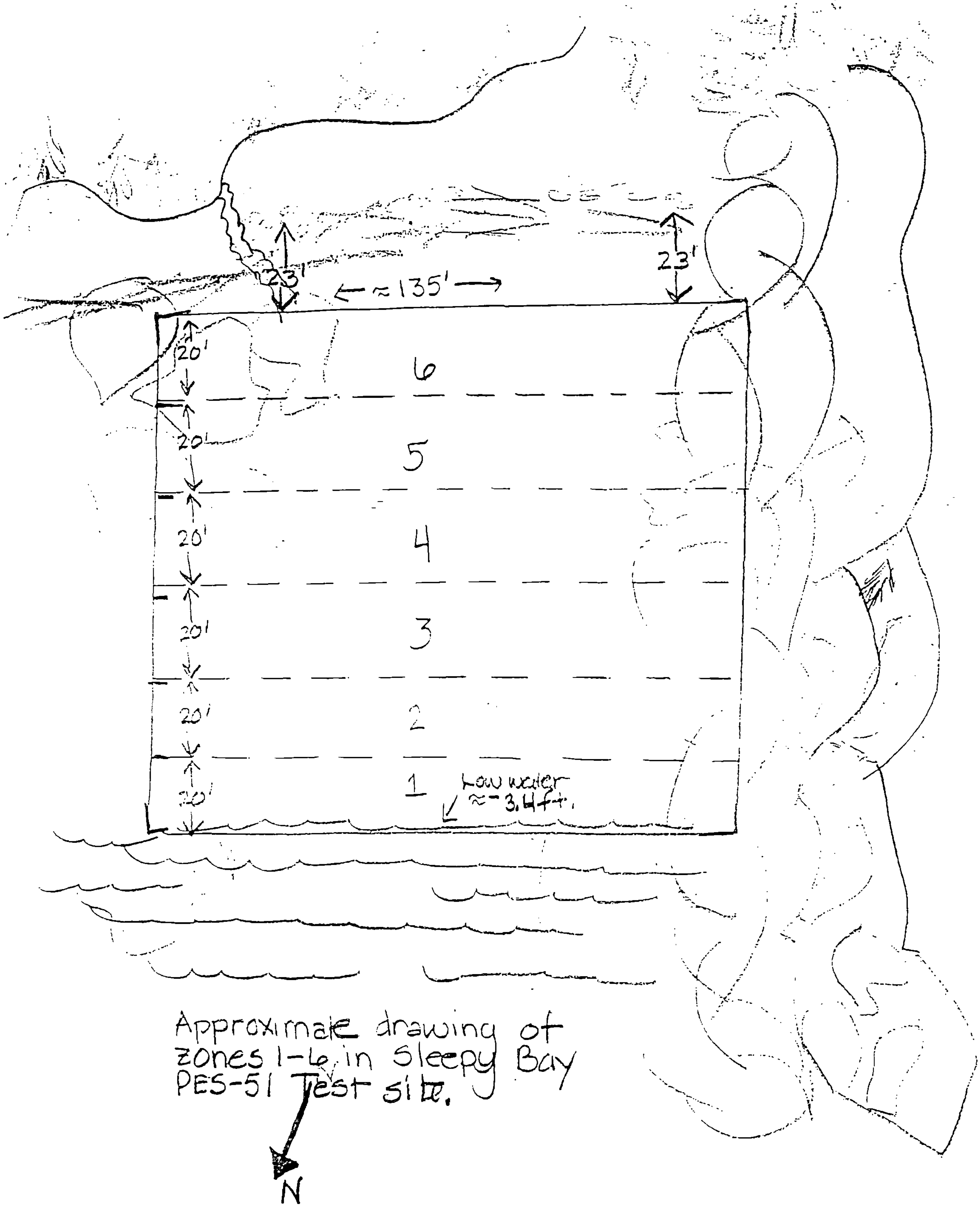
There seemed to be a general consensus that with more water, significantly less PES-51 would be needed.

Much of the floating product acted like it had a lot of surfactant; it didn't stick to things or even together and made discrete small droplets.

Some of the personnel applying PES-51 (the Chenega Corporation people), complained of headaches after the first application and requested respirators (organic vapor canisters) that they used for the remainder of the test. I did not notice anything other than dry hands and a slight headache from the smell (I am very sensitive to smells). The smell was pleasant, not offensive.

Conclusions

PES-51 appears to work very well at cleaning oil off rocky areas and out of substrates. This test addressed only effectiveness and was not designed so that any conclusions on environmental effects could be drawn. (Toxicity tests of PES-51 have been and are currently being independently conducted by Tesoro. As the next step in Tesoro's testing/marketing/review strategy of PES-51, Tesoro plans to compile all this effects data into a single volume.) PES-51 may be a valuable response tool if it proves to be relatively non-toxic, short-lived and not downwardly mobile. In addition, significantly greater quantities of water would be needed and careful attention must be paid to collection in the offshore area.



Approximate drawing of zones 1-6 in Sleepy Bay PES-51 Test site.

COMPENDIUM OF PES-51® AQUATIC TOXICITY DATA

Tesoro Alaska Petroleum Company, P.O. Box 190272, Anchorage, Alaska 99519-0272 (907) 561-5521 FAX (907) 561-5047

TABLE OF CONTENTS

I. INTRODUCTION

Petroleum Environmental Services, Inc. has prepared this compendium of aquatic toxicity data in an effort to provide a single source for this information. The compendium will be updated as more data becomes available.

As you review this information, please keep in mind that each toxicity test is different and requires its own interpretation. The brief interpretations are a general explanation of the results.

It should be noted that PES-51®, when used in accordance with the application instructions, has an "in the field" working concentration of less than 200 ppb. The dilution effect is created by the product application technique which involves instantaneous water deluge. Subsequently, the "in the field" toxicity of the product is greatly reduced.

