CHAPTER VII

Research and Development

The clear inadequacy of existing methods for locating and cleaning spilled oil on the water and for cleaning the shoreline led the Corps of Engineers to focus its research and development expertise and resources on these problems. Soon after President Bush called on the Defense Department to support the cleanup efforts, the Research and Development Directorate, HQUSACE, asked all Corps laboratories to provide information on the kind of expertise they could offer and the potential contributions they could make to the cleanup.

Two Corps laboratories, the Waterways Experiment Station (WES) in Vicksburg, Mississippi, and the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire, were particularly well qualified to provide technical assistance to the cleanup. WES had conducted research on the disposal of contaminated materials and the long-term effects of dredging operations and had provided support to DOD and EPA in hazardous and toxic waste cleanup activities. The laboratory had extensive experience dealing with hazardous and toxic materials and contaminated sediment.

CRREL had conducted studies of the biodegradation of Prudhoe Bay crude oil in Arctic environments and had been involved with the Environmental Protection Agency in Alaska in the long-term evaluation of crude oil spills on terrestrial environments. It was also studying a naturally occurring bio-organism that fed on oil seeps on the North Slope. In 1976 CRREL participated in two experimental spills in Alaska. Scientists applied two thousand gallons of hot Prudhoe Bay oil through a thirty-foot-long perforated pipe to one plot in February and the same amount to another plot in June. For the next three years they carefully monitored the sites to determine the effects on vegetation and soil properties.

CRREL also had ongoing research in the area of remote sensing. Through the Civil Works Remote Sensing Research Program, CRREL had developed a technology that could be applied in Alaska. The program sought to expand the use of data from remote sensing in implementing the Corps' water resource mission. At the time of the spill the Corps could process, store, analyze, integrate, and retrieve aircraft and satellite data quickly and then display graphically the products using prototype software. The system was already being used in a flood impact study in the Corps' Baltimore District and in a real-time flood forecasting model under development in Little Rock District.[1]

HQUSACE designated CRREL as the lead laboratory to coordinate all Corps research activities relating to the Alaska oil spill and to insure that all relevant laboratory resources were considered. Robert Oswald, Director of Research and Development, HQUSACE, directed CRREL to develop a proposal to support the National Oceanic and Atmospheric Administration's long-term environmental monitoring program, a strategy for direct technical support to the Coast Guard in areas of remote sensing and oil spill dispersion modeling, and a strategy for direct support to North Pacific Division and Alaska District, along with Corps headquarters EOC activities.

The Corps' research and development community outlined potential contributions that laboratories might make to the cleanup. WES said it could do some advisory work on shoreline cleanup, and CRREL offered to do remote sensing. At briefings in HQUSACE on 11 April and 27 April, research and development officials outlined their plan to process remote sensing data available in Alaska and use it to highlight the oil slicks on a ship's radar. General Kelly and Assistant Secretary Page enthusiastically supported the plan.[2]

In a spill the size of the *Exxon Valdez* spill, it was much easier and less expensive to recover oil while it was on the water, before waves and currents and natural dispersion made recovery more difficult. Use of multispectral sensors (sensors that simultaneously sense data in a number of energy bands) would enable scientists to locate and map the distribution of oil over large areas and therefore enable operators to recover it more rapidly.

Oil on water can be detected through a combination of sensors. Side-looking radar detects oil because oil damps the wave action and reduces radar return. Optical sensors, which measure reflected light in the ultraviolet, blue-green, and intermediate infrared bands, allow the detection of oil because of the differences in the amount of solar energy reflected from the oil and from uncontaminated water. Thermal infrared sensors have also been successful in detecting oil. Using a mixture of these sensing techniques in a multispectral sensing package offered the greatest probability of accurately detecting oil.

Multispectral sensors on satellites, such as Landsat Thematic Mapper, had the appropriate spectral bands for sensing oil over a large area, but satellite sensing did not occur on a daily basis, which was essential. However, for oil spill operations, aircraft-based multispectral systems could provide data appropriate for processing with the CRREL capability. The aircraft that had both the proper sensing capabilities and video capability were a Falcon jet owned by Innotech, Ltd., which had MEIS II and a Daedalus multispectral scanner, and two Twin Otters with dual ultraviolet and thermal infrared images. Exxon had contracted these aircraft, which were in Valdez flying on almost a daily basis. The Innotech aircraft concentrated on beach and shoreline, while the Twin Otters flew over open water.

