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HOT SPOT FEASIBILITY STUDY

NEW BEDFORD HARBOR

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EXECUTIVE SUMMARY

New Bedford Harbor is an urban tidal estuary located at the head of Buzzards Bay in southeastern Massachusetts. The harbor is home port to one of the largest commercial fishing fleets in the U.S. Industrial process wastes containing polychlorinated biphenyls (PCBs) used in the manufacture of electronic components were discharged into the harbor from the late 1940s through the late 1970s. Field studies conducted in the late 1970s and early 1980s showed PCB concentrations in the marine sediment over a 985-acre area to range from a few parts per million (ppm) to over 100,000 ppm. Water column concentrations of PCBs were found in excess of federal water quality criteria (30 parts per trillion), and fish/shellfish concentrations were found in excess of the U.S. Food and Drug Administration guideline (2 ppm) for edible tissue. In addition to PCBs, heavy metals (notably cadmium, chromium, copper, and lead) were found in the sediment in concentrations ranging from a few ppm to over 5,000 ppm. As a result of the widespread contamination, New Bedford Harbor was added to the U.S. Environmental Protection Agency's (EPA) Superfund National Priorities List in July 1982.

Numerous investigations have been conducted over the last decade to physically characterize the New Bedford Harbor site, determine the extent of PCB and metals contamination, and assess the transport and fate of these contaminants. Data from

these investigations were compiled into a computerized data base by Battelle Ocean Sciences in Duxbury, Massachusetts.

In 1984, NUS Corporation (NUS) completed a Feasibility Study (FS) of remedial action alternatives for the highly contaminated mudflats and sediment of the Acushnet River Estuary, north of the Coggeshall Street Bridge. This study was requested by EPA and the Commonwealth of Massachusetts because the extremely high levels of PCBs and heavy metals in these locations appeared to pose a near-term risk to public health, public welfare, and the environment.

As a result of extensive comments received on the NUS FS, EPA determined it was necessary to conduct additional studies before choosing a clean-up method for the upper estuary. The focus of the proposed additional studies would be the feasibility of dredging and disposal of contaminated sediment. EPA asked dredging and disposal experts from the U.S. Army Corps of Engineers (USACE) to design and carry out these studies. In response to EPA's request, USACE has been conducting bench- and laboratory-scale studies, which comprise their Engineering Feasibility Study (EFS) of Dredging and Dredged Material Disposal Alternative for the Acushnet River Estuary. In the late fall and winter of 1988-1989, the EFS was expanded to include a Pilot Study of Dredging and Disposal Alternatives.

An FS is currently being conducted for New Bedford Harbor by E.C. Jordan Co. under contract to Ebasco Services, Inc., as part of the REM III Superfund Program. The goal of this study is to present EPA with a range of remedial alternatives to address the cleanup of PCBs and metals in New Bedford Harbor. Previous work conducted by NUS, the EFS, and the pilot study are being incorporated into this FS.

The New Bedford Harbor FS is divided into three geographical study areas: the Hot Spot, the Acushnet River Estuary, and the Lower Harbor and Upper Buzzards Bay (see Figure 1-3). The Hot Spot is an approximate 5-acre area located along the western bank of the Acushnet River, directly adjacent to the Aerovox Corporation (Aerovox) facility. Based on the existing New Bedford Harbor data base, calculations of PCB mass indicate that the Hot Spot area contains approximately 45 percent of the total PCB mass in sediment within the Acushnet River Estuary and New Bedford Harbor.

In accordance with Section 300.430(a) of the National Contingency Plan (NCP) (FR 51503), the Hot Spot area was designated an operable unit by EPA Region I. This approach enables EPA to proceed with a response action on this discrete, well-defined portion of the site before selection of an appropriate overall remedial action. Implementation of remedial action for the Hot Spot area operable unit must be cost-effective and consistent with the overall remedial action

selected for the New Bedford Harbor site.

This report is the FS of remedial alternatives for the Hot Spot area. The purpose of the Hot Spot area FS is to present EPA with a range of remedial alternatives that specifically address protection of public health and the environment from PCBs and metals in the Hot Spot area sediment.

PCBs were actively discharged into the upper estuary from the late 1940s through the early 1970s. PCB contamination, which is widespread throughout the estuary, is greatest in the upper 12 inches; however, contamination extends to below 3 feet in localized areas. The Hot Spot area, located in the northern part of the upper estuary adjacent to the Aerovox facility, is defined as all areas where the sediment PCB concentration exceeds 4,000 ppm. This area contains approximately 10,000 cubic yards of PCB-contaminated sediment, representing approximately 48 percent of the PCB mass in the upper estuary, or 45 percent in the entire harbor. The 4,000-ppm target concentration limit is not risk-based, but was determined to be the minimum volume of sediment that contained the maximum PCB mass.

The Hot Spot area serves as a PCB source for the remainder of the estuary and lower harbor and bay. Diffusion of PCBs from the sediment into the water column was determined to be the prime transport mechanism. PCBs in the water column in the Hot

Spot area exceeded Ambient Water Quality Criteria (AWQC) and were an order of magnitude greater than those sampled in the lower harbor and bay. Studies have shown that there is a mean net seaward flux of water-column PCBs at the Coggeshall Street Bridge, ranging from 200 to 600 kilograms per year. Tidal pumping was determined to be the dominant transport mechanism for water-column PCBs.

The ultimate fate of the PCBs once they reach the outer harbor is not certain. Photolysis by sunlight, volatilization, biodegradation, and biological uptake are all believed to be factors. Of these, biological uptake is the greatest concern because of environmental impacts, public health impacts associated with ingestion of contaminated biota, and economic impacts on the local fishing industry. Sustained elevated concentrations of PCBs in lobster, winter flounder, and other species were documented in the outer harbor area from 1977 to 1987. For this reason, this area has been closed to fishing since 1979.

Public health and environmental risks are associated with the Hot Spot area. The public health risks associated with direct contact with Hot Spot area sediment exceeds the EPA carcinogenic target range of 10^{-4} to 10^{-6} . The Hot Spot area poses an environmental risk not only to biota associated with the Hot Spot area, but also with biota in the remainder of the estuary and lower harbor and bay. Because this area is a major source

of PCBs to the water column, its environmental impact extends beyond the site area boundaries.

Based on public health and environmental risks, the following three response objectives were developed for the Hot Spot area:

- provide protection to the public health threat posed by direct contact with Hot Spot area sediment
- provide protection to environmental receptors in direct contact with the Hot Spot area sediment
- reduce PCB migration from the Hot Spot area sediment, which acts as a PCB source to the water column and remainder of the harbor environment

Technologies that could potentially attain these response objectives were identified and screened for applicability to the Hot Spot area. Applicable technologies were developed into nine remedial alternatives. The remedial alternatives were developed to provide a range of treatment, including a no-action alternative, containment alternative, and treatment alternatives.

Following the development of alternatives, each alternative underwent initial screening to analyze the expected effectiveness, implementability, and cost. As a result of this

screening process, four alternatives were retained for detailed analysis. These alternatives are presented in Table ES-1 and Section 6.0.

A detailed analysis was performed for each of the four alternatives. During detailed analysis, the following criteria were evaluated: (1) short- and long-term effectiveness; (2) reduction of mobility, toxicity, or volume of contaminants; (3) implementability; (4) cost; (5) compliance with Applicable or Relevant and Appropriate Requirements (ARARs); (6) overall protection of public health and the environment; and (7) community and state acceptance. The detailed evaluation of alternatives is presented in Section 7.0; Table ES-2 is a comparison of the four remedial alternatives.

TABLE ES-1
SUMMARY OF HOT SPOT ALTERNATIVES

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ALTERNATIVE DEVELOPMENT (SUBSECTION 6.1)		ALTERNATIVES ELIMINATED DURING SCREENING (SUBSECTION 6.3)	ALTERNATIVES REMAINING FOR DETAILED EVALUATION
HS-NA-1	No-action		HS-NA-1 (HS-1)
HS-CONT-1	Capping	HS-CONT-1	
HS-CONT-2	Embankment/Capping	HS-CONT-2	
HS-DISP-1	Confined Aquatic Disposal	HS-DISP-1	
HS-DISP-2	Out-of-State TSCA/RCRA Disposal	HS-DISP-2	
HS-TREAT-1	On-site Incineration		HS-TREAT-1 (HS-2)
HS-TREAT-2	Solidification		HS-TREAT-2 (HS-3)
HS-TREAT-3	Solvent Extraction		HS-TREAT-3 (HS-4)
HS-TREAT-4	Off-site Incineration	HS-TREAT-4	

TABLE ES-2
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
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ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
● Reduction of Toxicity, Mobility, or Volume	No reduction in toxicity, mobility, or volume since no treatment is employed.	Reduction in toxicity and mobility of PCB-sediments. Volume also reduce unless ash is solidified to prevent metals leaching.	Reduction in mobility of the Hot Spot Sediments. No reduction in toxicity. Volume increased by solidification.	Reduction in toxicity and mobility of PCB sediments. Volume will increase if solidification is employed. to prevent metal leaching.
● Short-term Effectiveness				
- Time Until Protection is Achieved	Reduction in public health risk due to direct contact could be achieved in one month. No reduction in environmental risk.	Reduction in public health and environmental risk should occur within one year after remedial action is initiated.	Same as Alternative HS-2.	Same as Alternative HS-2.
- Protection of Community During Remedial Actions	No impact to community during remedial action.	Dredge controls and air quality controls will minimize community impacts.	Same as Alternative HS-2.	Same as Alternative HS-2.
- Protection of Workers During Remedial Actions	Minimal risk to workers during fence/sign installation.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered sediments and ash.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered sediments and solidification process.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered and treated sediments.
- Environmental Impacts	No significant adverse environmental impact from fence installation.	Minimal environmental impact expected from dredging or construction.	Same as Alternative HS-2.	Same as Alternative HS-2.
● Long-term Effectiveness				
- Magnitude Of Residual Risk	Significant risks remain for public health associated with direct contact of surface soils. Environmental risks would continue unmitigated.	After sediments have been incinerated and the ash solidified (if needed). There will be minimal risk associated with the treated sediments.	After sediments have been solidified and disposed off-site, there will be minimal residual risk.	After sediments have been treated and solidified (if needed), there will be minimal residual risk.
- Adequacy of Controls	No direct engineering controls; fence subject to vandalism; annual monitoring and repair required.	Incineration is a proven technology; no long-term management of treatment residuals required.	TSCA/RCRA landfill is a proven technology; annual monitoring and maintenance is required.	Treatment by solvent extraction is expected to produce a treated sediment that will not need long-term control.

TABLE ES-2
(continued)
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
- Reliability of Controls	Sole reliance on fence and institutional controls to prevent exposure; high level of residual risk.	Remedy will be highly reliable due to removal of sediment causing risk.	Likelihood of landfill failure is small as long as O&M is performed.	Same as Alternative HS-2.
● Implementation				
- Technical Feasibility	Fence/signs are easily constructed; environmental monitoring well-proven.	Incineration would require special equipment and operators; treated residuals would require testing to verify treatment effectiveness; technology has been demonstrated at other sites.	TSCA/RCRA Landfill easy to implement; dewatering and solidification of sediments proven during bench- and pilot-scale tests.	Solvent extraction would require special equipment and operators; treated residuals would require testing to verify treatment effectiveness; technology has been pilot-tested on Hot Spot sediments.
- Administrative Feasibility	No off-site construction; therefore, no permits required.	Same as Alternative HS-1.	Same as Alternative HS-1.	Same as Alternative HS-1.
- Availability of Services and Materials	Services and materials locally available.	Dredge, dewatering, and mobile incinerator equipment and operators needed; available services in eastern United States.	Dredge, dewatering, and solidification services available in eastern United States. TSCA/RCRA disposal facility not locally available.	Solvent extraction equipment available from vendors but not readily. Equipment construction or pilot-scale tests may be required.
● Cost				
- Capital Cost	\$ 48,000	\$14,397,300	\$13,300,200	\$12,168,650
- O&M Cost	407,000	--	--	--
- Present Worth Cost	455,000	14,397,300	13,300,200	12,168,650
● Compliance with ARARs/TBCs				
- Compliance with ARARs	AWQCs will not be attained.	AWQCs will not be attained. All other ARARs will be met.	Same as Alternative HS-2.	AWQCs will not be attained. Solvent extraction will need to achieve equivalent performance standards.
- Appropriateness of Waivers	Not justifiable.	Justifiable based on interim remedy.	Same as Alternative HS-2.	Same as Alternative HS-2.

TABLE ES-2
(continued)
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
- Compliance with Criteria, Advisories, and Guidance	Does not meet FDA level for PCBs in fish and shellfish.	Is not expected to achieve FDA level for PCBs in fish and shellfish.	Same as Alternative HS-2.	Same as Alternative HS-2.
● Overall Protection of Human Health and the Environment				
- How Risks are Reduced, Eliminated, or Controlled	Risks to public health are reduced by restricting site access; environmental risks are not mitigated.	Risks to public health and the environment are significantly reduced by the removal and treatment of the Hot Spot.	Same as Alternative HS-2.	Same as Alternative HS-2.
● State Acceptance	Preliminary comments indicate non-acceptance.	Preliminary comments indicate acceptance.	Same as Alternative HS-1.	Same as Alternative HS-2.
● Community Acceptance	Preliminary comments from the New Bedford community action group indicates non-acceptance.	Preliminary comments from the New Bedford community action group indicates acceptance.	Same as Alternative HS-1.	Same as Alternative HS-2.

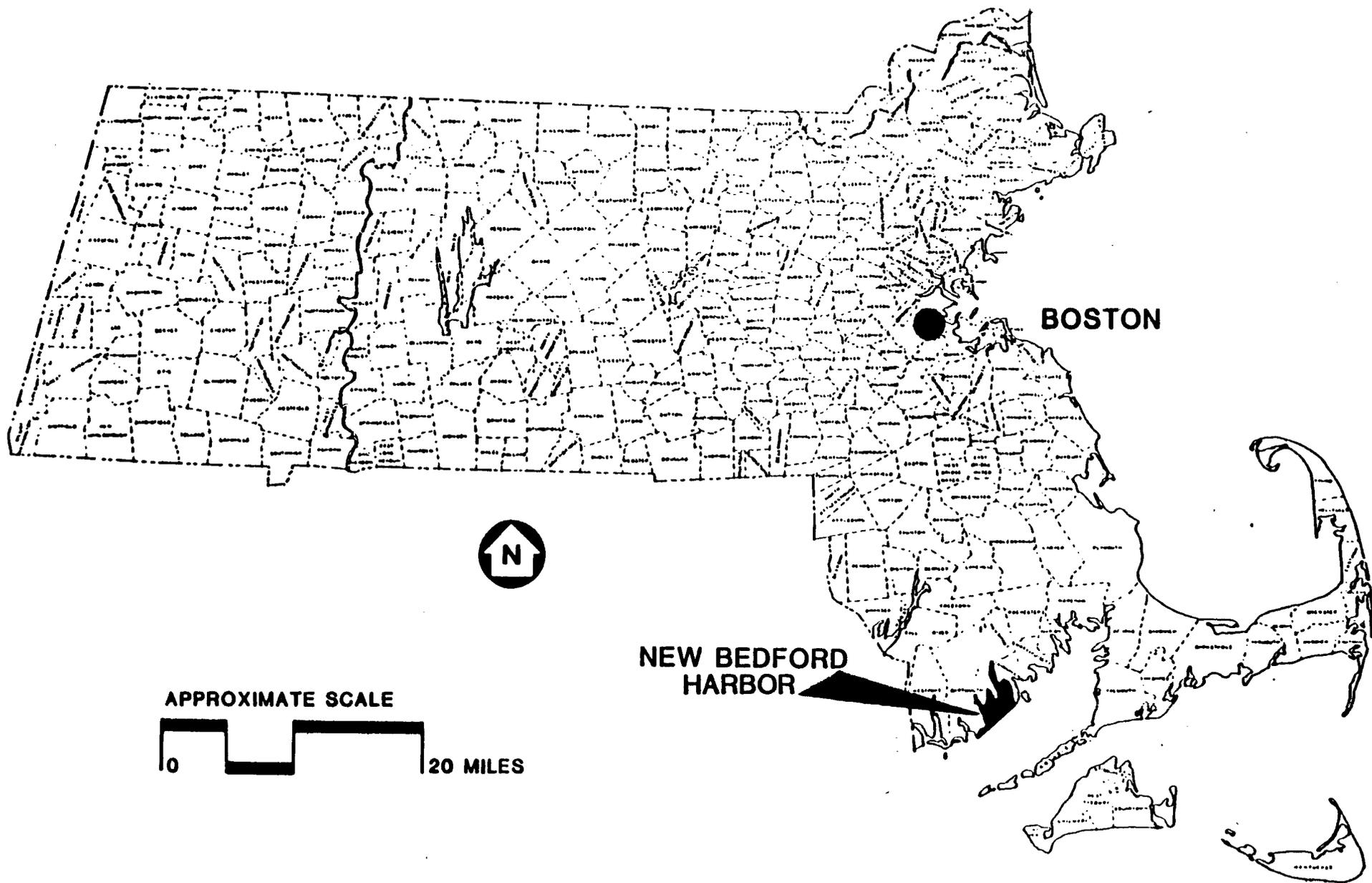
1.0 INTRODUCTION

1.1 BACKGROUND

New Bedford, Massachusetts, is a port city located at the head of Buzzards Bay, approximately 55 miles south of Boston (Figure 1-1). Historically, New Bedford is nationally known for its role in the development of the whaling industry in the early 1800s. Today, the harbor is home port to one of the largest commercial fishing fleets in the U.S.

In 1976, the U.S. Environmental Protection Agency (EPA) conducted a New England-wide survey for polychlorinated biphenyls (PCBs) (EPA, 1976). During this survey, high levels of PCB contamination were discovered in various locations throughout New Bedford Harbor. Further investigation identified two electrical capacitor manufacturers, Aerovox Corporation (Aerovox) and Cornell-Dubilier Electronics Corporation, as major users of PCBs from the time their operations commenced in the 1930s until 1977, when EPA banned the use of PCBs. These industries discharged wastewaters containing PCBs directly into New Bedford Harbor and indirectly via the municipal wastewater treatment system (EPA, 1976).

Field studies conducted in the late 1970s and early 1980s showed PCB concentrations in marine sediment over a 985-acre area to range from a few parts per million (ppm) to over 100,000 ppm.



**FIGURE 1-1
HARBOR LOCATION MAP
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

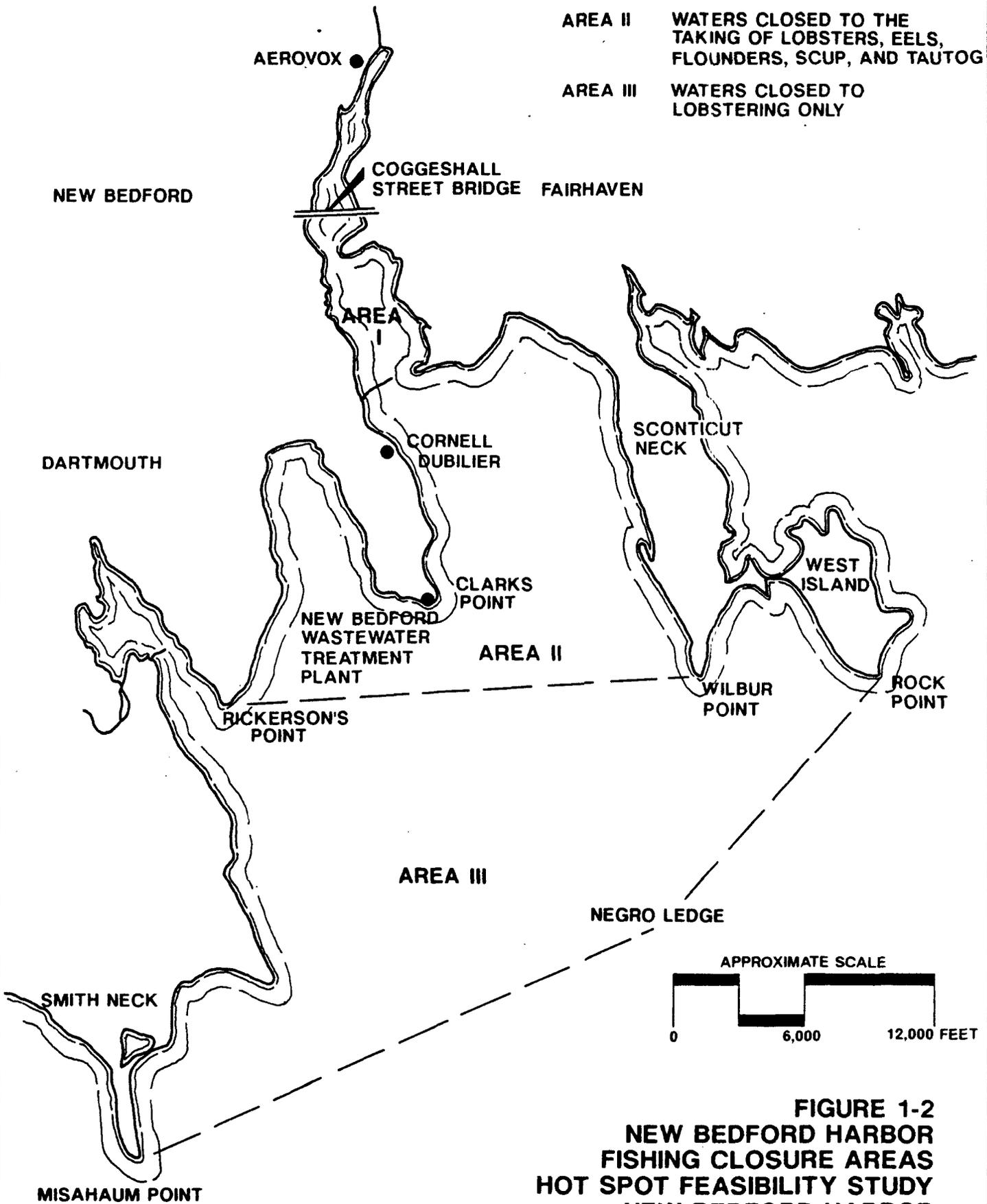
Portions of western Buzzards Bay are also contaminated, with sediment PCB concentrations in excess of 50 ppm. Water-column concentrations were found in excess of federal water quality criteria (30 parts per trillion), and fish/shellfish concentrations were found in excess of the U.S. Food and Drug Administration (FDA) guideline (i.e., 2 ppm) for edible tissue. In addition to PCBs, heavy metals (notably cadmium, chromium, copper, and lead) were found in sediment in concentrations ranging from a few ppm to over 5,000 ppm.