Should any questions or comments arise from your reading of this information, please address then to:

Dennis C. Owens
PES, Inc.
P.O. Box 680488
San Antonio, Tx 78268-0488
210-680-2950 or 210-283-2644 Office
210-523-5700 Fax

II.STATE OF CALIFORNIA OIL SPILL CLEANING AGENT TOXICITY DATA

The toxicity tests required by the State of California utilize some of the more sensitive aquatic species. You will note that the average LC50 of 580 mg/l for acute toxicity is well above the States acceptance level of 400 mg/l for these tests.

It is interesting to note that the state requires that the product (neat) and the test oil (neat) as well as a product/oil mixture be tested for toxicity. The reasoning behind this testing is to insure that the product/oil mixture does not increase toxicity to the environment.

You will note that the product/oil mixture in these tests actually reduced the toxicity of the hydrocarbon by a thousand fold.

OIL SPILL CLEANUP AGENT TOXICITY TESTING

LAB NO.: V-9105003 CLIENT/ID: PETROLEUM ENVIR. SERV. PES-51™

Three test species, fathead minnow (pimphales promelas), inland silversides (menidia beryllina), and brine shrimp (artemia salinas), were exposed to various concentrations of the Osca product, Osca plus No. 6 fuel oil, and Osca plus No. 6 fuel oil after 20 days of degradation. Test procedures follow the protocols given in "Evaluating Oil Spill Cleanup Agents", Publication No. 43 of the California State Water Resources Control Board (CSWRCB) 1970 and verbal guidance provided by CSWRCB.

ACUTE TOXICITY OF AGENT TO AQUATIC ORGANISMS

SPECIES	WATER TYPE	24 HR LC50	48 HR LC50	96 HR LC50
P. promelas	Fresh (42 mg/l)	810 mg/1	810 mg/1	810 mg/1
M. beryllina	Sea (20 ppt)	100 mg/1	100 mg/1	100 mg/1
A. salinas	Sea (20 ppt)	980 mg/1	840 mg/1	N/A

Average LC50 (94 hr for fish + 48hr for Artemia): 580 mg/1 OSCA

ACUTE TOXICITY OF 1:5 MIXTURE OF OSCA AND #6 FUEL OIL TO AQUATIC ORGANISMS

SPECIES	WATER TYPE	24 HR LC50	48 HR LC50	96 HR LC50
P. promelas	Fresh (42 mg/l)	>1600 mg/1	>1600 mg/1	>1600 mg/1
M. beryllina	Sea (20 ppt)	>1600 mg/1	>1600 mg/1	>1600 mg/1
A. salinas	Sea (20 ppt)	>1600 mg/1	>1600 mg/1	N/A

Average LC50 (94 hr for fish + 48hr for Artemia): >1600 mg/1 OSCA

ACUTE TOXICITY AFTER 20 DAYS OF AGING AT 15°C OF 10 TIMES INITIAL 96 HR LC50 CONC.

SPECIES	Pimephales promelas	Menidia beryllina	Artemia salinas
OSCA + #6 Fuel Oil	100% Surv. @ 1600 mg/l	85% Surv. @ 1600 mg/l	0% Surv. @ 1600 mg/l

OSCA = 10,000 mg/l of the 1:5 OSCA to #6 Fuel Oil Mixture (highest conc. used).

* Tests were conducted by Enseco, Ventura, California.

III. U.S. EPA NCP LISTING TOXICITY DATA

The results of these tests are very similar to the California toxicity tests with the same organism. The only difference in the tests involve different hydrocarbons ,#2 fuel oil instead of #6 fuel oil.

Additionally, this test contains data on the toxicity of the hydrocarbon. Under normal conditions, the results of the product/oil mixture would be an average between the two numbers (eg. 665 and 58) however, the mixture exhibits a reduction of toxicity by a thousand fold. The reduction in toxicity is directly due to the PES-51 product's ability to form a interfacial barrier that reduces the water soluble toxic fraction to enter the water column. This phenomeum is unique to this product and caused the EPA to request that the tests be rerun several times in order to verify that this action was for real.

STANDARD DISPERSANT TOXICITY REPORT

Client: Petroleum Environmental Services
P.O. Box 680488
San Antonio, Texas 78268-0488

Testing Facility: United States Testing Company
Biological Services
1415 Park Avenue
Hoboken, New Jersey 07030

Sample Description, Handling & Stability: Sample identified by Client as Petroleum Environmental Service's PES-51 oil spill dispersant: Chemical composition proprietary. Pale yellow, mobile liquid, pale reddish-brown sediment, with with a strong citrus odor. Sample stored in original sealed container, considered stable.
Received 2/ 3/92.

Project: 48 hour acute toxicity versus *Artemia* sp. (brine shrimp). Toxicity of PES-51 alone, PES-51 + #2 Fuel Oil, #2 Fuel Oil alone, and Dodecyl Sodium Sulfate.
Test dates 5/13 - 15/92.

Summary of Results: Acute toxicity, expressed as LC50, is as follows:

PES-51	PES-51 + #2 Fuel Oil	#2 Fuel Oil	DSS
665 ppm	1,542 ppm	58 ppm	5.0 ppm

STANDARD DISPERSANT TOXICITY REPORT

Client: Petroleum Environmental Services
P.O. Box 680488
San Antonio, Texas 78268-0488

Testing Facility: United States Testing Company
Biological Services
1415 Park Avenue
Hoboken, New Jersey 07030

Sample Description,
Handling & Stability: Sample identified by Client as Petroleum Environmental Service's PES-51 oil spill dispersant: Chemical composition proprietary. Pale yellow, mobile liquid, pale reddish-brown sediment, with with a strong citrus odor. Sample stored in original sealed container, considered stable.
Received 2/ 3/92.

Project: 96 hour acute toxicity versus Fundulus heteroclitus (killi fish). Toxicity of PES-51 alone, PES-51 + #2 Fuel Oil, #2 Fuel Oil alone, and Dodecyl Sodium Sulfate.
Test dates 3/5 - 14/92.