Exxon hired the Innotech Falcon jet, which had been flying for Environment Canada, to survey shorelines in Prince William Sound and the Gulf of Alaska. It was collecting all of the frequency range spectral data that the Corps scientists needed for their image processing system. The Falcon recorded a portion of the information on a VHS videotape, which had to be digitized before it could be entered into CRREL's processing system. Although Exxon collected the remote sensing data, it had no capability to process that data in Alaska, so it relied primarily on visual sightings.[3]

CRREL proposed that its personnel periodically receive imagery from the Exxon-directed aircraft in a VHS videotape format. Then CRREL and Joint Task Force officials would review the videotape information and enter the appropriate data into CRREL's Apple MacIntosh computer system. CRREL would correlate the tape outputs with LANDSAT

data through its software program to develop a map indicating the degree of shoreline contamination and oil contamination on the water. Once processed, the data would be entered into the JTF's computer system for use in decision making. The goal was to install the necessary computers on large vessels, such as the dredges, and then to use the computer programs to guide the vessels toward large concentrations of oil. Scientists, however, did not yet have the ability to image the data and put it rapidly into a management system for decision makers. No procedure had been devised to get information on the location of oil to cleanup vessels in a timely manner.[4]

At the request of the Corps, on 27 April the Director of Military Support issued a formal tasking to CRREL to use its remote sensing research and available resources to delineate the extent and relative thickness of the oil on the water and shoreline. After verifying the information obtained from the aircraft scanners and from photographs taken by helicopters, it was to process the data and produce and display graphic images indicating the distribution and relative thickness of oil. CRREL was then to provide this information to the Joint Task Force.[5]

The next day CRREL began establishing a support team at the Joint Task Force headquarters at Elmendorf AFB to carry out its mission. Other team members, headed by Dr. Harlan "Ike" McKim, arrived in Anchorage over the weekend 30 April–1 May and began setting up and testing their equipment. Meanwhile, the technical director of CRREL, Dr. Lewis E. Link, Jr., contacted the Division Engineer in North Pacific Division, General Stevens, to make sure that CRREL got the necessary aerial support to obtain the imagery they needed to provide remote sensing products tasked by DOMS. Proper aerial support, he explained, was "critical" to the successful completion of their mission.[6]

The CRREL people quickly arranged for a room to set up their equipment at Elmendorf AFB. Most of the equipment arrived in Anchorage late in the afternoon on 4 May, and team members spent the next few days setting up their systems. The biggest problem that CRREL personnel faced was their inability to obtain data from aircraft and satellite sensors in a compatible format and the lack of an automated

system to transmit the final oil spill map to the vessels doing the cleanup.[7]

In addition to the CRREL team, General Kelly sent two scientists from WES to Alaska to provide technical assistance. Their specific mission was to assess the effectiveness of current shoreline cleanup methods. Dr. Ray Montgomery, Chief, Environmental Engineering Division, and Dr. Conrad J. Kirby, Chief, Environmental Resources Division, went to Alaska on 2 May. The high rank of the scientists was an indication of the importance that officials in headquarters placed on their mission.

On 3 May Kirby and Montgomery met with Jacob Redlinger and James Reese from North Pacific Division and CRREL's Ike McKim. They visited the Alaska District offices where officials briefed them on the status of the cleanup operations and the District's involvement. Colonel Kakel expressed concern that the presence of the research and development people would worsen an already tense situation. The scientists had arrived at a politically sensitive time because of Vice President Quayle's visit and because of friction between various government agencies. They quickly became aware of the political sensitivities in Alaska and found it difficult to coordinate with other agencies. One CRREL team member cautioned, "The political situation here is one of vast fields of eggshells."[8]

Despite their best efforts, the Alaska District staff was unable to get the scientists into the field for the first few days because of Quayle's visit and because the logistics were difficult. Team members were frustrated by the delays, but they quickly went to work helping District personnel review the newly released drafts of Exxon's 1 May Waste Management and Shoreline Restoration plans.[9]

On 4 May the WES scientists continued to review potential methods for shoreline cleanup and acquired more information on Exxon's cleanup activities. The next day Kirby, Montgomery, McKim, Redlinger, Reese, and Guy McConnell flew by float plane to the U.S.S. *Juneau*, anchored a short distance from the Smith Island shoreline cleanup activities. The team went from there on a Navy boat to Seal Rock Cove and another beach on Smith Island that crews had flushed for days with hot and cold water. Crews had also wiped the

beach by hand with absorption materials. Both beaches had a high priority because they would be used for seal pupping. Because of Vice President Quayle's visit to Smith Island the previous day, the cleanup crews had worked long hours, so they did not leave the *Juneau* until about noon and then took a lunch break when they got to the beach. As a result, the team did not witness any actual cleanup work. Conversations with workers, however, indicated that they did not think their cleanup efforts were effective.