As a result of the widespread PCB contamination and the accumulation of PCBs in marine biota, the Massachusetts Department of Public Health established three fishing closure areas in September 1979 (Figure 1-2). These closures are still in effect at the present time. Area I is closed to all fishing: finfish, shellfish, and lobsters. Area II is closed to the taking of lobsters and bottom-feeding finfish, such as eels, flounders, scup, and tautog. Area III is closed to lobstering only. Closure of the New Bedford Harbor and upper Buzzards Bay area to lobstering has resulted in the loss of approximately 18,000 acres of productive lobstering ground.

In July 1982, New Bedford Harbor was added to the EPA Superfund National Priorities List (NPL), where it is currently listed in Group 2 as Site Number 76. Following the NPL listing, EPA Region I initiated a comprehensive assessment of the PCB problem in the New Bedford area in August 1982. The assessment included



<u>AREAS</u>	<u>DESCRIPTION</u>
AREA I	WATERS CLOSED TO ALL FISHING
AREA II	WATERS CLOSED TO THE TAKING OF LOBSTERS, EELS, FLOUNDERS, SCUP, AND TAUTOG
AREA III	WATERS CLOSED TO LOBSTERING ONLY



**FIGURE 1-2
NEW BEDFORD HARBOR
FISHING CLOSURE AREAS
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

sampling at the New Bedford and Sullivan's Ledge landfills; an area-wide ambient air monitoring program; a sediment PCB profile for the Acushnet River and the harbor; biota sampling in the estuary, harbor, and bay; and a study of sewer system contamination. Results of this assessment were presented in a Remedial Action Master Plan (RAMP) for the site in May 1983 (Weston, 1983). The RAMP included recommendations for studies to further delineate the contamination problems.

Concurrent with the assessment leading to the RAMP, EPA compiled a data base of sampling and analytical results of previous studies in the New Bedford Harbor and Buzzards Bay area. The final report on this data collection effort was issued by EPA in August 1983 (Metcalf & Eddy, 1983).

In 1983, NUS Corporation (NUS) prepared a work plan which included plans for a Feasibility Study (FS) of remedial action alternatives for the highly contaminated mudflats and sediment of the Acushnet River Estuary, north of the Coggeshall Street Bridge. This study was requested by EPA and the Commonwealth of Massachusetts because the extremely high levels of PCBs and heavy metals in these locations appeared to pose a near-term risk to public health, public welfare, and the environment. In October 1983, NUS received authorization to proceed with the FS for the upper estuary.

Upon completion of the Upper Estuary FS in August 1984, EPA sought public review and comment on the following five clean-up options:

1. Channeling of the Acushnet River north of the Coggeshall Street Bridge and capping contaminated sediment in the remaining open water areas.
2. Dredging of contaminated sediment and disposal in a partially lined confined disposal facility (CDF) located along the eastern shore in the northern part of the estuary.
3. Same as option No. 2, except that the CDF would be lined on the bottom as well as on the sides.
4. Dredging of contaminated sediment and disposal in a nearby upland containment site (no site was identified as available at that time).
5. Dredging of contaminated sediment to an elevation well below the depth of contamination. Contaminated dredged material would be placed in the bottom of the excavated cell and covered with a layer of clean sediment. The bottom of the upper estuary is returned to its original elevation. Disposal of contaminated

sediment in subaqueous cells is termed confined aquatic disposal (CAD).

EPA received extensive comments on the options from other federal, state, and local officials, potentially responsible parties, and the general public. Many of the comments concerned the adequacy of available dredging techniques and potential impacts of dredging on the harbor due to resuspension of contaminated sediment. The potential release of contaminated water (i.e., leachate) from an unlined disposal site was another area of concern.

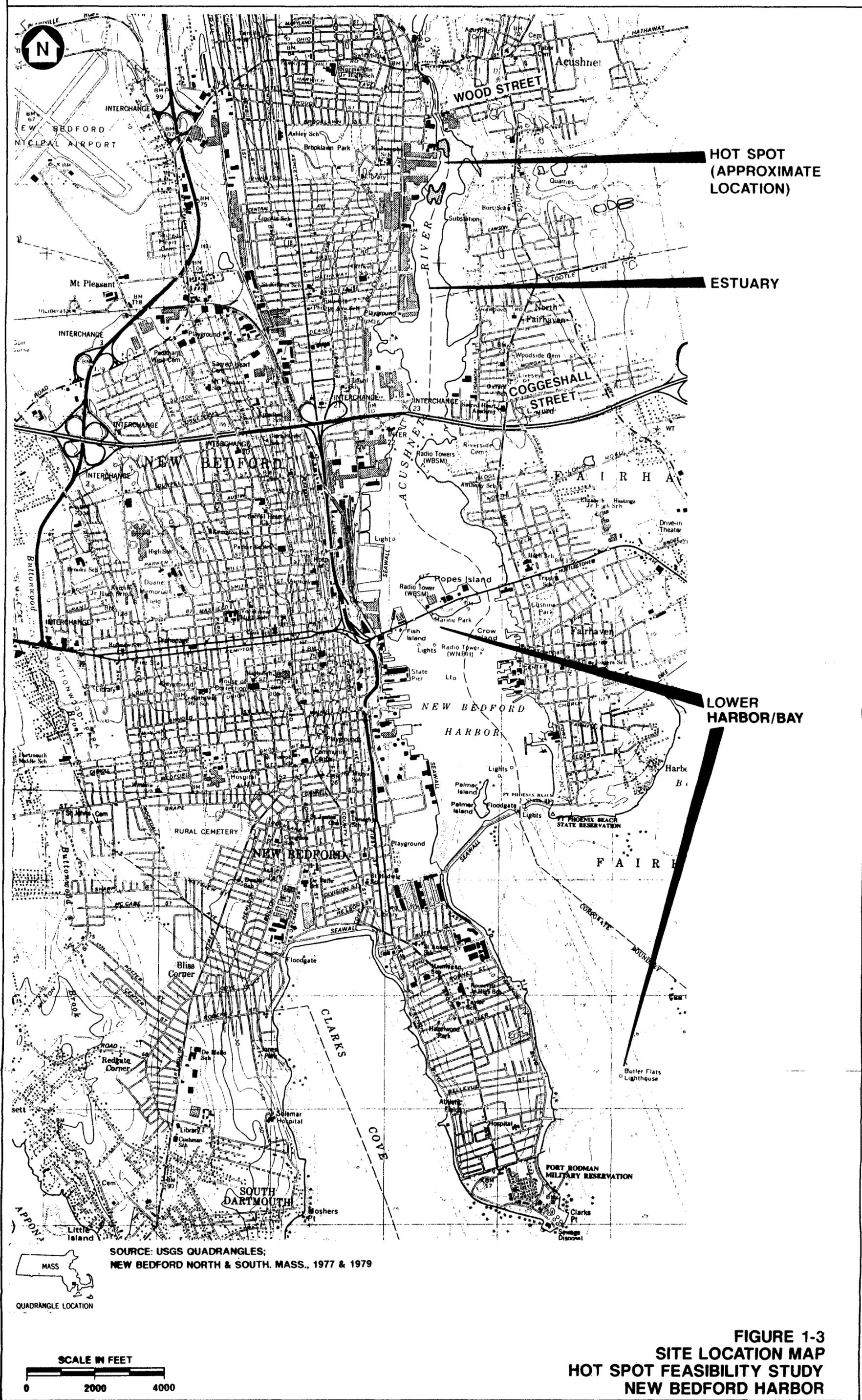
In attempting to respond to these comments, EPA determined it was necessary to conduct additional studies before choosing a clean-up method for the upper estuary. The focus of the proposed additional studies would be the feasibility of dredging and disposal of contaminated sediment. EPA asked dredging and disposal experts from the U.S. Army Corps of Engineers (USACE) to design and conduct these studies. In response to EPA's request, USACE has been conducting bench- and laboratory-scale studies, which comprise their Engineering Feasibility Study (EFS) of Dredging and Dredged Material Disposal Alternative for the Acushnet River Estuary (Francingues and Averett, 1988). Components of the EFS include (1) numerical modeling of sediment and contaminant transport during dredging; (2) studies of estuary sediment characterization, leachate and surface runoff

CDFs, subaqueous capping, solidification/stabilization (S/S) technologies, and settling and chemical clarification; and (3) conceptual designs of CDFs and CAD areas. The EFS was subsequently expanded to include a Pilot Study of Dredging and Disposal Alternatives, which was conducted in New Bedford Harbor during the late fall and winter of 1988-1989.

In August 1986, Ebasco Services, Inc. (Ebasco) prepared a work plan to complete the FS for the entire New Bedford Harbor site under the REM III Superfund Program (Ebasco, 1986; E.C. Jordan Co./Ebasco, 1986). Along with development of additional remedial alternatives for the site, the proposed scope of work included incorporating previous work conducted by NUS and the EFS and pilot study being conducted by USACE.

An overall FS is currently being conducted for New Bedford Harbor by E.C. Jordan Co. (Jordan) under contract to Ebasco (EPA Contract No. 68-01-7250; Work Assignment No. 04-1143). The goal of this study is to present EPA with a range of remedial alternatives to address the cleanup of PCBs and metals in New Bedford Harbor.

The New Bedford Harbor FS is divided into three geographical study areas: the Hot Spot area, the Acushnet River Estuary, and the Lower Harbor and Upper Buzzards Bay (Figure 1-3). The Hot Spot is an approximate 5-acre area located along the western bank of the Acushnet River, directly adjacent to the



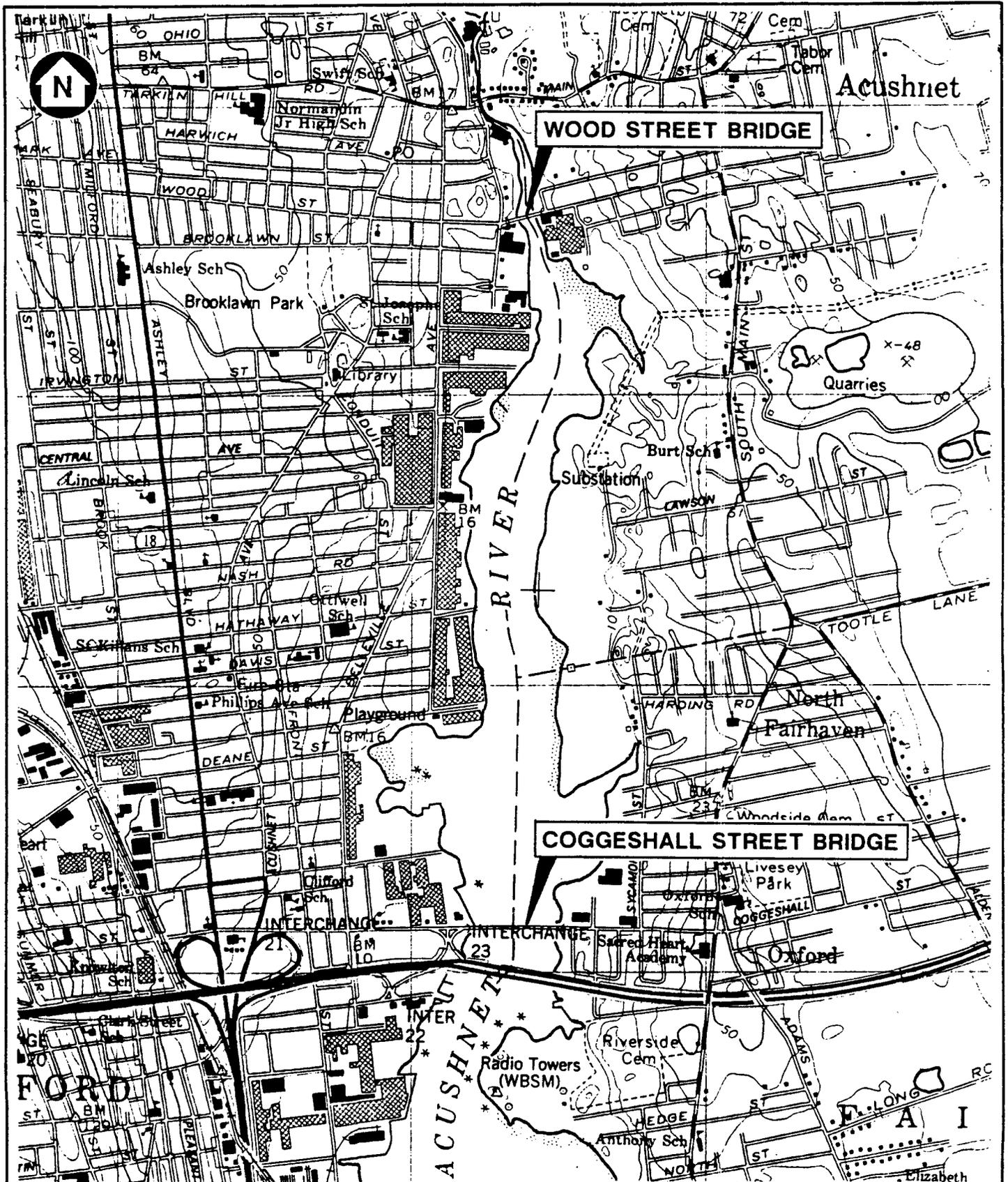
**FIGURE 1-3
SITE LOCATION MAP
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

Aerovox facility. A more detailed map of this area is shown in Figure 1-4. Sediment PCB concentrations in this area range from 4,000 to over 100,000 ppm. Sediment metals (i.e., cadmium, chromium, copper, and lead) concentrations range from below detection to approximately 4,000 ppm.

The Acushnet River Estuary is an area of approximately 230 acres (excluding the Hot Spot area), extending from the Wood Street Bridge to the north, to the Coggeshall Street Bridge to the south (see Figure 1-4). Sediment PCB concentrations in this area (excluding the Hot Spot area) range from below detection to approximately 4,000 ppm. Sediment metals concentrations range from below detection to over 7,000 ppm.

The Lower Harbor area consists of approximately 750 acres extending from the Hurricane Barrier, north to the Coggeshall Street Bridge. Sediment PCB concentrations range from below detection to over 100 ppm. Sediment metals concentrations range from below detection to approximately 3,000 ppm.

The Upper Buzzards Bay portion of the FS study area extends from the hurricane barrier to the southern boundary of Fishing Closure Area III, an area of approximately 18,000 acres (see Figure 1-2). Sediment PCB concentrations in this area range from below detection to a few parts per hundred in localized areas along the New Bedford shoreline near combined sewer and



SOURCE: USGS MAP NEW BEDFORD, MASS (NORTH & SOUTH) 1979



FIGURE 1-4
UPPER ACUSHNET RIVER
ESTUARY AND HOT SPOT
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

stormwater outfalls. The latter areas, comprising a few acres, will be evaluated for potential remediation.

1.2 PURPOSE AND APPROACH

1.2.1 The Hot Spot as an Operable Unit

Based on the existing New Bedford Harbor data base (Battelle, 1989), calculations of PCB mass indicate that the 5-acre area defined as the Hot Spot, and representing 0.5 percent of the total 985-acre New Bedford Harbor study area, contains approximately 4.5 percent of the total PCB mass in sediment within the Acushnet River Estuary and New Bedford Harbor (E.C. Jordan Co./Ebasco, 1989). Existing data indicate that PCBs continue to migrate from the Hot Spot area and that this area serves as a source of PCBs for the estuary and lower harbor and bay areas. Because a significant mass of PCBs is contained in such a small area, any remedial action implemented for New Bedford Harbor would begin with the Hot Spot area.

In accordance with Section 300.430(a) of the National Contingency Plan (NCP) (FR 51503), the Hot Spot area was designated an operable unit by EPA Region I. This approach enables EPA to proceed with a response action on this discrete, well-defined portion of the site before selection of an appropriate overall remedial action. Remediation of the Hot

Spot area operable unit will be conducted as an interim remedy. Implementation of remedial action for the Hot Spot area must be cost-effective and consistent with the overall remedial action selected for the New Bedford Harbor site.

This report is the FS of remedial alternatives for the Hot Spot area. The purpose of the Hot Spot FS is to present EPA with a range of remedial alternatives that specifically address protection of public health and the environment from PCBs and metals in the Hot Spot area sediment.

The Hot Spot area FS was conducted in accordance with the following legislation and guidance governing hazardous waste remediation:

- Superfund Amendments and Reauthorization Act (SARA) of 1986

- National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule (FR 47912, November 1985)

- National Oil and Hazardous Substances Pollution Contingency Plan; Proposed Rule (FR 51396, December 1988)

- Guidance for Conducting Remedial Investigations (RIs) and Feasibility Studies under CERCLA; Interim Final (EPA Office of Solid Waste Emergency Response [OSWER] Directive 9355.3-01, October 1988)

1.2.2 The Hot Spot in Relation to the Estuary and Lower Harbor/Bay FS

An FS of remedial alternatives for the estuary/lower harbor and bay is currently being conducted by Jordan/Ebasco, and will be published as a separate document. As part of the estuary/lower harbor and bay FS, remedial alternatives will be developed to achieve the response objectives and established target clean-up levels (TCLs) for the overall New Bedford Harbor site. The remedial alternative selected for the Hot Spot area will be consistent with the remedial strategy selected for the overall site so that the established TCLs will be achieved for the overall New Bedford Harbor site.

1.3 REPORT ORGANIZATION

Section 2.0 presents the physical and chemical characterization of the Hot Spot area and the adjacent areas comprising the upper estuary. The spatial extent of PCB and metals contamination is discussed, including the methodology used to calculate the area

and volume of PCB contamination in the Hot Spot area. Fate and transport of PCBs from the Hot Spot area are also discussed.

Section 3.0 summarizes the methodologies and results of the public health and environmental baseline risk assessments conducted for the overall New Bedford Harbor site. The magnitude of risk reduction for the overall New Bedford Harbor site due to Hot Spot remedial action will be assessed as part of the estuary/lower harbor and bay FS.

Section 4.0 presents the remedial action objectives developed for the Hot Spot area. These objectives were used as guidelines for the subsequent selection of remedial technologies and the development and evaluation of remedial alternatives.

Section 5.0 presents the identification, screening, and detailed evaluation of remedial technologies for New Bedford Harbor. This section is an inventory of applicable technologies that can be assembled into alternatives capable of meeting the remedial action objectives. This section includes discussions and results of numerous studies conducted in support of the New Bedford Harbor Superfund project. Section 5.0 concludes with a summary of the remedial technologies considered applicable for the Hot Spot area.

Section 6.0 describes the development and screening of remedial alternatives for the Hot Spot area. A range of alternatives is

developed as prescribed by SARA and EPA guidance for conducting FSs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The alternatives are screened on the basis of effectiveness, implementation, and cost. Remedial alternatives remaining after the screening are carried forward for detailed evaluation.