Summary of Results: Acute toxicity, expressed as LC50, is as follows:

PES-51	PES-51 + #2 Fuel Oil	#2 Fuel Oil	DSS
1,425 ppm	5,650 ppm	5,200 ppm	7.1 ppm

IV.U.S. EPA TOXICITY DATA

-__*Oncorhynchus mykiss*__ (Rainbow trout)

These toxicity test are very sensitive due to the fact that the test organisms are juvenile fish (<8 weeks old). Factors such as age and small size generally maximize toxic effect, numerically expressed as the LC50.

There was no significant difference in the response of __O.mykiss__ to USEPA #2 Fuel Oil and to PES-51 in the presence of USEPA #2 Fuel Oil. The 96hr __O.mykiss__ LC50 for PES-51 was determined to be 98 ppm (see USTC Report #065505-1). The 96hr LC50 for both PES-51 + #2 Fuel Oil and #2 Fuel Oil alone was determined to be approximately 500 ppm.

PES-51 in a working mixture of #2 Fuel Oil does not pose a significant toxic threat to this test organism.

-__Crassostrea gigas__ (Pacific oyster) and __Mytilus edulis__ (Bay mussell)

The oyster larvae exhibited an EC50 value of 19 ppm when exposed to PES-51®. PES-51, in the presence of oil, yielded and EC50 of 128 ppb. #2 fuel oil was toxic to oyster larvae at 185 ppb. As with the trout, mysids and urchins, these results demonstrate an expected trend; PES-51 was less toxic than PES-51 plus oil.

The oysters were less sensitive than the urchin to PES-51. This is due to organism life stage. Urchins were tested by first exposing the sperm for one hour, and then adding the eggs; the oyster sperm and egg were mixed together for one hour before exposure. The oysters were exposed as fertilized embryos, and the urchins were not.

The mussel larvae exhibited and EC50 value of 9 ppm when exposed to PES-51. This result was, as expected, very similar to the result of the oyster larvae test (EC50= 19 ppm).

Under actual field use conditions PES-51 will average concentrations of less than 200 ppb, under correct application methods (i.e. immediate water deluge).

United States Tes[illegible] Company, Inc.

Report# 065505-4
PES-51

AQUATIC TOXICITY TESTING REPORT

Client: Petroleum Environmental Services, Inc.
P.O. Box 680488
San Antonio, Texas 78268-0488

Testing Facility: United States Testing Company
Biological Services Division
1415 Park Avenue
Hoboken, New Jersey 07030

Sample Description, Handling & Stability: Sample identified by Client as PES-51: Organic Biocleanser, chemical composition proprietary. Yellow, mobile liquid, with a strong citrus odor. Not water soluble. Sample stored in original sealed container, at room temperature, considered stable.
Sample received 3/26/93.

Project: Larval Development vs Bay Mussel (*M. edulis*)

Test Dates: 5/28 - 30/93

Summary of Results: 48hr EC50 = 9.6 ppm
No Observed Effect Concentration = 3.125 ppm

AQUATIC TOXICITY TESTING REPORT

Client: Petroleum Environmental Services, Inc.
P.O. Box 680488
San Antonio, Texas 78268-0488

Testing Facility: United States Testing Company
Biological Services Division
1415 Park Avenue
Hoboken, New Jersey 07030

Sample Description, Handling & Stability: Sample identified by Client as PES-51: Organic Biocleanser, chemical composition proprietary. Yellow, mobile liquid, with a strong citrus odor. Not water soluble. Sample stored in original sealed container, at room temperature, considered stable. Sample received 3/26/93.

Project: 96 Hour Acute Toxicity of PES-51, in the presence of #2 Fuel Oil, versus Rainbow Trout (*O. mykiss*)

Test Dates: 6/24 - 28/93

Summary of Results:

PES-51 + #2 Fuel Oil	96hr LC50 = 500 ppm NOEC = 250 ppm
#2 Fuel Oil	96hr LC50 = 518 ppm NOEC = 250 ppm
PES-51	96hr LC50 = 98 ppm * NOEC = 62.5 ppm *

* see USTC Report #065505-1

AQUATIC TOXICITY TESTING REPORT

Client: Petroleum Environmental Services, Inc.
P.O. Box 680488
San Antonio, Texas 78268-0488

Testing Facility: United States Testing Company
Biological Services Division
1415 Park Avenue
Hoboken, New Jersey 07030

Sample Description, Handling & Stability: Sample identified by Client as PES-51: Organic Biocleanser, chemical composition proprietary. Yellow, mobile liquid, with a strong citrus odor. Not water soluble. Sample stored in original sealed container, at room temperature, considered stable.
Sample received 3/26/93.

Project: Larval Development vs Pacific Oyster (*C. gigas*)

Test Dates: 5/21 - 23/93

Summary of Results: 48hr EC50 = 18.7 ppm
No Observed Effect Concentration = 6.25 ppm

AQUATIC TOXICITY TESTING REPORT

Client:	Petroleum Environmental Services, Inc. P.O. Box 680488 San Antonio, Texas 73268-0488
Testing Facility:	United States Testing Company Biological Services Division 1415 Park Avenue Hoboken, New Jersey 07030
Sample Description, Handling & Stability:	Sample identified by Client as PES-51: Organic Biocleanser, chemical composition proprietary. Yellow, mobile liquid, with a strong citrus odor. Not water soluble. Sample stored in original sealed container, at room temperature, considered stable. Sample received 3/26/93. #2 Fuel Oil: USEPA Reference Oil (lot WP-681), obtained through Fisher Scientific.
Project:	Larval Development vs Pacific Oyster (*C. gigas*) PES-51 in the presence of #2 Fuel Oil
Test Dates:	5/21 - 23/93

Summary of Results:

PES-51 + #2 Fuel Oil:	48hr EC50 = 127.7 ppb No Observed Effect Concentration = 62.5 ppb
#2 Fuel Oil:	48hr EC50 = 185.3 ppb No Observed Effect Concentration = 62.5 ppb

5ML

U. S. COAST GUARD MARINE SAFETY OFFICE VALDEZ, ALASKA

REPORT ON:

TESORO ALASKA PETROLEUM CO.