The Corps' scientists concluded that the hot water flushing and cold water flushing methods had been somewhat effective in removing surface ponded oil but not in cleaning oil that had seeped into the cobble and gravel materials below the surface. When they dug into the beaches, they found significant amounts of oil below the surface. Despite six to eight passes of hot and/or cold water flushing, considerable amounts of oil remained on the beach. Thus the team concluded that the effectiveness of the cleaning methods was "marginal." The team also observed that it was difficult to provide for the health and safety of workers in this harsh environment. They discussed various mechanical, chemical, and biological cleanup methods and mitigation with North Pacific Division and Alaska District representatives.[10]

The team returned to Alaska District Friday evening to report to Colonel Kakel, but he was still meeting with General McInerney. The team returned to the District office Saturday morning, shared their observations, and left Anchorage that day without seeing the colonel. Colonel Kakel and his staff were upset by what seemed to be an abrupt departure. The WES officials, however, believed that they had completed their mission and there was nothing more that they could contribute because Exxon had all the scientific expertise needed. They concluded that cold water wash was ineffective and that unless restrictions were removed the Corps would be no more effective at cleaning the beaches than Exxon. Reese and some others favored natural cleansing, but they realized such a recommendation would be politically unacceptable.[11]

Reese and Redlinger returned to Portland with bags of rocks from a "clean" beach and from one not yet cleaned. When they showed the rocks to General Stevens, he could

not tell the difference. The rocks effectively illustrated the ineffectiveness of cold water washing.[12]

In their trip report, Montgomery and Kirby concluded that the Corps would find it "very difficult" to provide effective cleanup support during the short time remaining until mid-September. The contaminated shorelines were in remote areas where housing was limited and transportation to worksites was dangerous. The short-term cleanup, they concluded, provided no "winning opportunities" for the Corps. However, they recommended that the experience be documented in case the Corps was asked to support future oil spill cleanup activities. The team saw opportunities for future research and development but cautioned against getting involved in short-term cleanup activities that had little chance of success. Exxon had the experts, equipment, and manpower to do the "best possible job" on the cleanup. Reese and Redlinger concurred. They too saw contributions that the Corps could make in research and development, such as remote sensing mapping techniques, but recommended against Corps involvement in shoreline cleanup. In interviews with the local press when they returned to Vicksburg, Kirby and Montgomery reiterated that the Corps could do little to help because Exxon had hired most of the experts and purchased most of the cleanup equipment.[13]

Corps officials were disappointed in the results of both laboratory visits, but especially the WES visit.[14] Kirby and Montgomery's blunt report and conservative statements to the press did not fit in well with the Corps' proactive approach to the cleanup. CRREL successfully established a data management system used in Alaska District and the JTF, but it had not accomplished its basic mission because the scientists could not get the instrumented aircraft data they needed from Exxon. Exxon refused to release any data that it had on the extent and location of the oil.

After the site visit, CRREL continued its efforts to get the data that it needed. At the Corps' request, General Smith informed General McInerney on 10 May that the Corps needed the following Exxon tape output: VHS tape output from the Innotech Falcon jet that flew over the spill area daily and videotape output from the Twin Otters flying each day. Smith requested seven days of output.

General McInerney asked FOSC Robbins to prod Exxon to surrender the data. The alternative was to task Navy or Air Force planes for a special imagery collection mission, which would be very expensive. The Air Force, Navy, Coast Guard, and NOAA each had aircraft that could collect the data, but none had aircraft available in Alaska. Nor was any agency willing to expend operational funds to send an aircraft to Alaska.[15]

In late May Exxon agreed to provide copies of video and computer tapes. Dr. Hugh Brown, Exxon Director of Surveillance and Tracking in Valdez, authorized Innotech to prepare some examples of the tapes and transmit them to CRREL. Innotech agreed to mail by 22 June 1989 two or three tapes for three or more sites, which would represent data for both open water and shoreline, at a cost of $2,000 to $3,000. The data would come from flight lines on or near 7 April, so that CRREL could compare this to data they had already analyzed from LANDSAT imagery for that date.[16]