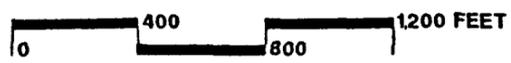
Section 7.0 presents the detailed evaluation of remedial alternatives for the Hot Spot area. Each alternative contains a conceptual design and an evaluation using the nine criteria prescribed by CERCLA RI/FS guidance (Interim Final, October 1988) and the NCP (FR 51506 (e)(9)). Section 7.0 also presents a comparative analysis of the remedial alternatives to evaluate the relative performance of each alternative in relation to each specific criterion.

2.0 SITE DESCRIPTION

The Hot Spot area of New Bedford Harbor is located on the western bank of the upper Acushnet River Estuary, directly adjacent to the Aerovox facility. The water bottom slopes gently from the shoreline toward the center of the river channel in this area. Low tides expose much of the Hot Spot area as mudflats. Low water elevations range from -1.6 to -2.2 feet MSL. The Hot Spot includes all areas where PCB concentrations exceed 4,000 ppm. Sediment PCB contamination in excess of 4,000 ppm occurs to a depth of 3 feet; however, the largest aerial extent occurs in the top foot. As illustrated in Figure 2-1, there are actually four areas that exceed the 4,000-ppm concentration. These areas comprise approximately 5 acres, and are collectively referred to as the Hot Spot area. The two northern areas are the largest and appear to be the result of direct PCB discharge and/or runoff into the estuary from the Aerovox property. The discharge of wastewater containing PCBs from the Aerovox facility has been documented by the EPA (EPA, 1976). Sediment in the Hot Spot area are 75- to 80-percent silts and marine clays, with 20- to 25-percent of the grains not passing the 200-mesh sieve (i.e., sands).

2.1 DEFINITION OF THE HOT SPOT

During a 1985 sampling episode in the Upper Estuary, EPA determined that a small area near the Aerovox property had



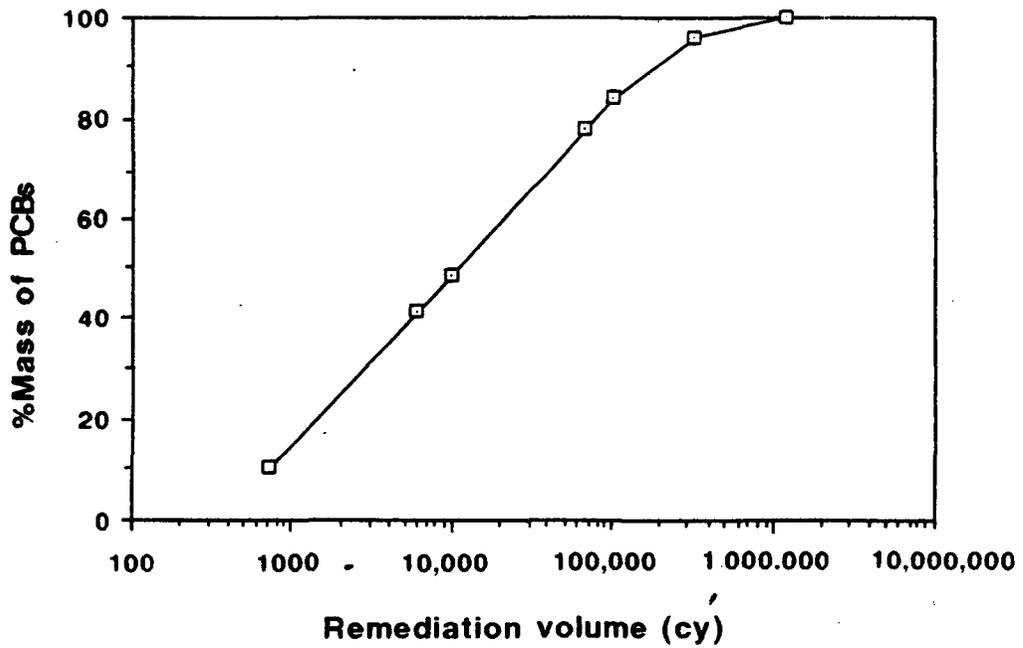
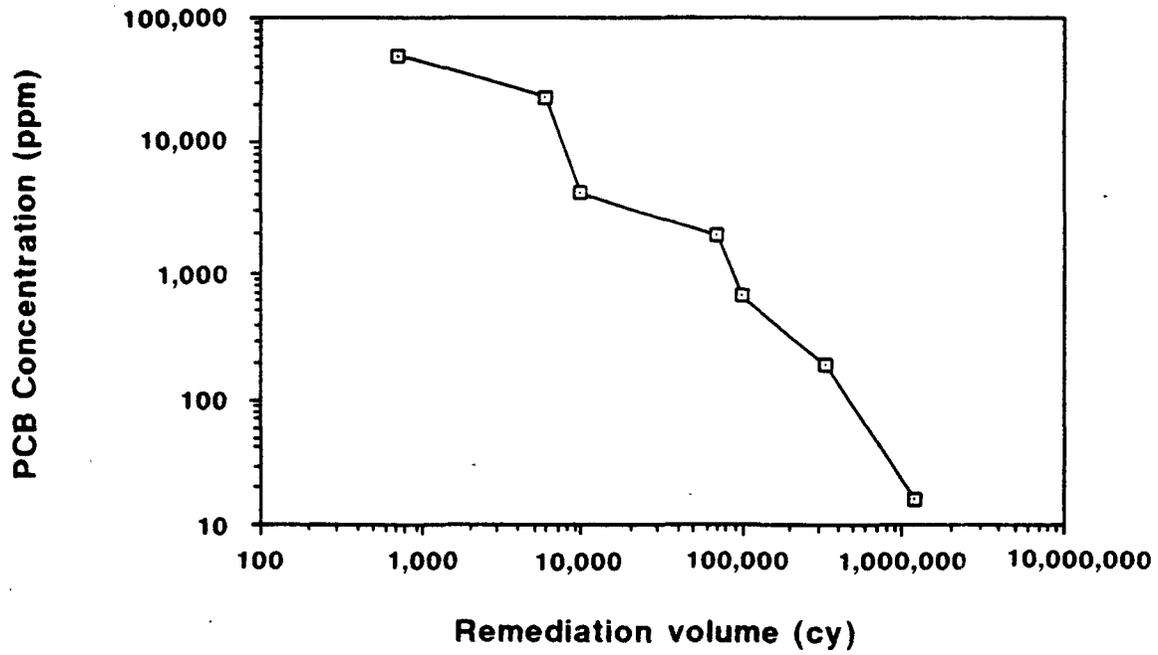
**FIGURE 2-1
INTERPRETATION OF
TOTAL PCB CONCENTRATIONS*
DEPTH: ZERO TO 12 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

* SUM OF AVAILABLE AROCHLOR DATA

significantly higher PCB sediment concentrations than the remainder of the estuary, lower harbor, and bay. It was noted that the sediment in this area appeared to contain more oily substance than at other locations. Laboratory analyses of sediment samples from one grid indicated sediment PCB concentrations over 30,000 ppm. In 1986, EPA set a preliminary level of 10,000 ppm for the lower boundary of sediment PCB concentrations to define the Hot Spot area, and evaluated removing this area as an emergency response action consistent with the requirements of the NCP. However, this was not possible because remediation costs exceeded the \$2-million ceiling outlined in the NCP (E.C. Jordan Co./Ebasco, 1987).

Subsequent to this evaluation, EPA requested that USACE conduct additional sediment sampling to further define the Hot Spot area and volume; this was completed in 1987. The USACE Hot Spot sampling data were combined with the earlier estuary sediment sampling data to determine if the 10,000-ppm level was an appropriate TCL (see Subsection 2.3).

Figure 2-2 presents an analysis of the PCB sediment sampling data in the estuary. The top portion of this figure illustrates PCB concentrations in the estuary with a corresponding remediation volume. This figure shows that the remediation volume increases as the target PCB level becomes lower. The lower portion of Figure 2.2 is another interpretation of the same data. In this illustration, the percent mass of PCBs in



**FIGURE 2-2
ACUSHNET RIVER ESTUARY
SEDIMENT DATA INTERPRETATION
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

the estuary is plotted against the corresponding remediation volume. This figure shows that in order to remove 100 percent of the PCBs in the estuary, over one million cubic yards of sediment would have to be excavated and/or treated.

The purpose of separating the Hot Spot area into an operable unit was to identify the area in the estuary that contained a large portion of the PCB mass in a relatively small volume. Table 2-1 summarizes the data presented in Figure 2-2. In this table, different PCB target levels were selected to determine the lowest remediation volume that would optimize the PCB removal/treatment. From this table, the target level of 4,000 ppm was selected for the Hot Spot area. This target level is a "common sense" target level and is the optimization of sediment remediation volume and PCB mass removal/treatment.

2.2 CONTAMINATION ASSESSMENT

Numerous studies and reports completed for the New Bedford Harbor Superfund site outlined the nature and extent of contamination, the location and functional value of the wetland areas, the fate and transport of PCBs in the estuarine environment, and the risks associated with the PCB contamination. These reports are used herein to assess the Hot Spot PCB sediment data in order to highlight the relationship of

TABLE 2-1
ACUSHNET RIVER ESTUARY DATA INTERPRETATION
(PCB TARGET LEVELS, REMEDIATION VOLUME, % PCB MASS)

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

PCB TARGET LEVEL CONCENTRATION (PPM)	REMEDICATION VOLUME (CY)	% MASS OF PCBs
500	200,000	89.0
1,000	92,000	82.0
2,000	66,000	77.0
3,000	39,000	63.0
4,000	10,000	48.0
5,000	9,700	47.6
6,000	9,500	47.2
7,000	9,300	46.8
8,000	9,100	46.5
9,000	8,900	46.2
10,000	8,700	45.5
20,000	6,400	41.8
30,000	4,400	32.0

the PCB contamination in the Hot Spot area to the estuary and lower harbor and bay.

The following five sediment sampling data sets were used to determine the nature and extent of PCB contamination in sediment of the Acushnet River Estuary:

- U.S. Coast Guard Sediment Sampling Program (1982)
- USACE FIT Sampling Program (1986)
- Battelle Hot Spot Sediment Sampling Program (1987)
- USACE Wetlands and Benthic Sediment Sampling Program (1988)
- USACE Hot Spot Sediment Sampling Program (1988)

These data sets were used for the Hot Spot contamination assessment because of consistent sampling and analytical procedures. The data from these sampling programs are presented in tables in Appendix A.

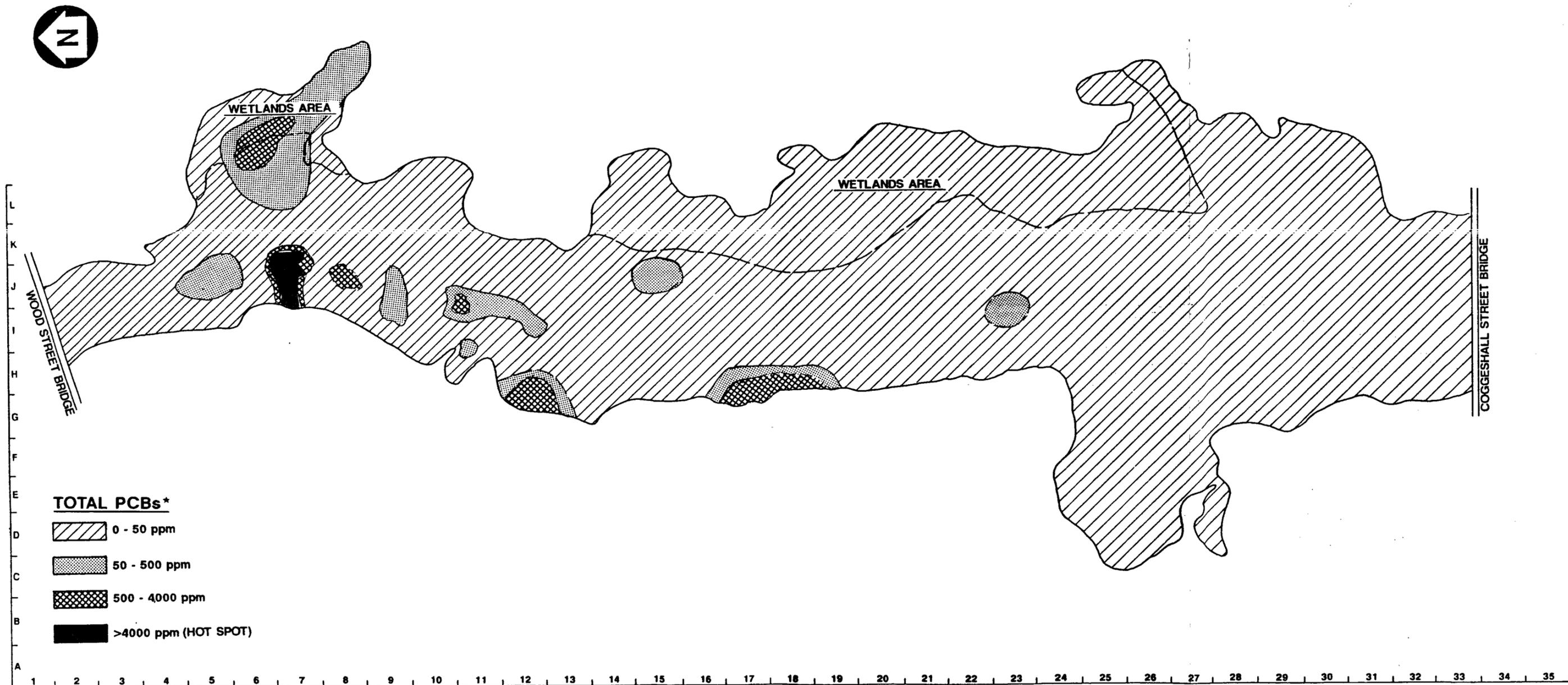
To determine the nature and extent of contamination in the estuary, sample location maps and PCB concentration maps were prepared from the data presented in Appendix A for three depths: zero to 12 inches, 12 to 24 inches, and 24 to 36 inches. Except for the northernmost Hot Spot area, there was minimal contamination below 36 inches; therefore, maps were not prepared for depths below 36 inches. The sample location from each of the five sampling programs was marked on each sample

location map along with the corresponding sample number. These sample location maps are also included in Appendix A. PCB concentration maps were developed from the corresponding sample location map by:

- assigning each sediment sample location the corresponding total PCB concentration (Aroclor summation)
- developing a contamination range for contamination contouring
- contouring the sediment PCB concentrations to illustrate the extent of contamination

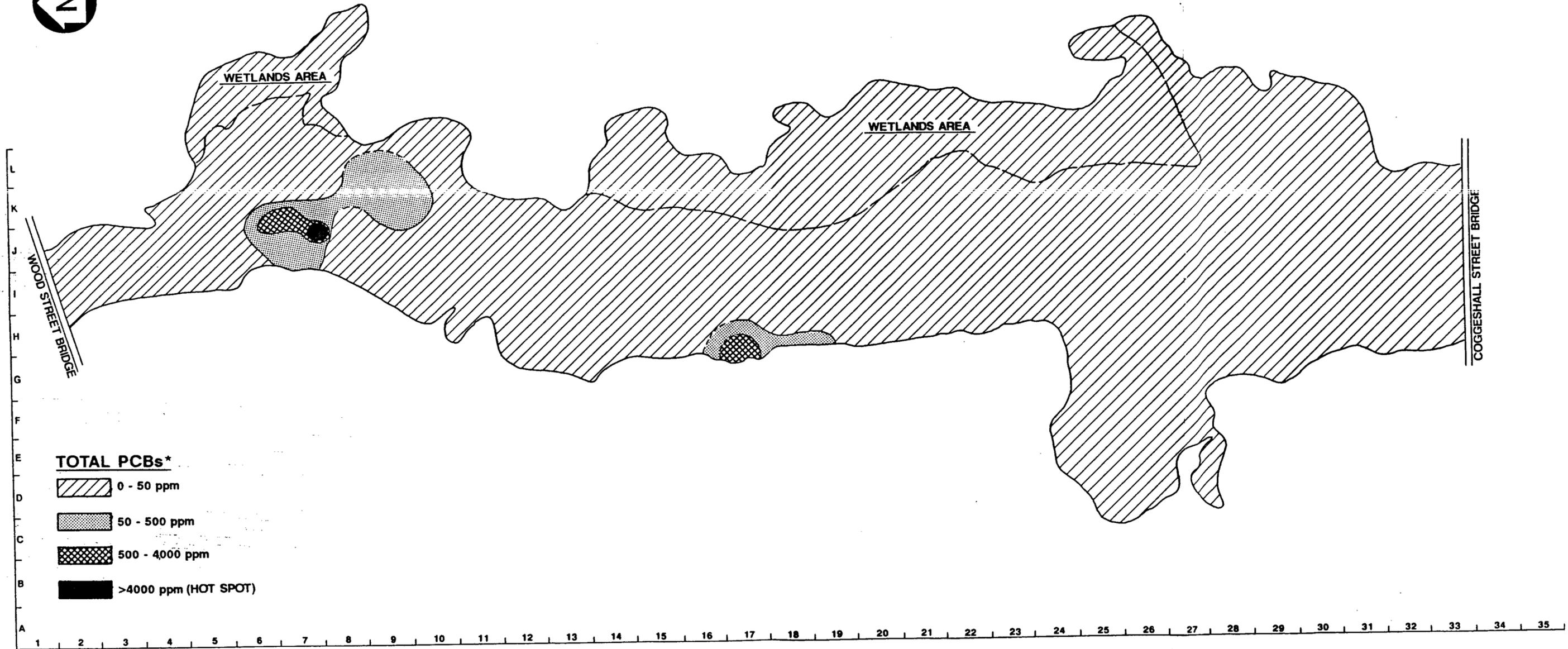
Figures 2-1, 2-3, and 2-4 are the PCB concentration maps for the zero to 12-inch, 12- to 24-inch, and 24- to 36-inch depths, respectively.

A contouring procedure was used to delineate the distribution of contamination in the estuary. To enhance data interpretation, order-of-magnitude concentration ranges were established. The PCB ranges illustrated on these figures are zero to 50 ppm, 50 to 500 ppm, 500 to 4,000 ppm, and greater than 4,000 ppm. This range was developed to be consistent with the Toxic Substance Control Act (TSCA) definition of PCB-contaminated material (50



**FIGURE 2-3
 INTERPRETATION OF
 TOTAL PCB CONCENTRATIONS
 DEPTH: 12 TO 24 INCHES
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR**

* SUM OF AVAILABLE AROCHLOR DATA



**FIGURE 2-4
INTERPRETATION OF
TOTAL PCB CONCENTRATIONS*
DEPTH: 24 TO 36 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

to 500 ppm), PCB material (greater than 500 ppm), and the 4,000 ppm TCL established to define the Hot Spot area. Isoconcentration contours were derived by dividing the distance between sample points of different concentration ranges. For example, if the sample points differed by one range, the contour was drawn half-way between the points; for two ranges, the distance was divided into thirds, and the two contours drawn at these points. This method provides a qualitative assessment of contaminant distribution and is an acceptable method for determining PCB-contaminated sediment volume where there is adequate data density. Sampling in and around the Hot Spot area provided substantial data. The remediation volumes that were developed based on the PCB-concentration maps are expected to be accurate to within 15 percent.