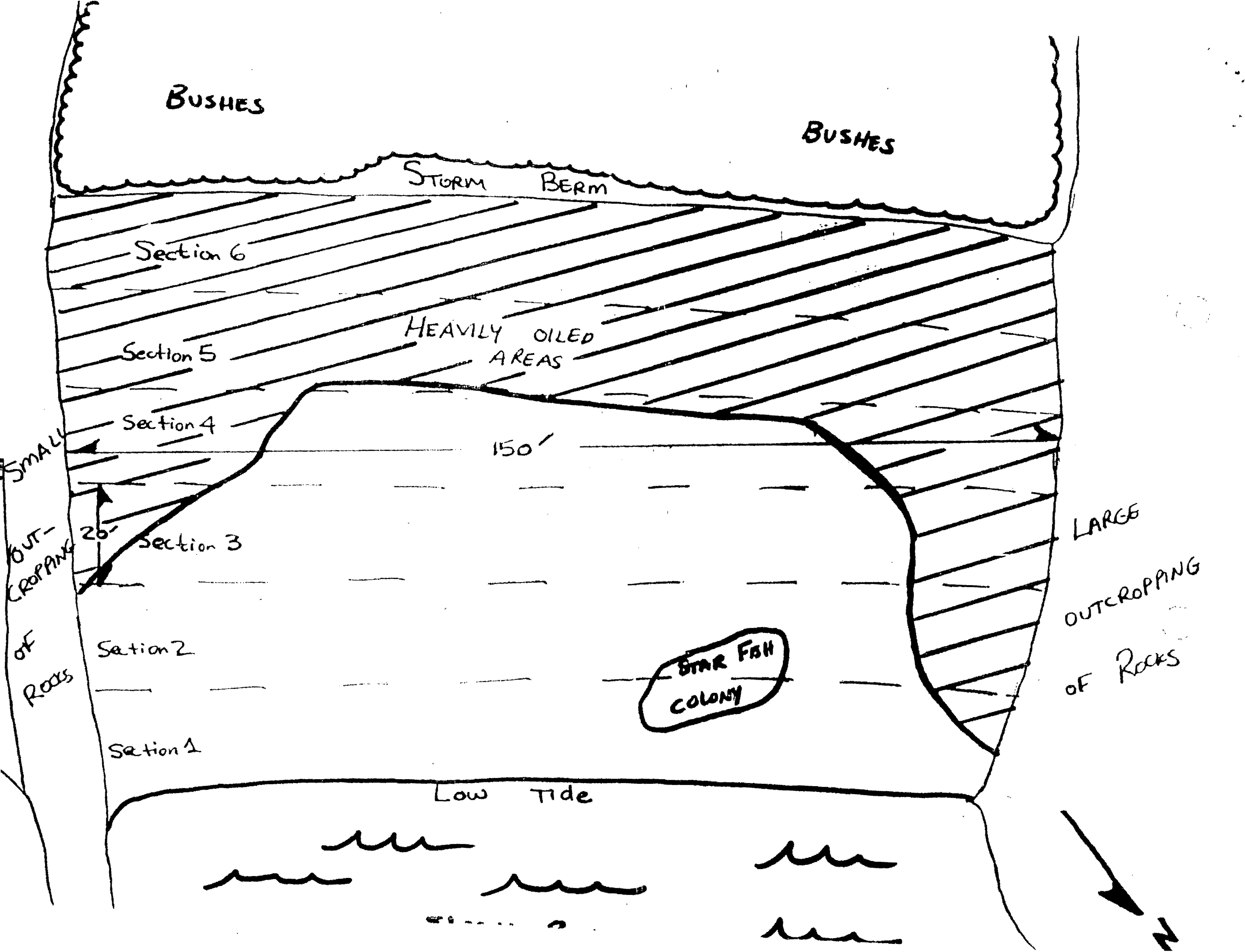
PES-51 DEMONSTRATION

SLEEPY BAY, LATOUCHE ISLAND

July 1-6, 1993

BY

MST1 Michael Rudolph


BUSHES
BUSHES
STORM BERM
Section 6
HEAVILY OILED AREAS
Section 5
Section 4
150′
SMALL OUT-CROPPING OF ROCKS
20′
Section 3
LARGE OUTCROPPING OF ROCKS
Section 2
STAR FISH COLONY
Section 1
LOW TIDE
N

PARTIES INVOLVED:

Tesoro: Steve Rog: Senior Project Manager
Dennis Owens: PES-51 Developer
Mike High: Marketing Rep.
Chuck Green
Richard Wright: Tesoro Consultant

Martech USA: Don Orvis and 2 workers

USCG: MST1 Michael Rudolph
ADEC: Leslie Pearson
NOAA: John Whitney
UAF: Dr. Mark Tumeo and Tamara Venotor
TCS Video: Jerry Lavine
Journalist: Natalie Fobes
RCAC: John Hayes
Chenega Natives: Chuck Totemoff, Gail Evanoff and 6 workers

INTRODUCTION:

Tesoro Alaska Petroleum Company proposed to the Hazardous Materials Research Council to conduct a shoreline cleaning/habitat restoration demonstration of an area of beach in Sleepy Bay on Latouche Island that was heavily oiled during the *Exxon Valdez* oil spill. In 1992, the ADEC Spill Response Office Survey identified numerous shorelines in Prince William Sound that still contain significant amounts of oil. The survey reported that it is obvious that this impacted area is not naturally cleaning up and requires assistance to be returned to its near natural condition.

The product that was used for the demonstration is titled PES-51. PES-51 is made up of bacteria by-products and sugars and part-sugars. In approximately 96 hours after application, it is nearly 100% biodegradable. The product has two opposite ends to its molecule to provide the means for moving the oil. One end is hydrophilic (water loving) and attaches to a water molecule while the other end is oleophilic (oil loving) and attaches to an oil molecule. With adequate flushing of cold water, the oil is moved to a place for better recovery. PES-51 also provides a protective film when sprayed on shoreline or other surfaces. The film does not allow the oil to cling or stain the areas that were treated. PES-51 will not allow the oil to disperse into the water column and also prevents oil from emulsifying into a difficult to recover mousse (additional chemical information can be obtained by calling Dennis Owens at 1-512-680-2950).