Months later the Corps received directly from Exxon a video cassette on which Exxon had recorded samples of the infrared and ultraviolet images collected during the daily surveillance flights. The images on the tapes were of poor quality and were not documented as to where, when, and what they depicted. The data was for the most part unusable. CRREL was able to put the data into its system to insure that the system worked. CRREL also received samples of Innotech data on computer compatible tapes.[17]

In addition to the remote sensing technology, Corps elements made other contributions. At the time of the spill there was no good accurate measurement of the miles of shoreline in Prince William Sound and the Gulf of Alaska. A team from the Engineer Topographical Laboratory's Terrain Analysis Center at Fort Belvoir measured 6,000 miles of Alaska coastline and offshore islands that were affected by the spill. They also determined the general composition of the measured coastline (i.e., sand, gravel, or large rocks) to help the Corps estimate the extent of the damage and the amount of effort required for the cleanup. In addition, the Navigation Data Center, part of the Water Resources Support Center, provided information about crude petroleum handling in general and details specific to Valdez. With its new data base management

system, the center was able to program, produce, and distribute this information within two hours.

WES's Coastal Engineering Research Center provided statistical wind and wave information from the Wave Information Studies to CRREL to help predict the movement of the oil slick. The wind and wave data covered a twenty-year period for the months of April and May at a site near the disaster.[18]

The Corps was also involved, if only to a minor extent, in another oil spill cleanup technology, bioremediation. Bioremediation is the digestion or degradation of oil by naturally occurring microorganisms (bacteria). Bacteria degrade the hydrocarbon molecules of oil into fatty acids, bacterial protoplasm, and other by-products. The process of hydrocarbon degradation is going on continuously in nature using various sources of hydrocarbon to include oil and products of photosynthesis among many others. For years scientists have been developing techniques to increase the number of organisms per unit area and increase their effectiveness by adding certain fertilizers — nitrogen and phosphorus — to accelerate the digestion of hydrocarbons. Fifty tons of commercially prepared microbes existed and were available for large scale application in Alaska.

Dr. Carl H. Oppenheimer, professor at the University of Texas and owner of Alpha Environment, Inc., testified before a subcommittee of the House Committee on Merchant Marine and Fisheries that he wanted to test a bioremediation program on three miles of representative shoreline and adjacent waters in Alaska.[19]

A briefing was held at the Pentagon on 14 April featuring Dan Kirkendall (a retired congressman from Memphis, Tennessee) in support of work being done by Oppenheimer. Kirkendall told the Corps' research and development people about a workshop sponsored by EPA to consider bioremediation technologies. At General Kelly's request, William R. Rushing from the Research and Development Directorate in Corps headquarters arranged to attend the workshop as an observer and to involve E.A. Theriot, a WES expert in biotechnology.

The "Bioremediation of Oil-Contaminated Aquatic Environments" workshop was held on 17–18 April in Crystal City,

Virginia. The purpose was to assemble a panel of experts to assess the feasibility of bioremediation in Alaska and to make recommendations to the EPA Administrator for further action. The participants decided to recommend to the EPA Administrator that the Alaska oil spill situation be treated as a laboratory to increase the nation's knowledge and readiness for action in future oil spills. Workshop participants agreed that test plans should be developed for using fertilizer in a small-scale experimental project to study the impact. These test plans would be reviewed by participants and final recommendations would be made to the EPA Administrator. Rushing recommended that the Corps offer engineering assistance to EPA.[20]

Rushing concluded that bioremediation could be effective, especially if used immediately after the spill, and that the risk factors were minimal. The engineering aspects of bioremediation studies contemplated by EPA were "seriously lacking" in application, techniques, equipment, etc. He recommended that the Corps offer assistance to EPA in the engineering/research and development aspects of projects because the Corps had the technical and logistical capabilities that EPA did not have. He also recommended that the Corps appoint a rapid response team to address future capability to respond.[21]

Research and development officials noted that it was too late to consider using bioremediation to clean up the Alaska oil spill but not too late for serious consideration of developing a program to do field tests of existing technology in preparation for future emergencies. "The situation in Alaska presents a unique opportunity for research on this technology at a field scale which should yield significant results and ultimately provide a capability to use this method of oil spill cleanup."[22]

The results of the laboratory visits were not as successful as Corps officials had hoped in that the scientists could do little to improve the current situation in Alaska. The problems of locating oil and cleaning the shoreline persisted. The Corps efforts, however, revealed that CRREL had an effective remote sensing technology that could be used in future cleanup operations.