PCBs are the primary contaminant of concern in the Hot Spot area and estuary. However, the Acushnet River Estuary is not a pristine estuarine environment, and has historically been polluted with industrial and sanitary waste discharges. Due to these other discharges, there are elevated levels of polycyclic aromatic hydrocarbons (PAHs) and heavy metals (i.e., copper, chromium, lead and cadmium) in the estuary sediment. The existence of PAHs in the Hot Spot area is not a public health or environmental hazard because of the relatively low levels (See Section 3.0), the occurrence with PCB contamination, and their ability to be treated by the technologies identified to treat

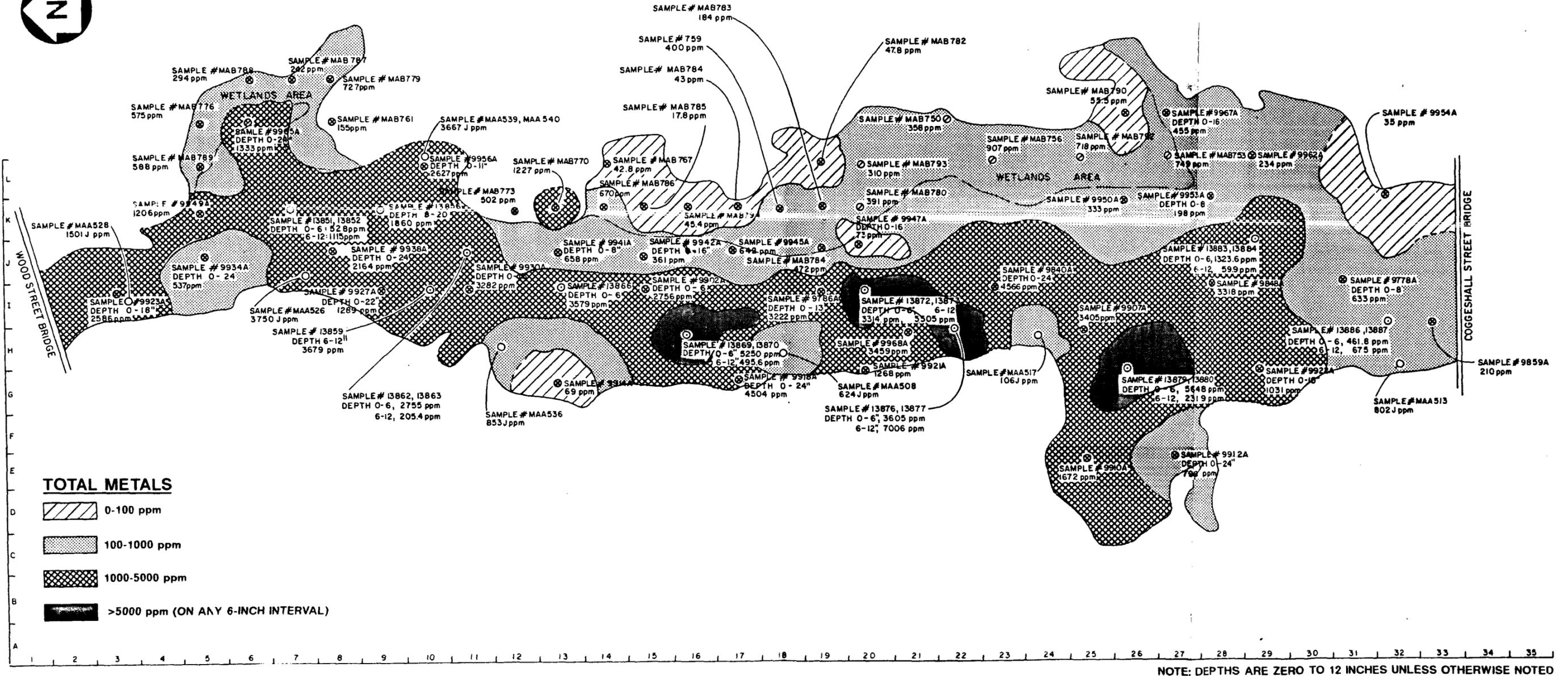
the PCB contamination (see Section 5.0). The metal contamination, however, is a concern because these contaminants cannot always be treated with the PCB treatment technologies and may serve as a future source of contamination during any disposal of treated sediment. Metals concentration maps (Figures 2-5 through 2-7) were prepared in a similar manner to that discussed for PCB contamination.

Subsection 2.2.1 discusses results of the sediment PCB contamination assessment. Subsection 2.2.2 presents results of the heavy metals contamination assessment. Subsection 2.2.3 outlines the volume for the Hot Spot area and the associated mass of PCBs contained within the Hot Spot.

2.2.1 Estuary PCB Contamination

Figure 2-1 is a contour map of the PCB sediment contamination in the top 12 inches of sediment. PCB contamination is more widespread in the upper 12 inches of the sediment than it is at other depths. The four separate Hot Spot areas are clearly identified at this depth, and comprise a total of 5 acres and approximately 8,000 cubic yards (cy) of PCB-contaminated sediment in excess of the 4,000 ppm action level.

Sediment PCB concentrations in the 500- to 4,000-ppm range surround the Hot Spot and extend northward toward the Wood Street Bridge, eastward into the cove area, and southward into



- LEGEND**
- BATTELLE HOT SPOT SAMPLING - GROUP 1
 - ⊗ USACE SAMPLES - GROUP 2
 - ⊙ USACE SAMPLES - GROUP 3

NOTE: DEPTHS ARE ZERO TO 12 INCHES UNLESS OTHERWISE NOTED

**FIGURE 2-5
INTERPRETATION OF
TOTAL METALS CONCENTRATIONS
(CADMIUM, COPPER, CHROMIUM, LEAD)
DEPTH: ZERO TO 12 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



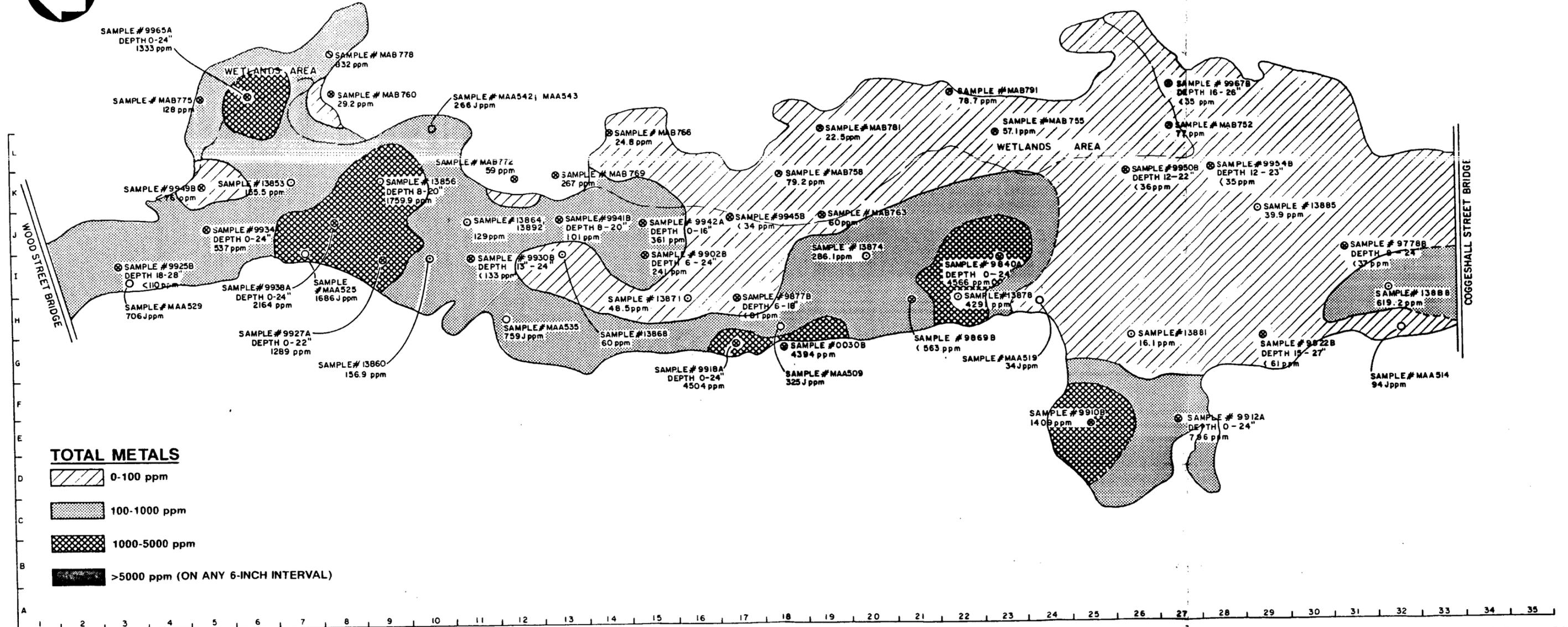
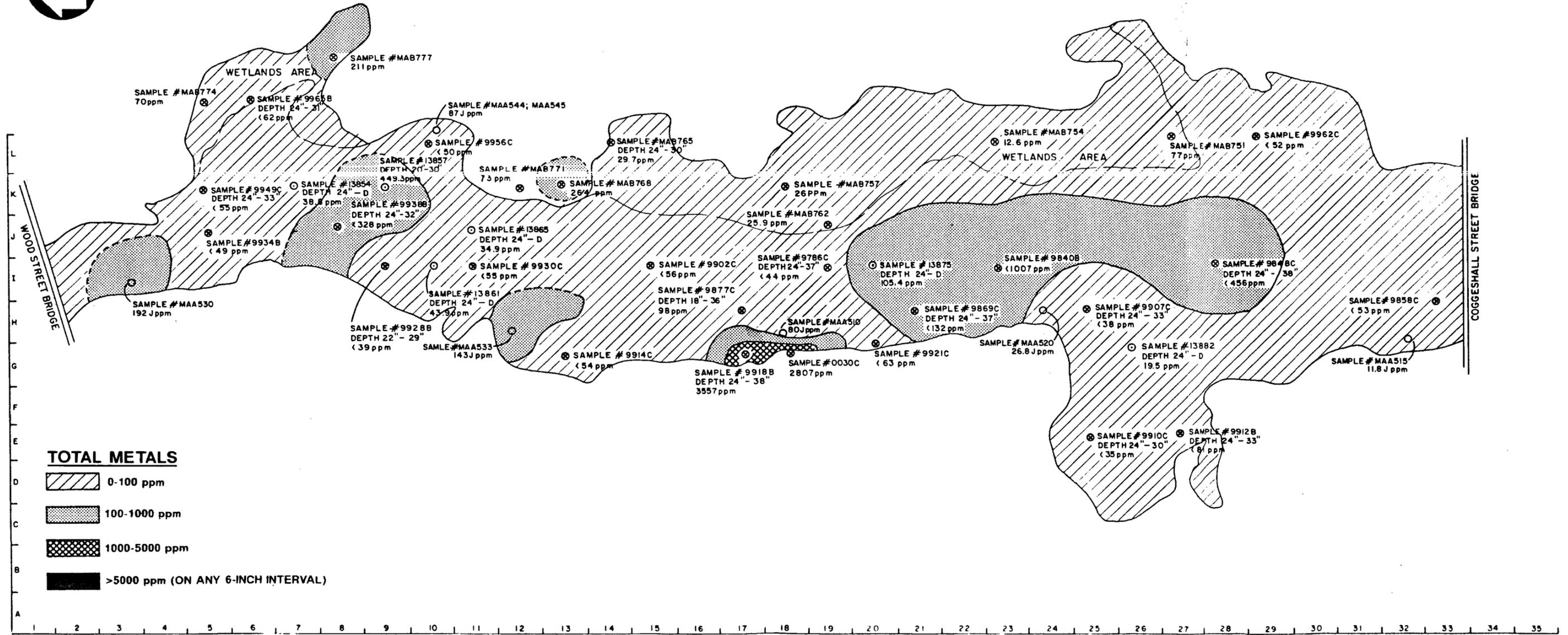


FIGURE 2-6
INTERPRETATION OF
TOTAL METALS CONCENTRATIONS
(CADMIUM, COPPER, CHROMIUM, LEAD)
DEPTH: 12 TO 24 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR



- LEGEND**
- BATTELLE HOT SPOT SAMPLING - GROUP 1
 - ⊗ USACE SAMPLES - GROUP 2
 - ⊙ USACE SAMPLES - GROUP 3

FIGURE 2-7
INTERPRETATION OF
TOTAL METALS CONCENTRATIONS
(CADMIUM, COPPER, CHROMIUM, LEAD)
DEPTH: 24 TO 36 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR



the estuary. The presence of PCB contamination in these areas is attributed to PCB migration from the Hot Spot area due to tidal fluctuations and wind-driven currents. Although PCB sediment contamination is in excess of 50 ppm throughout most of the estuary, concentrations decrease significantly with increasing distance from the Hot Spot area. Concentrations in the lower reaches of the estuary, near the Coggeshall Street Bridge, are generally below 50 ppm.

PCB contamination in the Upper Estuary extends into the wetlands located on the eastern side of the Acushnet River. However, studies completed by the USACE indicate that these wetlands continue to function as effective wetlands systems and possess high resource value (Bellmer, 1989).

Figure 2-3 is an interpretation of sediment PCB contamination in the 12- to 24-inch depth interval. At this depth, PCB contamination is substantially lower than the surface interval, and the Hot Spot area has been reduced to the northernmost area. Sediment PCB contamination in the 500- to 4,000-ppm range is limited to pockets located in the eastern cove area, in the area below the larger Hot Spot area, and two areas located along the western shore. These two areas are believed to be associated with the location of combined sewer overflows. In the 12- to 24-inch depth interval, sediment with PCBs exceeding

4,000 ppm cover an area of approximately 1.5 acres comprising approximately 1,600 cy.

In Figure 2-4 (24-36 inch depth interval), most of the estuary is below the 50-ppm level, with sediment PCB concentrations below the detection level in the Lower Estuary. The Hot Spot is limited to a small (northernmost) area. This area is estimated to be 0.25 acres with approximately 400 cy of PCB-contaminated sediment in excess of the 4,000-ppm target level. PCB sampling conducted below this 3-foot level indicates that significant levels (i.e., 2,010 ppm) of contamination persist to depths of 4.5 feet. Sediment PCB contamination at the 24- to 36-inch interval depth is isolated to the area around the northern Hot Spot area and adjacent to the combined sewer overflow on the west bank midway down the estuary.

As illustrated by these maps, the Hot Spot is the area of greatest sediment PCB contamination and appears to act as a source of PCB contamination for the estuary. PCB levels within the Hot Spot area are substantial, with the highest concentration noted as 249,000 ppm. This sample was collected and analyzed by Aerovox. Figure 2-8 is a detailed map of sediment PCB distribution in the Hot Spot area for the zero to 12-inch depth interval. This map was developed using the same data sets and procedures as outlined earlier. This figure illustrates that the Hot Spot still contains a substantial mass

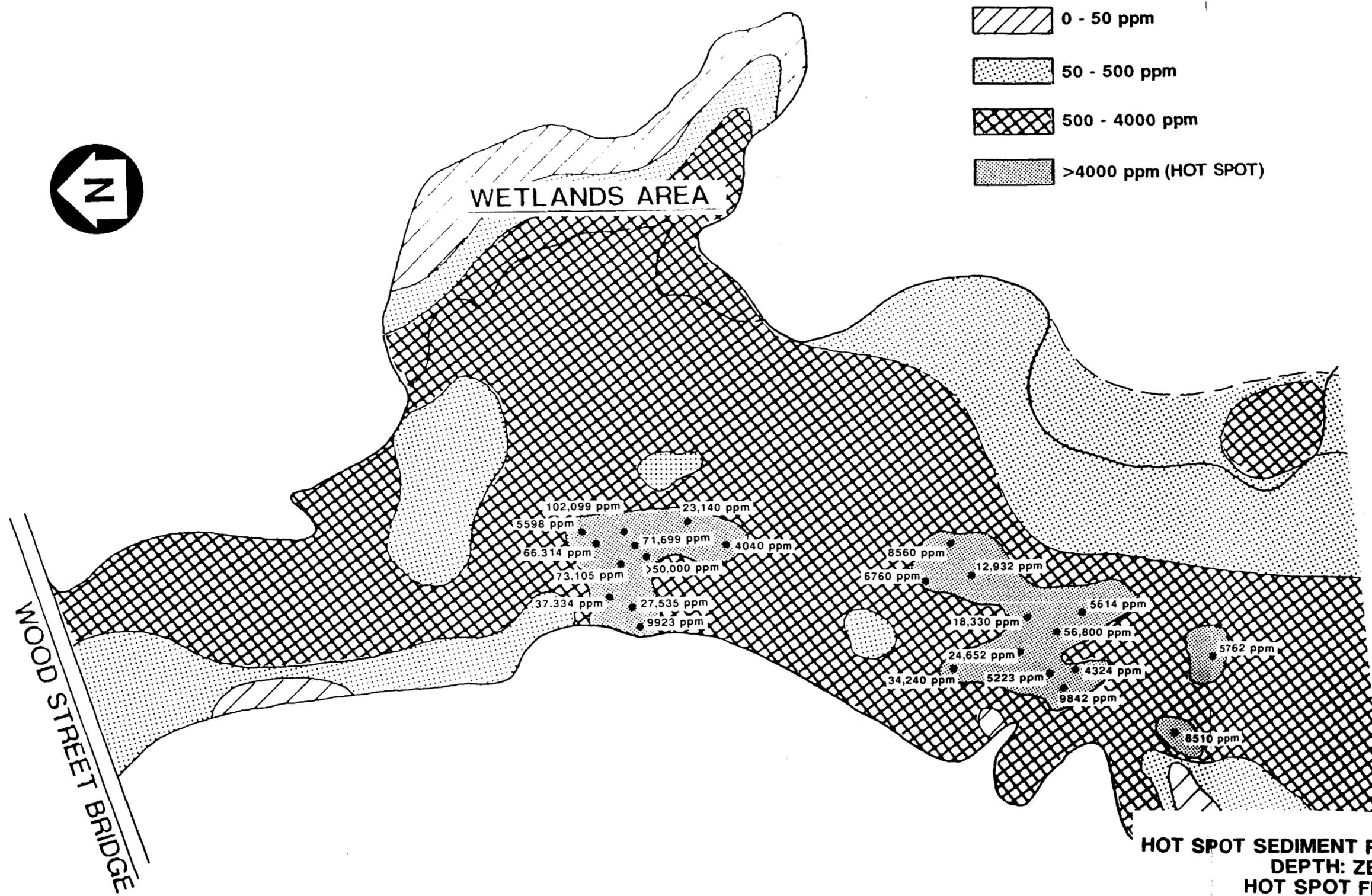


FIGURE 2-8
HOT SPOT SEDIMENT PCB DISTRIBUTION
DEPTH: ZERO TO 12 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

of PCBs (48 percent) which can continue to act as a source of PCB contamination for the rest of the estuary (See Section 2.3).

2.2.2 Heavy Metal Contamination Assessment

The contour maps in Figures 2-5 through 2-7 show sediment total metals (i.e., cadmium, copper, chromium, and lead) concentrations at depths of zero to 12 inches, 12 to 24 inches, and 24 to 36 inches. These maps were developed in a manner similar to the PCB maps. Because there were fewer data points, the sample locations and associated concentrations were added to these figures. These four metals were selected based on their prevalence in the sediment and toxicity to aquatic biota.

Similar to PCBs, the metals concentrations are greatest in the top foot of sediment, decreasing with depth. Unlike the PCB maps, however, the Hot Spot area metal contamination to the estuary does not appear to emanate from the Hot Spot area. Metals contamination appears to be greatest in the southern cove area. This area, as well as the rest of the western shore of the estuary, is heavily industrialized. The location of the high sediment metal concentrations appears to correlate with the location of industrial discharge pipes and/or combined sewer overflow discharge pipes.

With respect to the Hot Spot area, the metal concentrations are elevated in this area throughout the 36-inch remediation depth.

There are public health and environmental risks associated with these metals (see Section 3.0); however, they comprise a small component of the total risk when combined with risks associated with the sediment PCB contamination. The occurrence of metals in Hot Spot area sediment is significant because many treatment technologies capable of treating the PCBs are ineffective for treating metals. For this reason, additional treatment steps may be required to treat the metals remaining in the sediment after treatment for PCBs.

2.2.3 Hot Spot Volume

Based on available sediment sampling data, the Hot Spot area consists of four separate areas, totalling approximately 5 acres and containing an estimated volume of 10,000 cy of PCB-contaminated sediment in excess of the 4,000-ppm target level. This relatively small volume of highly contaminated PCB sediment represents a significant portion of the mass of PCBs in New Bedford Harbor. It was estimated that approximately 48 percent of the total mass of PCBs in the estuary lies within the Hot Spot area. More significantly, the Hot Spot area accounts for approximately 45 percent of the total mass of PCBs for the entire study area, which includes the estuary, lower harbor and bay (E.C. Jordan Co./Ebasco, 1989).

2.3 CONTAMINANT FATE AND TRANSPORT

As illustrated in Figures 2-1, 2-3, and 2-4, significant vertical and horizontal transport of PCBs occurred in the Upper Estuary. PCB transport in both the vertical and horizontal directions is believed to have occurred primarily during active discharge; however, these transport processes are still substantial. Because of this, the Hot Spot area acts as a source of PCBs to the remainder of the estuary and lower harbor and bay. This section will outline the significance of these transport mechanisms.

2.3.1 Vertical PCB Transport

The majority of PCB contamination in the estuary is located in the top foot of sediment, in and around the Hot Spot area. This indicates that vertical transport of PCBs has not been as significant as horizontal transport because there are limited areas where PCB contamination exists at the lower depth intervals. PCB contamination at the lower depths (1 to 3 feet) is limited to pockets, primarily around discharge areas (e.g., storm water overflows, combined sewer outfalls). This can be attributed to turbulence and subsequent deposition that occurs around discharge pipes. Vertical migration of PCBs within the Hot Spot sediment is believed to be currently occurring. Two possible mechanisms for this migration are: (1) the solubilization of PCBs due to detergent-like agents present in

the sediment pore water; and (2) bioturbation. The vertical migration of the PCBs can have a significant consequence by allowing PCBs within the sediment to reach the surface and subsequently elute out into the water column (Brown and Wagner, 1986).