APPLICATION/RECOVERY:

Initial surveys of the shoreline of Sleepy Bay in June revealed that significant quantities of oil still remained trapped in the substrate imbedded within layers of cobble, rocks and dense sand. The larger amounts of oil were evident near the large boulders between two outcroppings on the beach. These boulders were near the upper tidal zone and extended further up the beach.

PES-51 can be applied in a number of ways. For example, it can be applied using a fog application or hand sprayer for surfaces, or injected using an air knife or well point into the substrate. Then flushed with copious amounts of water, the combination of the water and PES-51 provides an impressive vehicle for the oil to move.

The techniques applied to the Sleepy Bay project were that two air knives would be utilized along with a hand held fire extinguisher sized bottle of PES-51. Then, at least one water hose per air knife providing cold water flushing. The air knife effectiveness was impressive in that it could penetrate the closely packed rocks up to three feet deep, then with high pressure air, literally lift an area of rocks four feet in diameter (see photo #8). Once the air knife was in place, a small injection (approx. 4-8 oz.) was injected into the substrate. All the time, continuous cold water flushing was used to penetrate and move the oil. After the injection, it was just a matter of a few seconds before oil would start to flush out of the rocks. The method that worked the best was to conduct the injections along the waters edge and move further up the beach with the incoming tide. The wave action and tide provided the penetration and water necessary to give the best flushing.

The PES-51 injections were conducted for five days. The first and part of the last day was used for setup and demobilization of equipment. It took approx. 4-6 hours to set up the containment boom, hoses, pumps, air knives, and recovery systems the first day. For the subsequent days, it took only thirty minutes to an hour for setup. The technique that seemed to work the best was to have at least two hoses flushing a section before it was to be treated, then inject the PES-51, and have the hose continue to flush for several minutes thereafter until the oil stopped flowing (see photo #13). In some of the hot spots, this flushing was done nearly all day long and the oil was still leaching out of the rocks.

The large boulders on the beach had large amounts of oil trapped underneath. The PES-51 penetrated underneath the rocks, where no human hands could go, and flushed the oil out and away to where it could be recovered (see photo #9).

Once the oil was flowing out of the rocks and down the beach, mechanical cleanup began. Sorbent pads and sweeps were the primary sources of cleanup and much of the oil was recovered in small pools before it reached the water. But, when the tide rose higher and more of the heavily contaminated sites were treated, a thick (1/8-1/4") black and tarry film was present on the surface of the water contained within sorbent sweeps and the containment boom. A manta ray skimming system was used to recover oil on the water which was not effective enough for this project. A belt type or Desmi skimming system would have been much more efficient in the recovery of oil. However, approx. 250 gallons of oil was recovered by the skimmer, in only 2½ of the 5 days that it was used. In addition to the skimmer, 20 bales of sorbents, 5 rolls of sweeps, 300' of sausage boom and one box (containing 6) of sorbent pillows were used for recovery. Most of the sorbent material used in this project was saturated almost completely. An important note, PES-51 allows for sorbent material to become supersaturated (actually holding more than its capacity) and therefore improves the performance of the sorbents.

An important point that should be considered regarding the nature of this demonstration is that the oil used has weathered for over four years. Most of the oil was very tarry, yet the product worked remarkably well in moving the oil. How would this product work on a fresh oil spill? In speculation, I feel the evidence is there that it would work with greater efficiencies. During this project, less than 3 drums of product was used (less than 165 gallons for 18,000 square feet). Which computes out to 110 square feet per gallon of product used. In previous laboratory tests, one gallon would treat 200 square feet. So, even in a difficult field test, the efficiency was comparable with controlled laboratory tests.

On day 4, after high tide, there was a black, oil and tar ring around the rocks. One of the workers took a hand sprayer and treated this oily ring before the tide came in. When we came back the next day, only the sections that weren't treated with the hand sprayer, had traces of oil on the surfaces of the rocks. The "bathtub" ring was gone.

This product can also be used to decon equipment. When it came time to demobilize our gear, we sprayed some product on the boom and skimmer. With one water hose and two people wiping it clean, we cleaned the entire 500' of boom in less than an hour, which would have taken several hours without the product.

CONCLUSION/RECOMMENDATIONS:

With gained knowledge and technological advancements in the application process of PES-51, it can be a very effective tool in the cleaning of shorelines that have been impacted with oil. The product utilized cold water flushing that minimizes the shock placed on organisms in the tidal zone, and has a pour point of -50° F. So it can be said that it is "cold-loving". In comparison to a steam cleaning system or the use of heavy equipment to clean a shoreline, the equipment needed for use of PES-51 took only 4-6 hours to setup and with an experienced crew can be accomplished in half the time.

If this product were to be used in the field again, some more attention should be directed to the on water response. A manta ray skimmer and sorbent material did not meet the task. A more efficient skimming system such as one that uses a belt system or a powerful Desmi skimmer should be used. At least one work boat should be used for tending the boom and equipment used in the response.

Another area of improvement needed is bigger pumps for the flushing of water. The pumps utilized had only 2" connections. A pump that has at least a 4", preferably 6", connections attached to a header pipe used to constantly flush the sections of beach should be used. Then, the smaller fire hose type of hoses, could be used to follow behind the air knife injections.

Communications were a problem. Hand held comco's should be used in the future. It was difficult for the beach crew to communicate with the pump operator. This will also make the operation more safe.

The only question that still remains is the toxic data information that will come out in the UAF reports. The results on how it affects organisms in the intertidal zone will be the determining factor if this product should be used in future applications. Laboratory studies conducted in the past on its toxicity have shown that it has very little toxicity and affects on organisms (Dennis Owens, Tesoro Environmental Products).