2.3.2 Horizontal PCB Transport

Horizontal movement of PCBs within the estuary has occurred as illustrated in Figure 2-1. The majority of horizontal movement is believed to have occurred during discharge to the estuary. PCBs are heavy, water-insoluble oils that, when released to the estuary in the form of suspended droplets, would move various distances before sinking into the sediment. The depositional pattern would be determined by the location of the discharge pipes and the state of the tide (Brown and Wagner, 1988).

Two mechanisms were suggested for the long-term horizontal movement of PCBs once they have been deposited in the sediment: scouring and redeposition; and dissolution into and readsorption from the water column (Brown and Wagner, 1986). Studies performed by USACE indicate that sediment scour and redeposition in the upper estuary is relatively minor. In fact, the estuary area is depositional for the rest of the harbor, with suspended materials found to generally migrate from Buzzards Bay upstream into the estuary (Teeter, 1988). Sediment scouring or bed

erosion may be a more important transport mechanism during periods of high flow.

Dissolution into the water column is probably the more important transport mechanism. PCBs dissolved into the water column can remain in the water and be transported out to Buzzards Bay, or can be readsorbed onto suspended sediment and redeposited within the harbor area. Modeling studies performed for the EPA and the potentially responsible parties have assumed that diffusion of PCBs from the sediment to the water column is a principal transport mechanism. Calculations from one study indicates that the total PCB flux from the sediment to the overlying water column was 160.5 and 214 kilograms per year (kg/yr), (ASA, 1987). This model further demonstrated that the flux of PCBs from the sediment is primarily controlled by the interstitial pore water PCB concentrations and the thickness of the diffusive layer. This observation is significant in that the estuary receives water with lower PCB levels not only by the freshwater inflow of the Acushnet River but also by tidal fluctuations. The continual exchange of cleaner, less PCB-contaminated water with the contaminated sediment pore water may act to increase diffusion of PCBs from the sediment to the pore water and subsequently to the water column.

Since the Hot Spot area contains the highest concentration of PCBs in the harbor, it is believed to be the major source of PCBs to the water column. Water quality sampling by Battelle in

1984 and 1985 supports this hypothesis (Battelle, 1987). Water quality sampling at 17 stations located throughout the estuary, lower harbor, and bay indicates that the water in the vicinity of the Hot Spot contained a total of 13,754 ng/l of PCBs when compared to 236 ng/l for the lower harbor, and 58 ng/l for the bay. The particulate and dissolved portion of these samples documented a similar trend; water column PCBs in the upper estuary area are greater than any other area by as much as an order-of-magnitude.

Studies by the USACE and others have shown that once PCBs are in the water column of the estuary, there is a mean net seaward flux of PCBs at the Coggeshall Street bridge ranging from 200 to 600 kg/year (ASA, 1987; and Teeter, 1988). These studies confirmed the estuary as a source of PCBs to the lower harbor and bay. Tidal pumping was determined to be the dominant transport mechanism for suspended material. Tidal pumping and transport of PCBs from the Coggeshall Street bridge through the Hurricane Barrier and out into Buzzards Bay is also believed to occur. A report by Brown indicates that approximately 35 percent of the PCBs originally released into the upper estuary (Hot Spot) have already traveled through the waters of the lower estuary and Buzzards Bay to the Atlantic (Brown and Wagner, 1986). Brown verifies this transport mechanism has occurred by identifying the congener composition of the PCBs in the water of the outer harbor with those of the estuary. If this estimate is

correct, approximately 65 percent of the original PCBs discharged in the upper estuary still remain within the estuary. These PCBs will continue to act as a source of contamination for the lower harbor and bay. The Hot Spot area of the estuary contains approximately 48 percent of the mass of PCBs and therefore functions as a major source of PCB contamination.

2.3.3 Fate of the PCBs in New Bedford Harbor

The ultimate fate of PCBs, once they reach the outer harbor, is not certain. Photolysis by sunlight, oxidative biodegradation, and biological uptake are all believed to be factors. Of these, biological uptake is the greatest concern because of environmental impacts, public health impacts associated with ingestion of the contaminated biota, and economic impacts on the local fishing industry.

Sustained elevated concentrations of PCBs in lobster and several other species have been documented in fishing closure Area 3 (Figure 1-1). Monitoring conducted from 1977 to 1987 indicates mean PCB concentrations in lobsters have remained relatively constant, exceeding the 2-ppm FDA tolerance level. The mean PCB concentration was 3.9 ppm in 1977 (Kolek and Ceurvels, 1981); 4.2 ppm in 1985 (Massachusetts Division of Marine Fisheries, unpublished data); and 5.0 ppm in lobsters collected during 1987

(Pruell et al., 1988). PCB concentrations exceeding the 2-ppm FDA limit were also observed in winter flounder (Pruell et al., 1988).

Naturally occurring physical and chemical processes such as volatilization, hydrolysis, and photo-oxidation, are not expected to significantly reduce the volume of PCBs in the Hot Spot area and estuary sediment. Volatilization, hydrolysis, and photo-oxidation are all recognized as attenuative processes for PCBs. However, because of the relatively slow rates at which these processes occur, a significant reduction in sediment PCBs is not expected.

In-situ biodegradation of PCBs in aquatic sediment was rigorously investigated as a natural attenuative mechanism. Recent studies conducted by General Electric on Hudson River sediment suggest that selective, reductive dechlorination of PCB congeners is occurring slowly via anaerobic microorganisms (Brown et al., 1986). However, the bacterial strains capable of degrading the heavily chlorinated PCB congeners have not been isolated. Researchers at the USEPA Gulf Breeze Laboratory reviewed Brown's work and found his conclusions for anaerobic degradation of PCBs in sediment to be reasonable explanations of the data (EPA, 1988).

There is evidence to suggest that anaerobic degradation of PCBs is occurring in New Bedford Harbor sediment. Studies conducted

by the EPA Environmental Research Laboratory (ERL) in Narragansett, Rhode Island, on sediment cores collected from the pilot dredging study area (with PCB concentrations in the 100-ppm range), suggested that anaerobic dechlorination of PCBs is not a significant process at this site (Pruell, 1988). However, more recent studies conducted by EPA-ERL on estuary sediment samples with PCB concentrations of 500 ppm and higher revealed that significant reductive dechlorination of highly chlorinated PCB congeners was occurring in a manner consistent with Brown's data supporting anaerobic processes (Pruell, 1988). These findings suggest that anaerobic degradation of sediment PCBs may be occurring more readily in highly contaminated (i.e., greater than 500 ppm) sediment; however, little or no anaerobic degradation is occurring in sediment with low (i.e., less than 500 ppm) PCB concentrations. Research conducted by General Electric focused on the comparison of congener composition in commercial PCB products (e.g., Aroclors) with the congener distributions in New Bedford Harbor sediment as a means of supporting their contention for anaerobic degradation (Brown and Wagner, 1986). However, it was suggested that depletion and shifts in congener distributions can also result from various physical and chemical processes, such as differential adsorption, volatilization, hydrolysis, and photo-oxidation (Myers, 1989).

Although biodegradation of PCBs in New Bedford Harbor sediment appears to be occurring, the studies conducted to date have not provided sufficient data for a reliable estimation of in-situ biochemical decay rates or half-lives. This information is crucial in evaluating the length of time that would be required for removal of PCBs from the Hot Spot area sediment by natural processes. Brown suggested that the half-life of anaerobic degradation of heavily chlorinated PCBs may range from 7 to 50 years (Brown and Wagner, 1986). Based on Brown's half-life estimate and assuming first order decay, the time required for biodegradation to reduce a sediment PCB concentration of 4,000 ppm (the lower limit of PCB concentration defining the Hot Spot area) to 50 ppm (TSCA) is approximately 50 to 300 years.

3.0 SUMMARY OF BASELINE PUBLIC HEALTH AND ENVIRONMENTAL RISK ASSESSMENT

As part of the New Bedford Harbor Superfund FS, baseline risk assessments were conducted to identify the public health and environmental risks associated with contaminants found within the New Bedford Harbor site area. A draft final baseline public health risk assessment report is scheduled to be released in May 1989. The baseline environmental risk assessment is scheduled for completion in June 1989.

The New Bedford Harbor site area was divided into three areas to assess the potential for exposure and subsequent public health and environmental risks. These areas, shown in Figure 3-1, were defined as follows:

- Area 1: the area between the Wood Street and Coggeshall Street bridges
- Area 2: The area between the Hurricane Barrier and the Coggeshall Street bridge
- Area 3: the area south of the Hurricane Barrier

For the assessment of risks associated with fish consumption, fish sampling data from beyond Area III were also included.

The public health and environmental risk assessments are based on current conditions and will serve as the basis for evaluation

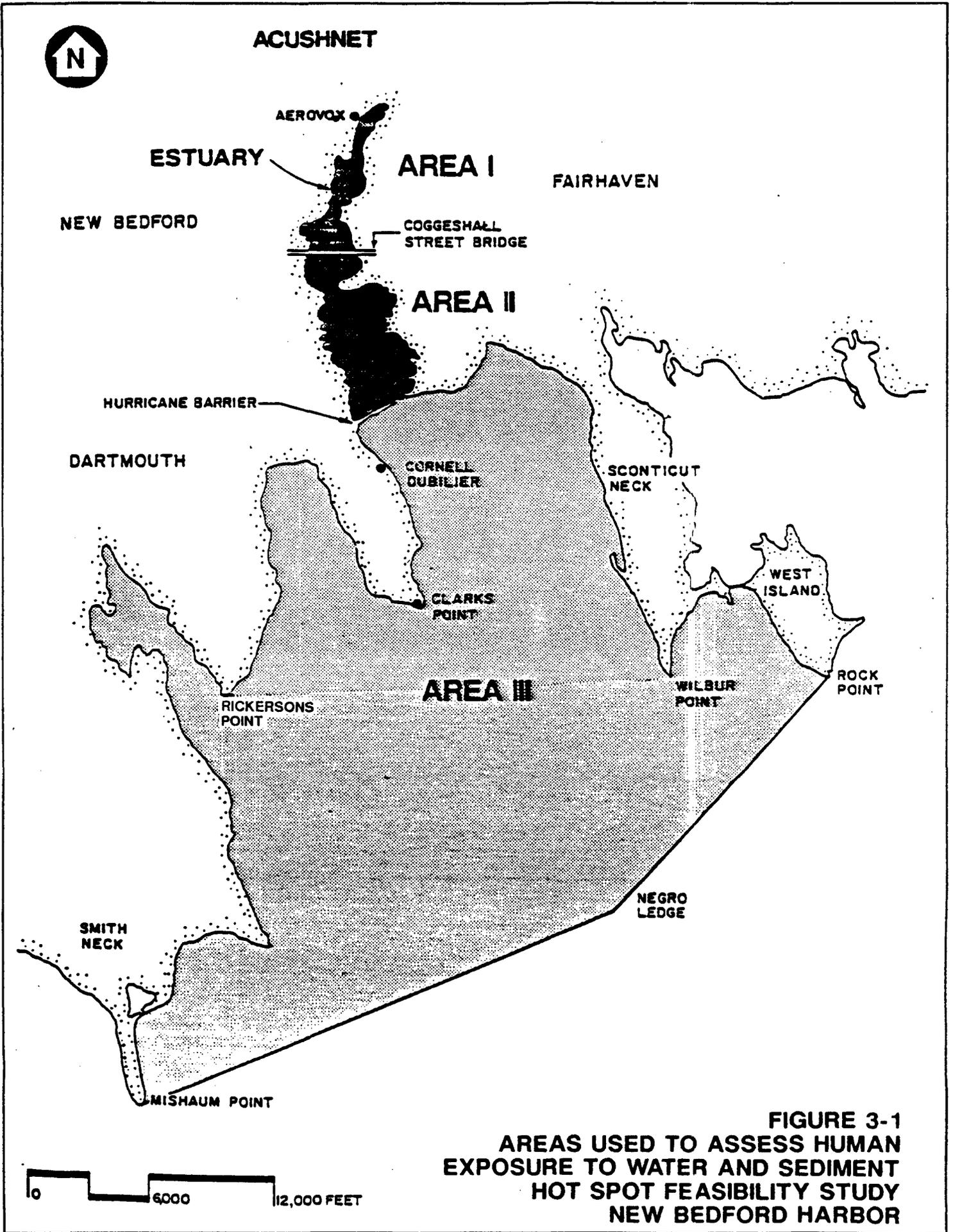


FIGURE 3-1
AREAS USED TO ASSESS HUMAN
EXPOSURE TO WATER AND SEDIMENT
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

of the no-action remedial alternative. A summary of the baseline risk assessment follows.

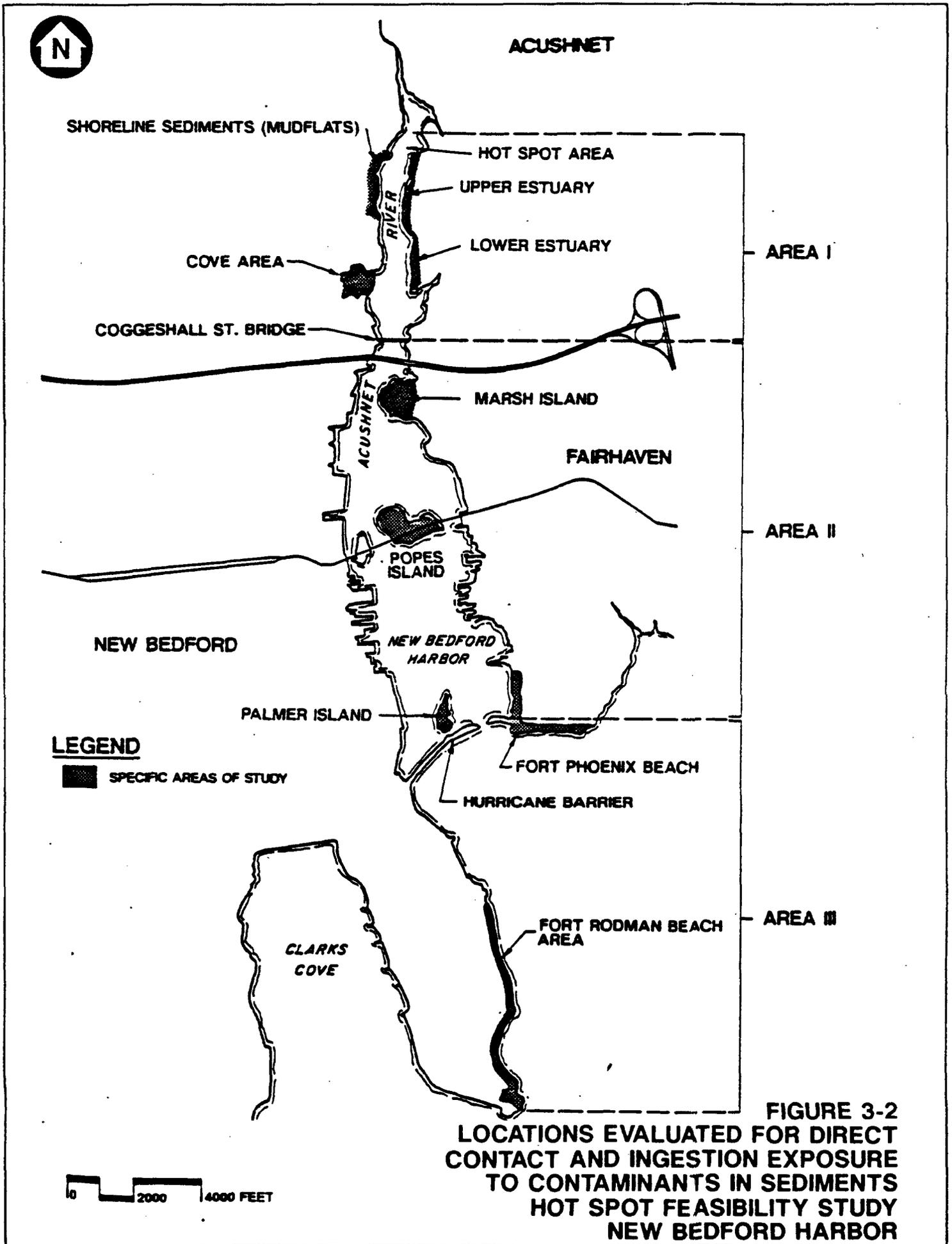
3.1 PUBLIC HEALTH RISK ASSESSMENT

3.1.1 Methodology

The purpose of the baseline public health risk assessment was to estimate risks to public health under current conditions due to exposure to PCBs and metals detected in the sediment, surface water, and biota within the New Bedford Harbor site. In addition to PCBs, heavy metals (i.e., cadmium, copper, and lead) were also found in sediment at elevated levels compared to data gathered in uncontaminated areas.

Within Areas I, II, and III, risks were evaluated at specific locations where activities likely to result in exposure occur (e.g., swimming, wading, and fishing). For Area I, separate risk estimates were developed for the cove area and the upper and lower estuary (Figure 3-2). For Area II, exposure was evaluated at Popes, Palmer, and Marsh Islands; for Area III, at the Fort Rodman and Fort Phoenix state beaches (i.e., locations that support recreational activities).

Based on results of a screening process designed to identify



**FIGURE 3-2
 LOCATIONS EVALUATED FOR DIRECT
 CONTACT AND INGESTION EXPOSURE
 TO CONTAMINANTS IN SEDIMENTS
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR**

pathways of exposure at the New Bedford Harbor site, direct contact and incidental ingestion of shoreline sediment and ingestion of aquatic biota were selected as the exposure pathways of primary concern (E.C. Jordan Co./Ebasco, 1989).

Screening results showed that under worst-case conditions, exposure to PCBs and metals in the surface water does not result in significant contaminant exposure; therefore, this pathway was not evaluated further in the risk assessment. Limited data were available to assess risks associated with inhalation exposure to PCBs.

Noncarcinogenic and carcinogenic risks were evaluated in the baseline risk assessment. Noncarcinogenic risk estimates were developed to assess the toxicity from exposure to PCBs, cadmium, copper, and lead. These estimates were generated by comparing the chronic daily intake of a contaminant (CDI) to the most applicable health-based standard or reference dose (RfD). The ratio of these values (CDI/RfD) was used to evaluate risk. In this report, this ratio is referred to as the risk ratio.

Generally, EPA states that if the ratio is less than 1, the predicted body dose level is anticipated to be without lifetime risk to human health (EPA, 1986). For example, a value of 0.25 implies that a person is receiving an estimated average daily dose equal to 25 percent of the acceptable intake of that contaminant. If the ratio exceeds 1, the estimated average

daily dose levels exceed a level considered safe; therefore, the exposure could potentially result in adverse health effects.

Carcinogenic risk estimates for PCBs (classified by EPA as probable human carcinogens) were calculated by multiplying the potency factor for PCBs (expressed as $(\text{mg}/\text{kg}\text{-day})^{-1}$) by the estimated body dose (expressed as $\text{mg}/\text{kg}\text{-day}$) of PCBs. The product of these two values is an estimate of the incremental lifetime cancer risk, which is defined as the excess probability that an individual will develop cancer over a lifetime.

EPA guidance states that the target total carcinogenic risk for an individual resulting from exposure at a Superfund site may range from 10^{-4} to 10^{-7} . Response objectives and remedial alternatives are developed to reduce total carcinogenic risks to levels within this range.

In addition to EPA guidance on evaluating health risks at Superfund sites, the Commonwealth of Massachusetts has issued regulations in the Massachusetts Contingency Plan (MCP) that are applicable to the site. As stated in the MCP, the total site cancer risk should be compared to a cancer risk limit of 1 in 100,000 (1×10^{-5}). The total site noncarcinogenic risk should be compared to a risk limit represented by a hazard index equal to 0.2. (A hazard index for a particular exposure pathway is equal to the sum of the risk ratios estimated for individual chemicals.)

The risk estimates generated in the baseline risk assessment were evaluated using the EPA guidance levels and on the MCP criteria.

3.1.2 Results of Baseline Public Health Risk Assessment

Numerous risk estimates were developed as part of the baseline risk assessment. Because the concentrations of contaminants and the potential for exposure varies greatly by location within the New Bedford Harbor site, separate risk estimates were generated for the three areas shown in Figure 3-1, as well as the specific locations within a given area (See Figure 3-2). The major findings of the baseline risk assessment are discussed in the following subsections.

3.1.2.1 Sediment

Area I. Exposure to sediment by direct contact and incidental ingestion in Area I was considered likely based on the ease of access to the shoreline, the large mudflat areas suitable for clamming, and the high population density around this area. Exposure to all subpopulations (children, older children, and adults) was evaluated. Children, ages 0-6, were considered to be at greater risk to PCB exposure than older children and adults. This is due, in part, to the fact that children engage in more activities that could result in contaminant exposure.