Overall, the product performed exceptionally well. Judging from previous shoreline cleanup plans, this one was unique in that it accomplished what it set out to do. Personally, I was impressed and overwhelmed at the amounts of oil it was flushing out of the rocks and the ease and versatility of its application. Pending the results of the UAF reports, this product may be recommendation for use, given substantial circumstances where mechanical cleanup is not feasible and shoreline impact is imminent or in the case where oil has already impacted the shoreline and cleanup measures are being considered.

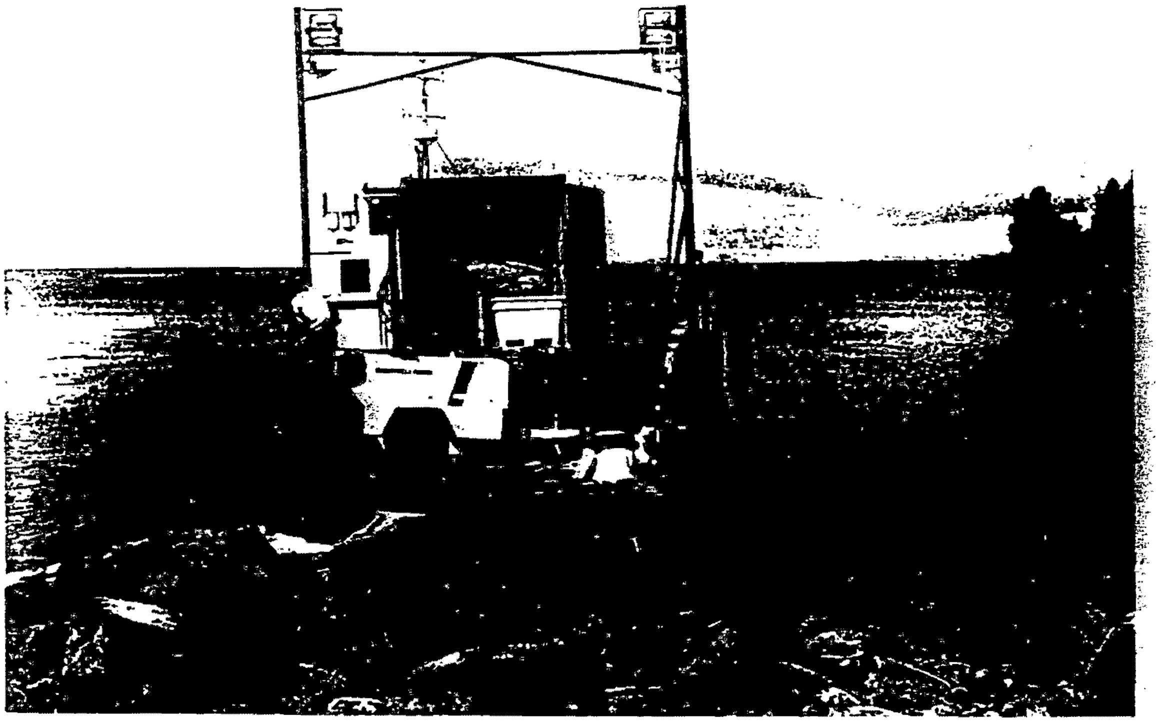


Photo #1

The landing craft Blue Fox was utilized as the supply vessel and working platform for pumps and the air compressor. A landing craft with more deck space or even an additional vessel could benefit future operations. This vessel proved to be too small and congested once all equipment was deployed and operating.

Photo #2

After moving just a few rocks, oil could be seen below the surface.

Photo #3

There were several sections of beach that looked like this photo. With a sheen evident and stained soil under the rocks.

Photo #4

This photo was taken at the base of a group of large boulders. Stained rocks and oil is visible beneath the rocks.

Photo #5

The area of land beyond the containment boom was not treated with PES-51, but the driftwood poles mark hot spots where oil was visible beneath the rocks.

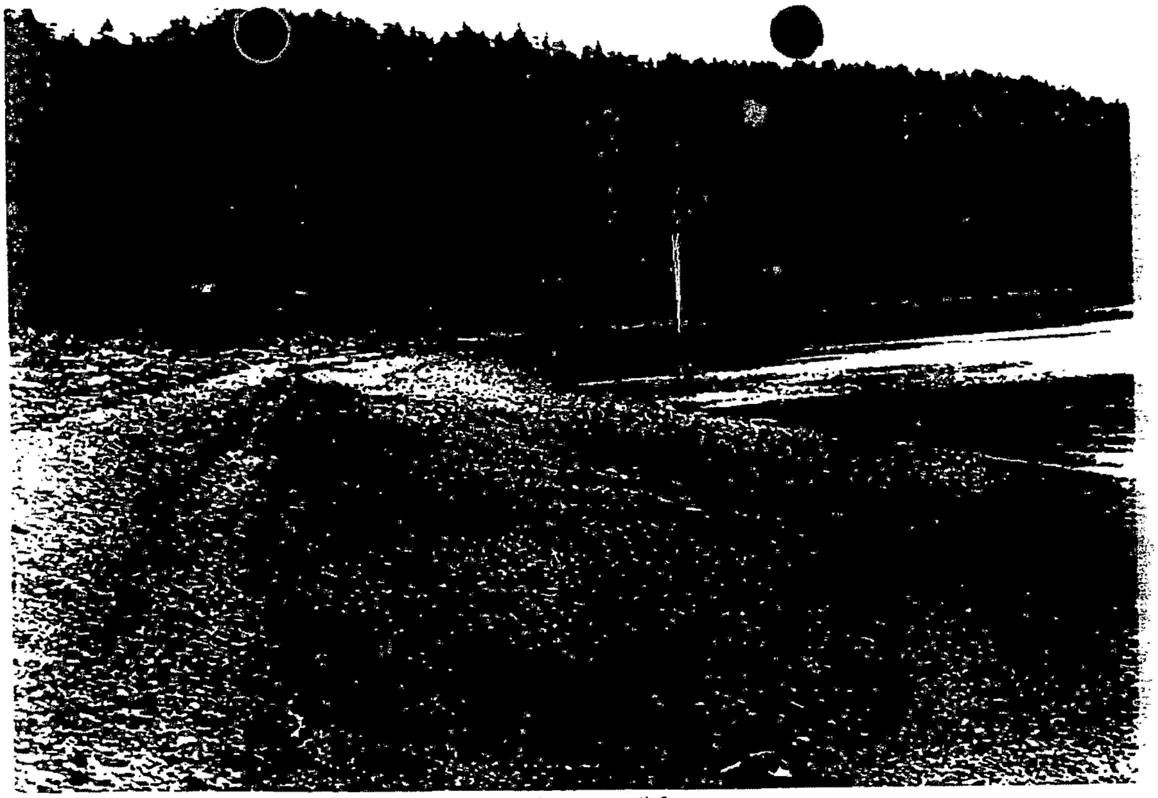


Photo #6

To provide comparison of past techniques of shoreline cleanup, this photo depicts a section of Sleepy Bay on the other side of the large outcropping to the north, that was heavily bioremediated, tilled, and steam cleaned during past restoration projects. As this photo points out, the beach is literally sterile. There are no barnacles, muscles, starfish, or other visible organisms. And there are no large rocks on this section of beach, as there are on the rest, due to the affects of heavy equipment mechanical cleanup techniques.

Photo #7

Dr. Tumeo, University of Alaska-Fairbanks, along with Tamara Venotor took hundreds of samples of the areas treated and areas not treated by PES-51. Additional sampling will continue monthly until July 1994.

Photo #8

Michael High, Tesoro Alaska, operates an air knife and PES-51 can. Constant cold water flushing is the key to making this product work efficiently on rocky shorelines like Sleepy Bay.

Photo #9

After the PES-51 was injected, the oil flowed, or more appropriately, bled out of the rocks. Here a relatively small concentration of oil has pooled at the base of a boulder.

Photo #10

A Chenega village worker sops up oil using sorbent pads. Notice the trail of soiled rags in the foreground.

Photo #11

This outcropping of large boulders held a large concentration of oil beneath the surface.

Photo #12

At the base of the large boulders, oil would pool into highly concentrated puddles. It was necessary to change out pads about every 3-8 minutes when it was this thick.

Photo #13

Through trial and error, many techniques were improved during the week. Such as this photo displays, at least two hoses were used to constantly flush the area, then the air knife injected the PES-51 into the ground, while another person tended the bottle and air line.

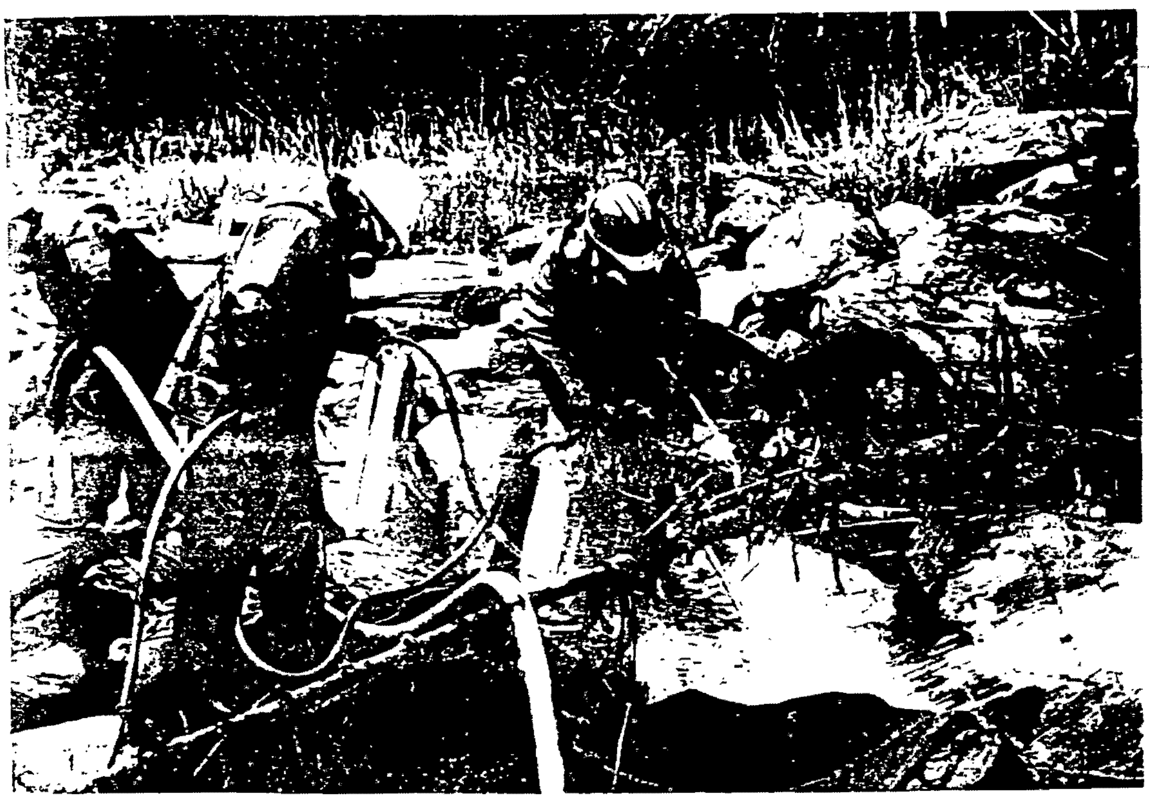


Photo #14

Another photo of the efficient technique developed for the application.

Photo #15

Notice the pooled oil that has flown out of the subsurface.