Because of the wide range of contaminant concentrations detected in shoreline sediment from this area, separate evaluations were made for the upper and lower halves of the estuary and the cove area (see Figure 3-2).

The majority of carcinogenic and noncarcinogenic risk estimates calculated, based on exposure to PCBs in sediment from these three areas, exceeded levels of risk considered to be at potential concern under current EPA and state guidance. A summary of the risk estimates based on a child's exposure to shoreline sediment appears in Table 3-1.

Noncarcinogenic risks associated with exposure to heavy metals in the sediment of Area I were not significant.

Area II. A majority of the shoreline in Area II is not readily accessible. Private property abutting the shoreline is fenced off and much of the land use is classified as industrial. However, three locations within this area are accessible and support recreational land uses: Popes Island, Marsh Island, and Palmer Island.

The PCB concentration in shoreline sediment was lowest for the Palmer Island area (mean 3 ppm; maximum 11 ppm) than for Marsh Island (mean 8 ppm; maximum 22 ppm) or Popes Island (mean 11

TABLE 3-1
 SUMMARY OF RISK ESTIMATES BASED ON A CHILD'S EXPOSURE TO
 PCB-CONTAMINATED SEDIMENT IN AREA I

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

<u>LOCATION</u>	<u>NONCARCINOGENIC RISKS</u> BASED ON EXPOSURE TO		<u>CARCINOGENIC RISKS</u> BASED ON EXPOSURE TO	
	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>
<u>Direct Contact Exposure</u>				
Area I:				
Upper Estuary	0.3	92	3×10^{-4}	3×10^{-2}
Lower Estuary	0.1	6	1×10^{-4}	2×10^{-3}
Cove Area	0.2	6	2×10^{-4}	2×10^{-3}
Hot Spot	3.2	490	3×10^{-3}	2×10^{-1}
<u>Ingestion Exposure</u>				
Area I:				
Upper Estuary	0.5	170	3×10^{-5}	1×10^{-2}
Lower Estuary	0.2	11	1×10^{-5}	6×10^{-4}
Cove Area	0.4	11	2×10^{-5}	6×10^{-4}
Hot Spot	5.6	950	3×10^{-4}	5×10^{-2}

TABLE 3-1
(continued)
SUMMARY OF RISK ESTIMATES BASED ON A CHILD'S EXPOSURE TO
PCB-CONTAMINATED SEDIMENT IN AREA I

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

<u>LOCATION</u>	<u>NONCARCINOGENIC RISKS</u>		<u>CARCINOGENIC RISKS</u>	
	<u>BASED ON EXPOSURE TO</u>		<u>BASED ON EXPOSURE TO</u>	
	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>
<u>Multi Media Exposure (concurrent exposure via direct contact with and ingestion of sediment)</u>				
Area I:				
Upper Estuary	0.8	260	3×10^{-4}	4×10^{-4}
Lower Estuary	0.3	17	1×10^{-4}	3×10^{-3}
Cove Area	0.6	17	2×10^{-4}	3×10^{-3}
Hot Spot	8.8	1,440	3×10^{-3}	1×10^{-1}

ppm; maximum 34 ppm). The incremental carcinogenic risks associated with contaminant exposure were greatest for children and older children. A summary of the risks associated with exposure in these three areas appears in Table 3-2.

Noncarcinogenic risks associated with exposure to metals were not significant.

Area III. Direct contact exposure to PCBs in sediment in Area III was assessed for the Fort Rodman (mean 2.1 ppm; maximum PCB 7.1 ppm) and Fort Phoenix (mean 0.6 ppm; maximum 0.8 ppm) state park beach areas. Risk estimates based on exposure to these concentrations fell below or within the target range (2×10^{-8} to 3×10^{-5}). Noncarcinogenic risks associated with heavy metals exposure were not considered to present a public health risk. Therefore, it was concluded that exposure to sediment in these areas does not pose a public health risk under current exposure conditions.

3.1.2.2 Biota

Exposure to PCBs through ingestion of biota was assessed based on concentrations detected in lobster, winter flounder, and clams. These species were considered representative of the biota most commonly consumed in the New Bedford Harbor area. Edible-tissue PCB concentrations were used when available. The range of PCB concentrations evaluated in this risk assessment

TABLE 3-2
 SUMMARY OF RISK ESTIMATES BASED ON A CHILD'S EXPOSURE TO
 PCB-CONTAMINATED SEDIMENT IN AREA II

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

<u>LOCATION</u>	<u>NONCARCINOGENIC RISKS</u> BASED ON EXPOSURE TO		<u>CARCINOGENIC RISKS</u> BASED ON EXPOSURE TO	
	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>	<u>MEAN CONCENTRATION</u>	<u>MAXIMUM CONCENTRATION</u>
<u>Direct Contact Exposure</u>				
Area II:				
Palmer Island	0.2	0.8	2×10^{-6}	4×10^{-5}
Marsh Island	0.6	1.6	5×10^{-6}	9×10^{-5}
Popes Island	0.8	2.5	8×10^{-6}	1×10^{-4}
<u>Ingestion Exposure</u>				
Area II:				
Palmer Island	0.08	1	4×10^{-6}	8×10^{-5}
Marsh Island	0.2	3	1×10^{-5}	1×10^{-4}
Popes Island	0.3	5	2×10^{-5}	2×10^{-4}
<u>Multi Media Exposure (concurrent exposure via direct contact with and ingestion of sediment)</u>				
Area II:				
Palmer Island	0.2	1.8	6×10^{-6}	1×10^{-4}
Popes Island	0.8	4.6	1×10^{-5}	2×10^{-4}
Marsh Island	1.1	7.5	3×10^{-5}	3×10^{-4}

5.89.18
 0007.0.0

was 0.039 to 2.7 ppm. Exposure frequencies of one fish meal per day, per week, and per month were assumed. A fish meal was considered to be an 8-ounce (227 grams) portion for older children and adults, and 4-ounce (115 grams) portion for younger children.

The risks from exposure to contaminants via ingestion of biota was greatest for children. Both noncarcinogenic and carcinogenic risk estimates in excess of EPA and state criteria were observed. The noncarcinogenic risk estimates for a child based on concurrent exposure to the mean PCB and metals concentrations detected in the three species ranged from 2.5 to 19. This range increased to 7.0 to 52 when assuming exposure to the maximum contaminant concentration detected in each species. The carcinogenic risk estimates for a child (chronic exposure) ranges from 1×10^{-4} to 1×10^{-2} for Area I; 4×10^{-5} to 8×10^{-3} for Area II; 3×10^{-5} to 5×10^{-3} for Area III, and 0×10^{-6} to 2×10^{-3} for Area IV.

3.1.3 Public Health Risks Associated with Hot Spot Areas

As discussed previously, the baseline risk assessment focused on locations within Area I where, based on land use patterns, it appeared that the potential for exposure was highest. These locations included the cove area and the areas designated as the upper and lower estuaries (See Figure 3-2). Additional locations within the Hot Spot area that are adjacent to the

shoreline also present the potential for exposure and were also evaluated. In particular, two locations at the northern end of the estuary in the Hot Spot area contain high concentrations of PCBs in sediment (i.e., 4,040 and 34,334 ppm), and are accessible to both children and adults.

Incremental carcinogenic risks associated with direct contact to this sediment exceed the EPA target range. Assuming exposure to sediment containing 4,040 ppm PCBs, the risks range from 3×10^{-4} to 1×10^{-2} under average and conservative exposure conditions, respectively. At 34,334 ppm PCBs, the estimated cancer risks range from 3×10^{-4} to 1×10^{-1} . On average, these estimated risks represent an increase of one to two orders of magnitude over risks predicted for the cove area and upper and lower estuary areas of Area I.

Based on the direct contact hazard presented by the highly contaminated sediment in the Hot Spot area, significant public health risks would be expected under the assumed conditions of exposure.

3.2 ECOLOGICAL RISK ASSESSMENT

3.2.1 Methodology

The ecological risk assessment for the New Bedford Harbor site examined potential risks to marine biota due to exposure to

PCBs, cadmium, copper, and lead. Because the focus of this document concerns the effects of the PCB Hot Spot area in the upper estuary, only risks due to PCBs will be considered.

Thirty-three species were identified as aquatic receptors in the harbor. These species were considered representative of the range of organisms in New Bedford Harbor and included species from each major trophic level. Routes of exposure considered in the assessment included direct contact with water and sediment and ingestion of contaminated food. EPA Ambient Water Quality Criteria (AWQC), laboratory-derived toxicity data, and site-specific toxicity data (when available) were used in the risk assessment.

Exposure to contaminated sediment was evaluated separately for each of the three harbor areas (i.e., Areas I, II, and III). The area boundaries were the same as those defined in the public health risk summary (see Subsection 3.1.1). Potential ecological risks were evaluated by comparing the mean and maximum contaminant concentrations in these areas to site-specific toxicity data and EPA criteria values.

Exposure to contaminants in the water column was assessed for the same three areas as sediment and for an additional area that extended farther into Buzzards Bay (see Figure 3-1). Water-column contaminant concentrations in these areas were compared to both chronic criteria, and maximum concentrations to

acute criteria.

Body burden of PCBs was evaluated for the same area of the harbor used in the public health evaluation by comparing tissue concentrations in biota with species-specific toxicity data.

3.2.2 Results of Environmental Baseline Assessment

Exposure to sediment from Areas 1 and 2 of New Bedford Harbor has been shown to produce toxic response in test organisms. Mortality rates greater than 90 percent and greater than 50 percent were observed in amphipods exposed to sediment from Areas I and II, respectively. Fish demonstrated increased mortality when exposed to sediment from Area I and impaired reproductive capacity when exposed to sediment from Areas I and II. No significant effects were observed with sheepshead minnows or amphipods exposed to sediment containing up to 10 ppm PCBs.

Comparison of total PCB water column concentrations to the AWQC indicated that mean PCB concentrations exceeded the chronic AWQC in Areas I, II, and III of the harbor, indicating that there is an expected impact to aquatic life in these areas. A toxicity quotient analysis, comparing mean PCB concentrations to a laboratory benchmark concentration, indicated a potential risk due to PCB exposure in Areas I and II. This analysis also indicated that there is little or no risk to aquatic organisms

in Areas III and IV.

PCB body burdens in winter flounder from all areas of the harbor were found to exceed levels determined by Black and Capuzzo to result in reproductive effects (Black, 1986; and Capuzzo, 1986). Reproductive impairment in winter flounder occurs at organ-specific concentrations as low as 0.1 ppm; maximum whole body PCB concentrations in New Bedford were up to 8.2 ppm in Area 1.

Based on evaluations of species-specific effects due to PCB contamination, it is probable that the structure and function of the New Bedford Harbor ecosystem were impacted by PCB contamination. Levels of PCBs, particularly in Area 1, are sufficient to result in mortality, decreased reproduction, and decreased food resources. A study of benthic populations in the harbor indicated impaired community structure in the upper estuary (USACE, 1986) and toxicity tests conducted by EPA (Hansen, 1986) have demonstrated the toxicity of sediment from this area to amphipod crustaceans, an important component of estuarine communities.

3.2.3 Ecological Risks Associated with the Hot Spot Area

The Hot Spot area represents both the majority of the PCB mass in the upper estuary and the most concentrated source of PCBs to the water column and biota. As discussed in Section 2.0, mean

PCB concentrations in the water column in the vicinity of the Hot Spot area are the highest recorded in the harbor, and decreasing consistently with distance from the Hot Spot area. These observations clearly indicate that PCBs are desorbed from the Hot Spot sediment and/or are resuspended with the sediment, thereby becoming available for transport throughout the upper estuary and then to the lower harbor and bay.

Risks to aquatic life directly related to the Hot Spot area occur in the same three forms discussed: via direct contact with sediment, through contact with contaminants in the water column, and via ingestion of contaminated food. Due to the extreme contamination present in Hot Spot surface sediment, benthic and demersal organisms are effectively precluded from living in the area. This loss of habitat is potentially significant and may be readily compared to the total estuarine habitat available in the area. As a loss to the system, it is considerably less significant than potential effects due to transport of PCBs from the Hot Spot area to the remainder of the system.

Ecological risks due to transport of PCBs from the Hot Spot sediment are a function of the amount of sediment exposed and the extent of contamination in the sediment. Although the Hot Spot area represents a relatively small percentage of the sediment in the upper estuary, the extreme concentrations exposed for partitioning into the water column are apparently

sufficient to dominate the patterns of water column contamination in the area. As such, the Hot Spot area represents the source of a significant fraction (approximately 48 percent) of the total PCB mass in the upper estuary.

Risk to aquatic organisms is a probabilistic function of the areal distribution of contaminant levels and the effect of a given level on the target species. Because the latter is constant for a given contaminant in a given system, any increase in the total amount of PCBs in the system directly increases the area extent of contamination, therefore resulting in an increase in the probability of deleterious effects on resident organisms. Patterns of contamination in the estuary are sufficient to indicate that the Hot Spot area dominates contamination in the area; accordingly, it is the most important variable to control with respect to environmental risk in the New Bedford Harbor system.

4.0 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES, APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, AND GENERAL RESPONSE ACTIONS

Remedial action objectives serve as guidelines in the development of alternatives for remediation. The remedial action objectives specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals.

The potential applicable or relevant and appropriate requirements (ARARs) and the remedial action objectives for the Hot Spot area are in Sections 4.2 and 4.3, respectively. These objectives are subsequently used to develop general response actions (Section 4.4) that will formulate the basis for the selection of technologies (See Section 5.0), and the development and evaluation of alternatives for remediation of the Hot Spot area (See Sections 6.0 and 7.0).

4.1 INTRODUCTION

Prior to SARA's enactment on October 17, 1986, remedial actions taken in response to releases of hazardous substances were conducted in accordance with the revised NCP (40 CFR Part 300) dated November 20, 1985. While the existing NCP and the standards and procedures established by SARA overlap in many areas, there are differences between the two. Section 121 of SARA, for example, added new clean-up objectives to CERCLA. In

the interim, until the proposed NCP becomes final, the procedures and standards employed by the EPA in responding to releases of hazardous substances, pollutants, and contaminants are to comply with Section 121 of SARA and, to the maximum extent practicable, the proposed NCP.

SARA retained the original CERCLA mandate to conduct protective and cost-effective remedial actions. Remedial actions, as defined by 300.68(a)(1) of the NCP, are those responses to releases that are consistent with a permanent remedy to protect against or minimize release of hazardous substances, pollutants, or contaminants so that they do not migrate to cause substantial danger to present or future public health and welfare or the environment.

In formulating a remedy, CERCLA now requires EPA to emphasize risk reduction through destruction or treatment of hazardous waste. Section 121 of SARA establishes a statutory preference for remedies that permanently and significantly reduce the mobility, toxicity, or volume of hazardous waste over remedies that do not use such treatment. Section 121 also requires EPA to select a remedy that is protective of public health and the environment, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Furthermore, Section 121 requires that, upon

completion, remedies must attain ARARs unless specified waivers are granted.

Section 300.68 of the NCP, in conjunction with EPA guidance on conducting FSS (EPA, 1988), sets forth the remedial alternative development and evaluation process. This process consists of the following steps:

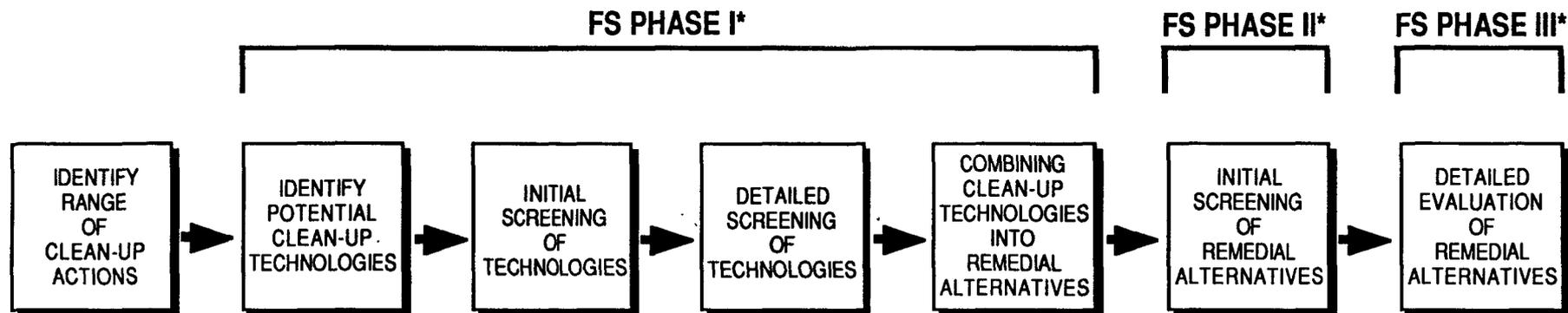
- Identify the nature and extent of contamination and threat presented by the release (300.68[e][2]).
- Identify general response objectives for site remediation.
- Identify and screen remedial technologies potentially applicable to wastes and site conditions.
- Develop alternatives to achieve site-specific response objectives (300.68[f]).
- Conduct initial screening of alternatives (300.68[f]).
- Conduct initial analysis of alternatives (300.68[g]).

An overview of the FS process for the New Bedford Harbor Superfund site is illustrated in Figure 4-1.

As an initial step, both CERCLA and the NCP require the identification of the nature and extent of site contamination. The nature and distribution of contamination and the threat posed by the release of contaminants from the Hot Spot area are discussed in Sections 2.0 and 3.0. Beyond initial site characterization, Section 121 of SARA retains the basic framework for the remedial alternatives development and remedy selection process enacted through NCP; however, each phase must be modified to reflect the provisions of SARA.

4.2 SITE-SPECIFIC ARARS

Section 121(d) of SARA and the NCP (40 CFR Part 300; November 20, 1985) require that CERCLA remedial actions comply with all federal ARARs. State requirements must also be attained under Section 121 (d)(2)(c) of SARA, if they are legally enforceable and consistently enforced statewide. ARARs are used to determine the appropriate extent of site cleanup, scope and formulate remedial action alternatives, and to govern the implementation and operation of the selected action. According to SARA, requirements may be waived by EPA under six specific conditions, provided protection of public health and the



* EPA OSWER DIRECTIVE OCTOBER, 1988:
GUIDANCE FOR CONDUCTING REMEDIAL
INVESTIGATION AND FEASIBILITY STUDIES
UNDER CERCLA

FIGURE 4-1
OVERVIEW OF THE FS PROCESS
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

environment is still assured. These conditions include the following:

- The selected remedial action is an interim remedy.
- Compliance with such requirements will result in greater risk to public health and the environment than alternative options.
- Compliance with such requirements is technically impracticable from an engineering perspective.
- The selected remedial action will provide an equivalent standard of performance using another approach.
- The requirement is a state requirement that has been inconsistently applied.
- Attainment of the ARAR would entail extremely high costs relative to the added degree of reduction of risk afforded by the standard (i.e., Fund Balancing).

In this section, the approach to ARARs for the Hot Spot FS is discussed, and potential ARARs are identified.

4.2.1 Definition of ARARs

To consider ARARs and, more importantly, to incorporate consideration of ARARs in the FS and remedial response processes, the NCP and SARA have defined both applicable requirements and relevant and appropriate requirements as follows:

Applicable Requirements. Applicable requirements are those federal and state requirements that would be legally applicable, either directly or as incorporated by a federally authorized state program, if response actions were not taken pursuant to Section 104 or 106 of CERCLA.

Requirements that are applicable to, and have jurisdiction over, given situations are considered "applicable requirements." An example of an applicable requirement would be Maximum Contaminant Levels (MCLs) for a site that exhibits groundwater contamination entering a public water supply.

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those federal and state requirements that, while not legally "applicable," can be applied if the decision-maker's best professional judgement determines that site circumstances are sufficiently similar to those situations that are jurisdictionally covered, and use of the requirement

makes good sense. During the FS process, relevant and appropriate requirements are intended to have the same weight and consideration as applicable requirements.

The term "relevant" was included so that a requirement initially screened as non-applicable because of jurisdictional restrictions would be reconsidered and, if appropriate, included as an ARAR for the site. For example, MCLs would be a non-applicable, but relevant and appropriate for a site that exhibited groundwater contamination in a potential (as opposed to an actual) drinking water source.

Other Requirements to be Considered. A third category of requirements to be considered is federal and state nonregulatory requirements (e.g., guidance documents or criteria). Nonpromulgated advisories or guidance documents do not have the status of ARARs. However, where there are no specific ARARs for a chemical or situation, or where such ARARs are not sufficient to be protective, guidance or advisories should be identified and used to ensure that a remedy is protective.

4.2.2 Development of ARARs

Under the description of ARARs set forth in the NCP and SARA, many federal and state environmental requirements must be considered. These requirements include ARARs that are:

- chemical-specific (i.e., govern the extent of site cleanup)
- location-specific (i.e., pertain to existing site features)
- action-specific (i.e., pertain to proposed site remedies and govern implementation of the selected site remedy)

Chemical-specific ARARs govern the extent of site cleanup and provide either actual clean-up levels or a basis for calculating such levels. For instance, surface water criteria and standards, as well as air standards, provide necessary clean-up goals for the Hot Spot FS. Chemical-specific ARARs are also used to indicate acceptable levels of discharge to determine treatment and disposal requirements, and to assess the effectiveness of remedial alternatives.

Location-specific ARARs govern natural site features such as wetlands and floodplains, as well as manmade features including existing landfills, disposal areas, and local historic buildings. Location-specific ARARs are generally restrictions on the concentration of hazardous substances or the conduct of activities solely because of the site's particular characteristics or location. These ARARs provide a basis for

assessing existing site conditions and subsequently aid in assessing potential remedial alternatives. For the Hot Spot FS, location-specific ARARs that pertain to the wetland and floodplain areas will be considered.

Action-specific ARARs are usually technology- or activity-based limitations that control actions at CERCLA sites. After remedial alternatives are developed, action-specific ARARs pertaining to proposed site remedies provide a basis for assessing the feasibility and effectiveness of the remedies. For example, these action-specific ARARs may include hazardous waste transportation and handling requirements, air and water emissions standards, and the Resource Conservation and Recovery Act (RCRA) landfilling and treatment requirements.

4.2.3 Identification of ARARs

A separate document has been published for the New Bedford Harbor site that has identified the potential chemical-, location-, and action-specific ARARs. This document, Regulation Assessment for New Bedford Harbor (E.C. Jordan Co./Ebasco, 1988), identifies both federal and state ARARs and provides a written summary of the procedural and technical requirements of these regulations. In this section, ARARs pertinent to the Hot Spot area will be summarized.

Tables 4-1, 4-2, and 4-3 present the potential chemical-, location-, and action-specific ARARs, respectively. To be consistent with the NCP definition of ARARs and changes made by SARA, each table has been subdivided as follows:

- federal requirements
- Massachusetts requirements
- federal criteria, advisories, and guidance documents
- Massachusetts criteria, advisories, and guidance documents

4.3 REMEDIAL ACTION OBJECTIVES

The remedial response objectives for the Hot Spot are specific to that area of the Acushnet River estuary and do not address the other areas of contamination in the harbor. As stated previously, the Hot Spot is a small volume of highly contaminated PCB sediment (>4,000 ppm) which constitutes a large portion of the PCB mass in the harbor. The removal and/or treatment of this sediment is considered an interim remedy, as the remainder of the PCB-contaminated sediment will need to be addressed.

TABLE 4-1
 POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE FOR THE
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
<u>Surface Water</u>				
State Regulatory Requirements	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE surface water quality standards incorporate the federal AWQE as standards for surface waters of the state.	AWQE applicable to the hot spot area are as follows: PCBs - 10 ppb (acute effects on aquatic life) - .03 ppb (chronic effects on aquatic life) Cadmium - 43 ppb (acute effects) 9.9 ppb (chronic effects) Copper - 2.9 ppb (acute effects) 2.9 ppb (chronic effects) Lead - 140 ppb (acute effects) - 5.6 ppb (chronic effects)
Federal Criteria, Advisories, and Guidance	Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC are health-based criteria that have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQC are incorporated into mass DEQE standards as discussed above.
FCAG	Federal Food, Drug and Cosmetic Act	To be Considered	This act sets forth FDA limit of 2 ppm for PCB concentrations in commercial fish and shellfish.	This level will be used as an ultimate clean-up level to which alternatives will be evaluated.
<u>Air</u>				
Federal Regulatory Requirements	CAA - National Ambient Air Quality Standards (NAAQS) - 40 CFR 40.	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Standards for particulate matter will be used when assessing excavation and emission controls for sediment treatments.
State Regulatory Requirements	DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00).	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Alternatives involving excavation, air and emission controls for sediment treatments will be compared against these standards.
Federal Criteria, Advisories, and Guidance	Threshold Limit Value (TLV)	To be Considered	These standards were issued as consensus standards for controlling air quality in workplace environments.	TLVs could be used for assessing site inhalation risks for soil removal operations.

TABLE 4-2
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE FOR THE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
<u>Wetlands/Floodplains</u> Federal Regulatory Requirements	Clean Water Act (CWA) 40 CFR Part 404	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.
	Fish and Wildlife Coordination Act (16 U.S.C 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Services. This requirement is addressed under CWA Section 404 requirements.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. If an alternative modifies a body of water, EPA must consult the U.S. Fish and Wildlife Services.
	RCRA Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	A facility located on a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless waste may be removed safely before floodwater can reach the facility or no adverse effects on human health and the environment would result if washout occurred.
State Regulatory Requirements	Coastal Zone Management Act (15 CFR 930,923.45)	Applicable	Any federal agency proposing to do work in a state's coastal zone must submit to the state a consistency determination 90 days before approval is required.	The requirements of this act will be incorporated into the remedial design and scheduled to comply with the 90 day time limit.
	DEQE - Wetlands Protection (310 CMR 10.00)	Applicable	These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated.	If alternatives involve removing, filling, dredging, or altering a DEQE-defined wetland, a Notice of Intent must be filed with the DEQE. If work is conducted within 100 feet of a wetland, a request for a Determination Applicability must be filed. Any person who files a Notice of Intent must demonstrate that the area is not significant to the wetland or that the proposed work will contribute to the protection of the wetland.
Federal Nonregulatory Requirements to be Considered	Environmental Affairs - Coastal Zone Management Program (310 CMR 20-22)	Applicable	These regulations outline Massachusetts requirements for compliance with the Coastal Zone Management Act.	The requirements of this act will be incorporated into the remedial design and scheduled to comply with the 90 day time limit.
	Wetlands Executive Order (EO 11990)	To be Considered	Under this regulation, federal agencies are required to minimize the destruction loss or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	Remedial alternatives that involve construction must include all practicable means of minimizing harm to wetlands. Wetlands protection considerations must be incorporated into the planning and decision-making about remedial alternatives.

TABLE 4-2
(continued)
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE FOR THE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
<u>Wetlands/Floodplains</u> Federal Nonregulatory Requirements to be Considered (continued)	Floodplains Executive Order (EO 11988)	To be Considered	Federal agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	The potential effects of any action must be evaluated to ensure that the planning and decision-making reflect consideration of flood hazards and floodplain management, including restoration and preservation of natural undeveloped floodplains.

TABLE 4-3
POTENTIAL ACTION-SPECIFIC ARARs FOR THE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
RCRA - General Facility Standards (40 CFR 264.10 - 264.18)	General facility requirements outline general waste analysis, security measures, inspections, and training requirements.	Any facilities will be constructed, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further landing requirements.
RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.31)	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies. Copies of the plans will be kept on-site.
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90 - 264.109)	This regulation details requirements for a groundwater monitoring program to be installed at the site.	A groundwater monitoring program is a component of all alternatives. RCRA regulations will be utilized as guidance during development of this program.
RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	This regulation details specific requirements for closure and post-closure of hazardous waste facilities.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be incorporated into the design.
RCRA - Regulations on Land Disposal Restrictions (40 CFR 268)	This regulation outlines land disposal requirements and restrictions for hazardous wastes.	Contaminated soils as listed in the regulations will be treated to the Best Demonstrated Available Technology levels before being placed or replaced on the land. Hazardous waste cannot be stored except for accumulation for recovery, treatment, or disposal.
RCRA - Surface Impoundments items (40 CFR 264.220 - 264.249)	This regulation details the design, construction, operation, monitoring, inspection, and contingency plans for a RCRA surface impoundment. Also provides three closure options for CERCLA sites; Clean closure, containment closure, and alternate closure.	To comply with clean closure, owner must remove or decontaminate all waste. To comply with containment closure, the owner must eliminate free liquid, stabilize remaining waste, and cover impoundment with a cover that complies with the regulation. Integrity of cover must be maintained, groundwater system monitored, and runoff controlled. To comply with alternate closure, all pathways of exposure to contaminants must be eliminated and long-term monitoring provided.
RCRA - Waste Piles (40 CFR 264.250 - 264.269)	Details procedures, operating requirements, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated subsoils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste may comply with either the waste pile or landfill requirements. The temporary storage of solid waste on-site, therefore, must comply with one or the other subpart.
RCRA - Landfills (40 CFR 264.300 - 264.339)	This regulation details the design, operation, monitoring, inspection, recordkeeping, closure, and permit requirements for a RCRA landfill.	Disposal of contaminated materials from the Sullivan's Ledge site would be to a RCRA-permitted facility that complies with RCRA landfill regulations, including closure and post-closure. On-site disposal would include a RCRA designed cap.

TABLE 4-3
(continued)
POTENTIAL ACTION-SPECIFIC ARARs FOR THE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
RCRA - Incinerators (40 CFR 264.340 - 264.599)	This regulation specifies the performance standards, operating requirements, monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	On-site thermal treatment must comply with the appropriate requirements specified in this subpart of RCRA.
RCRA - Miscellaneous Units (40 CFR 264.600 - 264.999)	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations for treatment, storage, and disposal units.	Units not previously defined under RCRA must comply with these requirements.
TSCA Disposal Requirements (40 CFR Part 761.60)	PCBs at concentrations greater than 50 ppm, but less than 500 ppm, must be disposed of either in an incinerator, or in a chemical waste landfill, or by another technology capable of providing equal treatment. PCBs at concentrations greater than 500 ppm must be disposed of in an incinerator or treated by an alternate technology capable of equal treatment or disposed of in a chemical waste landfill.	PCB Treatment must comply with these regulations during remedial action.
OSHA - General Industry Standards (29 CFR Part 1910)	These regulations specify the 8-hour time-weighted average concentration for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 9910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site. In addition, safety procedures will be followed during on-site activities.
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors and must be followed during all site work.
CWA - 40 CFR Part 403	This regulation specifies pretreatment standards for discharges to a publicly owned treatment works (POTW).	If a leachate collection system is installed and the discharge is sent to a POTW, the POTW must have an approved pretreatment program. The collected leachate runoff must be in compliance with the approved program. Prior to discharging, a report must be submitted containing identifying information, list of approved permits, description of operations, flow measurements, measurement of pollutants, certification by a qualified professional, and a compliance schedule.
CWA - 40 CFR Part 404	This regulation outlines requirements for discharges of dredged or fill material. Under this requirement, no activity that impacts a wetland shall be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	During the identification, screening, and evaluation of alternatives, the effects on wetlands must be evaluated.

TABLE 4-3
(continued)
POTENTIAL ACTION-SPECIFIC ARARs FOR THE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
National Environmental Policy Act (40 CFR 6)	This act sets forth the policy for carrying out the provisions of the Floodplain Management and the Protection of Wetlands Executive Orders.	The policies for management of floodplains and protection of wetlands should be considered during remedial alternative implementation.
Regulations on Disposal Site Determinations Under the Water Act (40 CFR 231)	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill material into U.S. waters, which include wetlands.	The dredged or fill material should not be discharged unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact on the wetlands.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labelling, manifesting, and transporting of hazardous materials.	Contaminated materials will be packaged, manifested, and transported to a licensed off-site disposal facility in compliance with these regulations.
DEQE - Hazardous Waste Regulations, Phases I and II. (310 CMR 30.000, MGL Ch. ZIC)	This regulation provides a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations.	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the Sullivan's Ledge site.
Massachusetts Environmental Policy Act Regulations (30 CMR 10.00)	These regulations describe the process for filing an Environmental Impact Report (EIR).	DEQE has filed an Environmental Notification form with the MEPA unit. MEPA will continue to review major documents as specified in the MEPA certificate.
MDWPC - Massachusetts Surface Water Discharge Permit Program (314 CMR 1.00-7.00)	This section outlines the requirements for obtaining an NPDES permit in Massachusetts.	Pollutant discharges to surface water must comply with NPDES permit requirements. Permit conditions and standards for different classes of water are specified.
NDWPC - Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00)	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulations. These regulations are applicable to: a water treatment unit; a surface impoundment that treats influent wastewater; and a POTW that generates, accumulates, and treats hazardous waste.	All owners and operators of RCRA facilities shall comply with the management standards of 310 CMR 30.500, the technical standards of 310 CMR 30.600, the location standards of 310 CMR 30.700, the financial responsibility requirements of 310 CMR 30.900, and in the case of POTWs, the standards for generators in 310 CRM 30.300.
Waterways Regulations (314 CMR 9.00 MGL Ch. 91)	This regulation is promulgated to establish procedures, criteria, and standards for the water quality certification of dredging and dredged material disposal.	Applications for proposed dredging/fill work need to be submitted and approved before work commences. Three categories have been established for dredge or fill material based on the chemical constituents. Approved methods for dredging, handling, and disposal options for the three categories must be met.
DPH - Right to Know (105 CMR 670)	This regulation establishes the Massachusetts Substance List. The goal of this regulation is to protect public health by providing information concerning hazardous substances.	This regulation will be attained during the implementation of the remedial alternative by providing all workers with hazardous substance information.

TABLE 4-3
 (continued)
 POTENTIAL ACTION-SPECIFIC ARARs FOR THE
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

ARARs	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARs
DEQE - Disposal of Solid Waste by Sanitary Landfill (310 CMR 19.00)	This regulation establishes rules and requirements for solid waste disposal facilities.	Landfilling of screened, non-hazardous material will comply with this regulation.
DEQE - Right to Know (310 CMR 33.00)	This regulation establishes rules and requirements for the dissemination of information related to hazardous substances to the public.	This regulation will be attained during the implementation of the remedial alternative by providing the public with hazardous substance information.
DOI - Right to Know (441 CMR 21.00)	This regulation establishes requirements for worker "right to know."	This regulation will be attained during the implementation of the remedial alternative by providing all workers with hazardous substance information.

The removal and/or treatment of the Hot Spot area would be the first step in clean-up of the harbor. The primary concern with the Hot Spot area is its function as a source of PCBs to the remainder of the harbor, and the direct public health and environmental threat posed by direct contact with the sediment. Based on this information, three response objectives have been developed:

- Provide protection to the public health threat posed by direct contact with Hot Spot sediment.
- Provide protection to the environmental receptors in direct contact with Hot Spot sediment.
- Reduce PCB-migration from Hot Spot sediment that acts as a PCB source to the water column and remainder of the harbor environment.

In selecting alternatives to achieve these remedial objectives, preference should be given to alternatives that:

- reduce the mobility, toxicity, or volume of the Hot Spot area PCB-contaminated sediment
- utilize permanent solutions and innovative treatment technologies to the maximum extent practicable.

4.4 GENERAL RESPONSE ACTIONS .

General response actions describe remedial actions that will satisfy the remedial action objectives. General response actions conceptualize potential remedial measure that may be employed to address remedial action objectives. These remedial measures include containment, sediment removal, treatment, institutional controls, or a combination of these options. General response actions lay the groundwork for identifying specific technologies, which are discussed in Section 5.0. The general response actions for this FS are listed in Table 4.4.

TABLE 4-4

GENERAL RESPONSE ACTIONS TO ADDRESS
REMEDIAL ACTION OBJECTIVESHOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIA	REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION/TECHNOLOGY	REMEDIAL TECHNOLOGY TYPES
Sediment	<u>Public Health Protection</u>	No-Action Institutional Actions:	No-Action/Institutional Actions:
	<ul style="list-style-type: none"> ● Provide Protection to Public Health Threat Posed by Direct Contact with Hot Spot Sediment 	<ul style="list-style-type: none"> - No-Action - Restrict Access - Monitor 	<ul style="list-style-type: none"> - Fencing - Deed Restrictions - Public Education
	<u>Environmental Protection</u>	Containment Actions:	Containment Actions:
	<ul style="list-style-type: none"> ● Provide Protection to the Environmental Receptors in Direct Contact with Hot Spot Sediment 	<ul style="list-style-type: none"> - Cap/Barriers 	<ul style="list-style-type: none"> - Soil/Sediment Cap - Synthetic Cap - Vertical Barriers (Sheet Pile, Embankment) - Sediment Control Barriers
	<ul style="list-style-type: none"> ● Reduce PCB-migration from the Hot Spot Sediment which Acts as a PCB Source to the Water Column and Remainder of the Harbor Environment 		
	<u>SARA Requirements</u>	Excavation/Treatment Actions:	Excavation/Treatment Actions
	<ul style="list-style-type: none"> ● Reduce Volume, Toxicity or Mobility of Hot Spot Sediment 	<ul style="list-style-type: none"> - Dredge/Dispose - Dredge/Treat/Dispose 	<ul style="list-style-type: none"> - Dredges - Mechanical Excavations - Slurry Pumps - Solidification - Dewatering - Water Treatment - Physical Treatment - Chemical Treatment - Biological Treatment - Thermal Treatment - In-situ Treatment
	<ul style="list-style-type: none"> ● Use Permanent Solutions 		
	<ul style="list-style-type: none"> ● Use Innovative Treatment Technologies 		

5.0 IDENTIFICATION, SCREENING, AND EVALUATION OF TECHNOLOGIES

5.1 INTRODUCTION

Remedial alternatives consist of combinations of technology types and process options that form a series of response actions necessary to achieve the remedial objectives developed for a site problem. Technology types may include: excavation/dredging; physical, chemical, thermal, and biological treatment; and containment. Several technology types may be identified for each response action. Specific technologies, or process options, may exist within each technology type. For example, physical treatment would include process options such as solvent extraction, solidification, and air stripping. General response actions and technology types were identified for New Bedford Harbor and are shown in Figure 5-1.

This section discusses the results of the identification, screening, and evaluation of technologies. Section 5.0 is an inventory of applicable technologies that can be assembled into remedial alternatives capable of meeting the remedial action objectives (see Section 4.0) for the Hot Spot area.

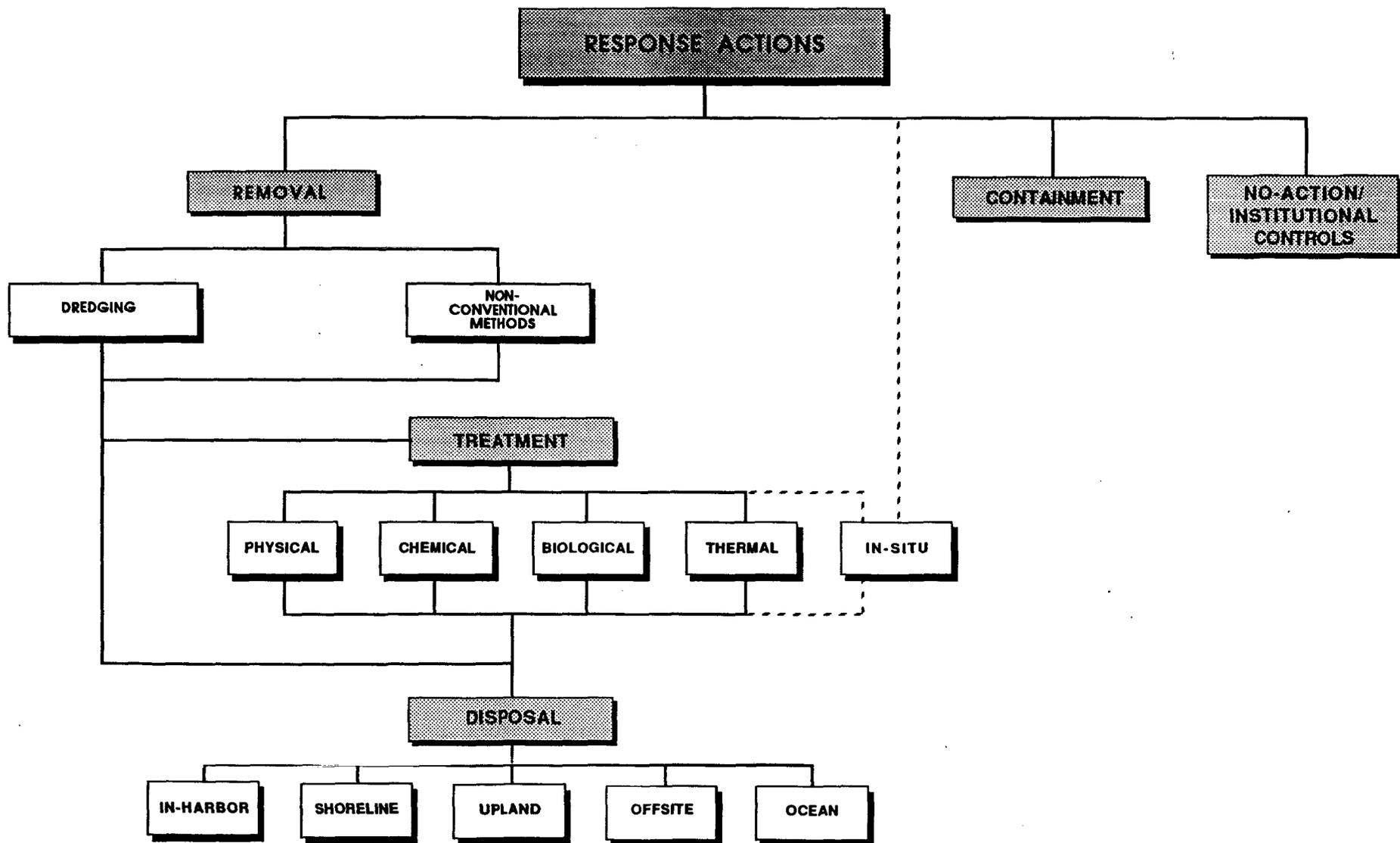


FIGURE 5-1
GENERAL RESPONSE ACTIONS & TECHNOLOGY TYPES
IDENTIFIED FOR NEW BEDFORD HARBOR
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

5.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

From a remedial standpoint, the PCB- and metal-contaminated sediment in New Bedford are the primary environmental medium of concern. The 5-acre Hot Spot area in the upper estuary contains approximately 10,000 cubic yards (in situ) of contaminated sediment with PCB concentrations ranging from 4,000 ppm to over 100,000 ppm. Sediment metals (predominantly cadmium, copper and lead) concentrations range from below detection to approximately 4,000 ppm. The sediment in the Hot Spot area is 75 to 80 percent fine-grained organic silts and marine clays. Total organic carbon content ranges from 17.1 percent to 140.3 percent with a mean value of approximately 89.4 percent. Moisture content of the sediment ranges from 30 to 60 percent.