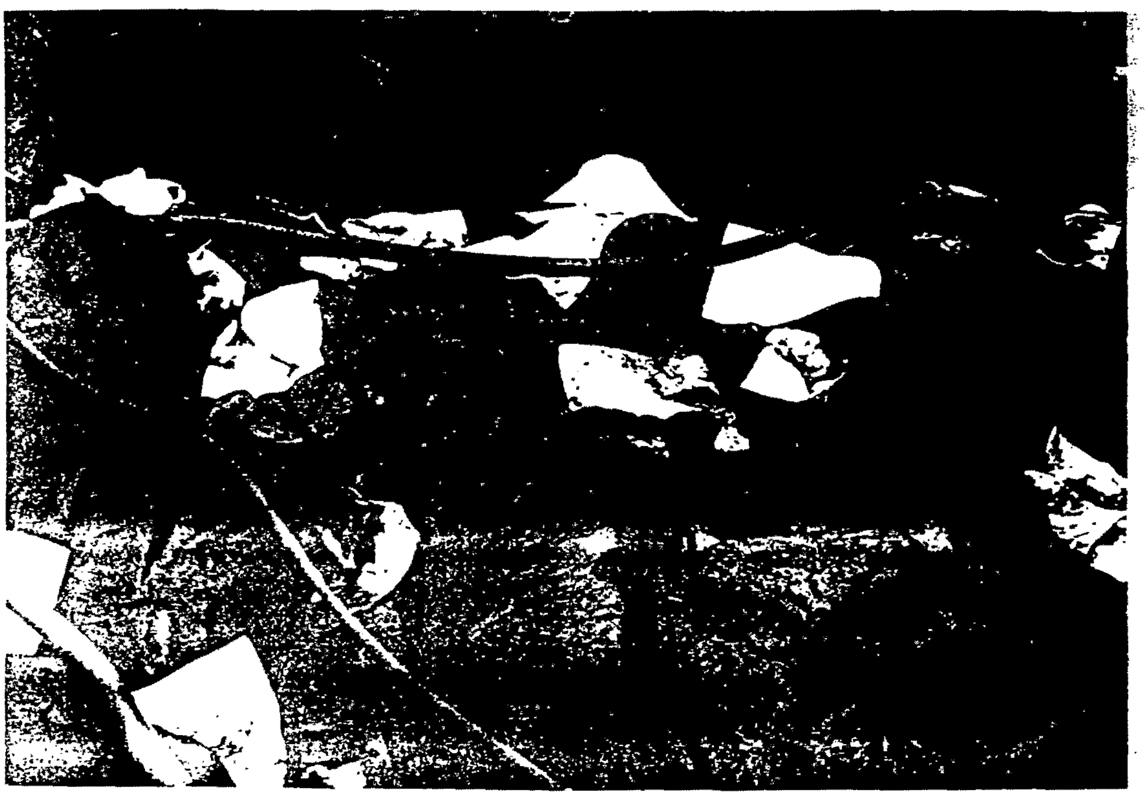


Photo #16

In the center of this photo, you can see a pad that has become so saturated with oil, it looks just like the black rocks.

Photo #17

Dennis Owens, Senior Scientist for Tesoro Environmental Products Co., was on hand to provide chemical and toxical data on PES-51.

Photo #18

The following photos of organisms were taken on days 5 & 6 of the operation. Well into the application period of PES-51. The organisms appeared to be unaffected by our presence during the week.

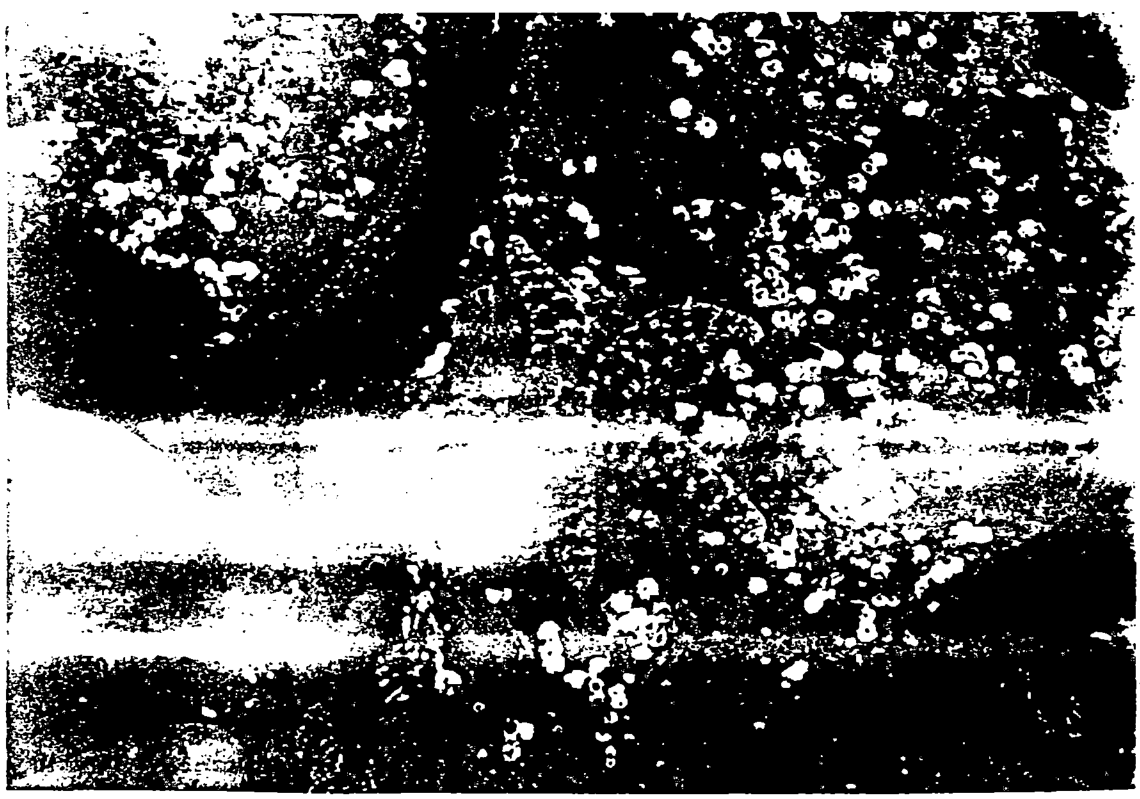


Photo #19

Starfish in lower tidal zone. -

Photo #20

A group of sea anemones were located in a tide pool on a large boulder in the midtidal zone. They, too, appeared to be unaffected by our presence.

Photo #21

Senior Project Manager Steve Rog.