Mean tidal ranges are 3.8 feet for the Acushnet River Estuary with a maximum difference between alternative tides of 1.2 feet. Low tide exposes much of the Hot Spot area as mudflats. Mean low water depths in this area range from -1.6 to 2.2 feet.

Remedial alternatives developed for the Hot Spot will also need to consider technology types and process options for treating PCB and metal contaminated water generated as a liquid waste stream during sediment dewatering and treatment.

Identification and screening of remedial technologies are the first steps in producing an inventory of applicable

technologies. Technology types and process options for remediating hazardous waste were identified through numerous sources including trade periodicals; computer database searches; EPA Superfund guidance documents and funded studies; other FSs; and direct contacts with technology vendors. Technology types and process options identified for New Bedford Harbor are presented in Table 5-1. In the subsequent screening step, technology types and process options were eliminated from further consideration on the basis of technical implementability with respect to the site and waste specific conditions found in New Bedford Harbor and the Hot Spot area within the harbor.

Figure 5-2 summarizes the technology types and process options that were retained for detailed evaluation. The identification and screening of technologies for New Bedford Harbor has been described in detail in numerous published reports (E.C. Jordan Co./Ebasco, 1987a,b,c; and Palermo and Pankow, 1988).

5.3 DETAILED EVALUATION OF TECHNOLOGIES

The purpose of the detailed evaluation of technologies is to refine the list of applicable technologies retained after screening. One representative process is selected, if possible, for each technology type to simplify the subsequent development, screening and detailed analysis of remedial alternatives (see Sections 6.0 and 7.0) without limiting flexibility during remedial design. Selection of a specific representative process

TABLE 5-1
 TECHNOLOGY TYPES AND PROCESS OPTIONS
 IDENTIFIED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM	RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
Sediment	Removal	Dredging Mechanical	Clamshell
			Watertight Clamshell
			Dragline
			Dipper
			Orange Peel
			Bucket-Loader
		Hydraulic	Backhoe
			Sauerman
			Terra Marine
			Plain Suction
			Dustpan
			Cutterhead
Special Purpose	Hopper		
	Sidecasting		
	Bucketwheel		
	Airlift		
	PNEUMA		
	Oozer		
Excavation		Cleanup	Refresher
			Waterless
			Drexhead
			Currituck
			Mudcat
			Hand Held
		Excavation	Dragline
			Clamshell
			Watertight Clamshell
			Scaper
			Dozers & Loaders
			Bucket Wheel
Backhoe			
Gradall			

TABLE 5-1 (Continued)
 TECHNOLOGY TYPES AND PROCESS OPTIONS
 IDENTIFIED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM	RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
		Non-conventional	Sorbents and Gels Bioharvesting Oil Soaked Mats
	Containment	Capping	Clay/Sediment/Sand & Gravel Fabric Impermeable Synthetics Multimedia
		Chemical Sealants Hydraulic Controls	Dikes/Berms Sheet Piling
	Treatment	Physical	Air Stripping Soil Aeration Carbon Adsorption Flocculation/Precipitation Evaporation Centrifugation Extraction Filtration Solidification Granular Media Filtration In-situ Adsorption Molten Glass Steam Stripping Liquified Gas Extraction Vitrification Particle Radiation Microwave Plasma Crystallization Dialysis/Electrodialysis Distillation Acid Leaching Catalysis

TABLE 5-1 (Continued)
 TECHNOLOGY TYPES AND PROCESS OPTIONS
 IDENTIFIED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM	RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
		Chemical	Alkali Metal Dechlorination Akaline Chlorination Catalytic Dehydrochlorination Electrolytic Oxidation Hydrolysis Chemical Immobilization Polymerization
		Thermal	Electric Reactors Fluidized Bed Reactors Fuel Blending Industrial Boilers Infrared Incineration In Situ Thermal Destruction Liquid Injection incineration Molten Salt Multiple Hearth Incineration Plasma Arc Incineration Pyrolysis Processes Rotary Kiln Incineration Wet Air Oxidation Supercritical Water Oxidation
		Biological	Advanced Biological Methods Aerobic Biological Methods Anaerobic Biological Methods Composting Land Spreading
		In-situ Biodegradation	
		Physical Stabilization	Vitrification Chemical Grouts

TABLE 5-1 (Continued)
 TECHNOLOGY TYPES AND PROCESS OPTIONS
 IDENTIFIED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

MEDIUM	RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
		Dechlorination	
	Disposal	In-Harbor	Island Construction Confined Aquatic Disposal
		Shoreline	Confined Disposal Facility
		Upland	Lined Landfills
		Offsite	Permitted Disposal Facility
		Ocean	Sited Offshore Disposal
Water	Treatment	Physical	Carbon Adsorption Flocculation/Precipitation Ion Exchange Resin Adsorption Reverse Osmosis Ultrafiltration
		Chemical	Neutralization Oxidation/Hydrogen Peroxide Ozonation Ultraviolet Photolysis

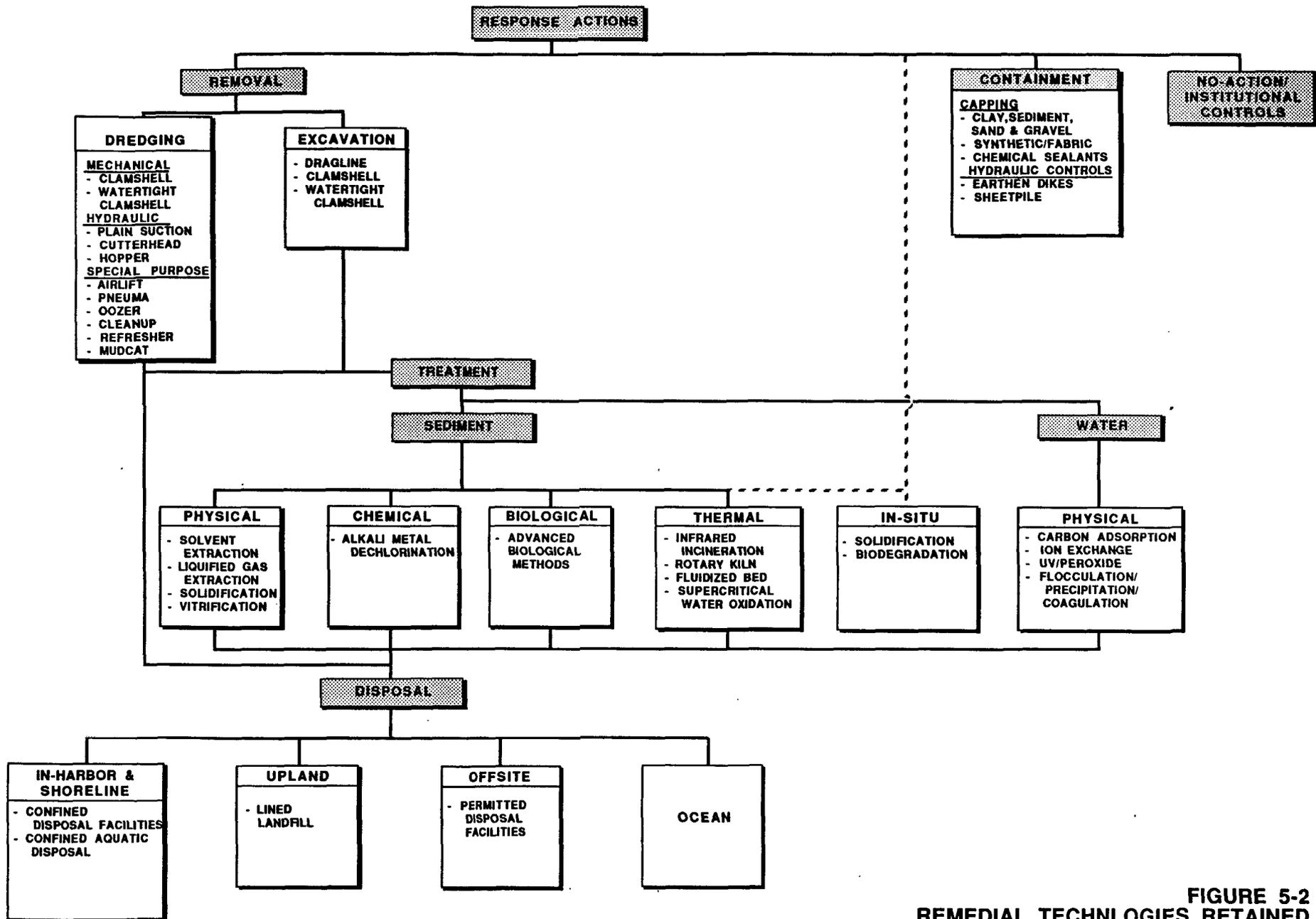


FIGURE 5-2
 REMEDIAL TECHNOLOGIES RETAINED
 FOR DETAILED EVALUATION
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR

provides a basis for developing performance specifications during the preliminary design.

Process options for New Bedford Harbor were evaluated on the basis of effectiveness, implementability and cost: the same criteria used to screen alternatives prior to detailed analysis. However, these criteria were applied only to the technologies and not to the site as a whole.

The effectiveness of each technology was assessed on the basis of the potential effectiveness in handling the estimated area or mass of contaminated sediment and in meeting the response objectives; the effectiveness in protecting human health and the environment during the construction and implementation phase; and the demonstrated level of development and reliability for the site and waste specific conditions in New Bedford Harbor.

The implementation of a technology considered factors relating to the technical, institutional, and administrative feasibility of installing, monitoring, and maintaining that technology. The cost estimates developed for each technology included direct and indirect capital costs, and operation and maintenance expenses (O&M).

As part of the detailed evaluation of technologies for New Bedford Harbor, bench scale and pilot scale testing of treatment technologies and pilot scale testing of dredging and disposal

options was conducted. Subsection 5.3 summarizes results of these tests.

Descriptions of individual process options and details of the evaluation process have been presented in numerous published reports (E.C. Jordan Co./Ebasco, 1987c; and Palermo and Pankow, 1988).

5.3.1 Dredging/Excavation

Two types of technologies for sediment removal were evaluated for New Bedford Harbor: excavation and dredging. The excavation of PCB/metal-contaminated sediment might occur along shoreline areas that are inaccessible to floating dredge equipment (due to insufficient draft) but accessible to land-based equipment operating from adjacent embankments. Of the three types of excavation equipment considered for detailed evaluation (i.e., dragline, clamshell, and watertight clamshell), only the watertight clamshell was retained. The watertight clamshell is a conventional crane equipped with a bucket having interlocking jaws that seal when closed to minimize leakage. Although these three excavation technologies are operationally similar, the major factor for retaining the watertight clamshell is that it produces the least amount of resuspended sediment (E.C. Jordan Co./Ebasco, 1987c).

Three types of dredges were evaluated for New Bedford Harbor:

mechanical, hydraulic, and special purpose. Mechanical dredges are essentially cranes with grab buckets or clamshells, or even front-end loaders or backhoes mounted on a barge. Mechanical dredges were eliminated from further consideration during the evaluation process for three reasons (E.C. Jordan Co./Ebasco, 1987c): (1) use of mechanical dredges would be limited to localized areas in New Bedford Harbor where water depths exceed 6 feet (a minimum operating depth for barges and tugs); (2) activities associated with mechanical dredging (e.g., as positioning of the barge by the tugs and transfer of contaminated sediment between the dredge barge and the hauling barge) would have potential for causing spillage and therefore sediment resuspension; and (3) poor vertical accuracy of this type of dredge would result in overexcavation (i.e., approaching a factor of 6), causing an increase in sediment volume to be handled and the commensurate increase in disposal costs. USACE confirmed the disadvantages of mechanical dredges when compared with hydraulic dredge types (Palermo and Pankow, 1988).

Of the three hydraulic dredges considered for detailed evaluation (i.e., cutterhead, hopper, and plain suction), only the cutterhead was retained in the E.C. Jordan Co./Ebasco study (1987c). The principle advantages of the cutterhead over the hopper and the plain suction dredge include (1) greater operational flexibility in being able to operate throughout New Bedford Harbor (sediment removal with a cutterhead is possible in 80 percent of the area from the estuary down to the lower

harbor); (2) better maneuverability near shorelines and wharfs; (3) less sensitivity to clogging than either the hopper or the plain suction dredge; and (4) minimal sediment resuspension with proper operational controls.

USACE concurred with the selection of the cutterhead dredge (Palermo and Pankow, 1988). In addition, USACE selected a second hydraulic dredge type (i.e., the matchbox) for further evaluation in their pilot dredging and disposal study. The matchbox dredge, originally developed in Holland for dredging contaminated sediment, is a plain suction dredgehead enclosed in housing that resembles a matchbox. Tests of this dredge conducted by USACE in Calumet Harbor on Lake Michigan indicated that the matchbox, if properly operated, is capable of removing sediment with little resuspension.

Six special-purpose dredge technologies were retained by Jordan for detailed evaluation (E.C. Jordan Co./Ebasco, 1987c): special dredgeheads or modifications to conventional hydraulic dredges, scaled-down versions employing conventional dredging methods, and the use of compressed air as a method of dislodging and lifting materials. Of the six special purpose dredges evaluated, the mudcat dredge (a horizontal auger dredge which is operationally a member of the hydraulic dredge family) was selected as the most versatile over the widest range of site conditions, based on minimal resuspension of material; production efficiency; and precision, accuracy, and control over

the sediment removal process (E.C. Jordan Co./Ebasco, 1987c). The mudcat dredge was also selected by USACE as the third dredge type to be evaluated in the pilot dredging and disposal study (Palermo and Pankow, 1988).

Two other special purpose dredges were identified by Jordan as having some application potential for New Bedford Harbor: the refresher dredge and the PNEMUA pump (E.C. Jordan Co./Ebasco, 1987c). The refresher dredge is a modification of the cutterhead dredge and is being developed in Japan. The PNEMUA pump, developed in Italy, uses a compressed-air chamber to remove sediment. Both dredges are capable of removing sediment with minimal resuspension and might be considered for removing sediment in small, localized areas and/or as back-up systems to the primary removal technologies selected for site work. However, USACE noted that both dredges were large draft vessels, which might preclude them from operating in many portions of New Bedford Harbor (Palermo and Pankow, 1988). Furthermore, the availability of the refresher and PNEUMA dredges for work in New Bedford Harbor is questionable due to U.S. restrictions on the importation of foreign technology.

In summary, the cutterhead, matchbox, and mudcat dredges were retained as the three dredge types to be tested by the USACE during their pilot dredging study. The results from this study will help in the selection of the best dredge type for dredging contaminated sediment in New Bedford Harbor.

5.3.1.1 USACE Pilot Dredging Study

As an extension of the EFS for the Acushnet River Estuary, a pilot study of dredging and dredged material disposal methods was conducted by USACE from late 1988 through early 1989. The study site was a small cove located north of the Coggeshall Street Bridge on the New Bedford side of the Acushnet River. The overall objective of this study was to evaluate different dredge types, dredge operating procedures, disposal methods, and control techniques. An overview of the USACE pilot study was presented by Otis and Averett (1988); a more detailed description is given in Otis and Andreliunas (1987). Results of the dredging portion of the pilot study are discussed herein. Results of the disposal methods portion of the pilot study are discussed in Subsection 5.3.3.

The technical objectives of the pilot dredging study were to (1) determine the efficiency of dredging for the removal of PCB- and metal-contaminated sediment from New Bedford Harbor; and (2) evaluate actual sediment resuspension and contaminant release under field conditions for each of the three dredge types, and assessment of operational controls, and turbidity containment techniques (Otis and Averett, 1988).

The three hydraulic dredges selected by USACE and Jordan (i.e., cutterhead, matchbox, and mudcat) were alternately used in the removal of approximately 3,000 cy (total) of contaminated sediment from the study area. PCB concentrations of the dredged sediment were in the 100-ppm range.

To assess the performance of the three dredges, USACE conducted a physical and chemical monitoring program during dredging operations. Data collected during this program was used to address the following (Otis and Averett, 1988):

- rate of sediment resuspension caused by the dredging operation
- rate of contaminant release, in particular PCB release, associated with each of the dredges
- contaminant flux in and out of the upper estuary during dredging
- efficiency of contaminant removal by the dredges
- dredging controls needed to minimize the rate of sediment resuspension at the dredge and measures that should be employed to contain the suspended sediment plume near its point of generation

Concurrent with the USACE monitoring of dredging operations, an aquatic monitoring program was conducted to evaluate the effectiveness of dredging in terms of the extent of a suspended sediment plume, far-field water quality, and the associated effects on marine organisms. The aquatic monitoring program was conducted by the EPA ERL (Narragansett, Rhode Island). An overview of the monitoring program has been described by Phelps et al. (1988). An air monitoring program for measuring levels of airborne PCBs was conducted by Ebasco as part of the pilot dredging and disposal study. Results from this program demonstrated that disposal of contaminated sediment in a shoreline CDF did raise the ambient levels above background. However, the increased levels did not threaten worker safety or public health, and were confined to the area immediately adjacent to the CDF.

Preliminary results of the pilot dredging study are summarized in the following paragraphs. These results are based on review of currently available data (Otis, 1989).

Sediment Resuspension. A sediment resuspension rate of 40 grams per second was used in the contaminant release estimates contained in the conceptual dredging studies conducted by USACE (Averett, 1988). During the pilot dredging study, sediment resuspension rates were empirically determined by sampling the water column immediately adjacent to the operating dredgehead for each of the three dredges. Data collected from these

samples were combined with the dredge swing speed or rate of forward advance, and water depth to derive a resuspension rate. Results indicated that the cutterhead dredge had the lowest resuspension rate, with an average of 13 grams per second over four days of operation. The matchbox dredge had an average of 48 grams per second over five days of operation. The mudcat dredge had the highest resuspension rate, with an average of 333 grams per second over four days of operation (Otis, 1989). The significantly higher resuspension rate for the mudcat dredge is due to the fact that sediment is being removed by a rotating auger 9 feet in width. Sediment resuspension is occurring along the entire length of the auger, which channels sediment toward the center for removal (Otis, 1989).

Contaminant Release. The standard elutriate test is used to estimate contaminant levels in the water column adjacent to the operating dredge. When results of the elutriate tests are combined with the sediment resuspension rate, an estimate of the contaminant release rate at the dredge can be obtained. Elutriate tests were conducted on sediment-water samples collected from two locations within the pilot study area. Results of these tests indicated average total PCB concentrations in the water fraction were approximately 74 parts per billion (ppb) (Otis, 1989).

Composite samples were collected adjacent to the dredgehead during the pilot study. Mean total PCB concentrations of 7.0,

2.6, and 54.9 ppb, were measured for the cutterhead, matchbox, and mudcat dredges, respectively (Otis, 1989). Although the differences between the dredges were found to be statistically insignificant because of the wide variability in measurements, the mudcat dredge appears to be less effective in reducing sediment resuspension and contaminant release at the point of dredging (Otis, 1989).

Results from the pilot study indicate that the elutriate test provides a conservative estimate of PCB concentrations in the water column during dredging and CAD filling operations. In general, PCB levels in the water column measured in the field were approximately one order of magnitude less than the elutriate test results.

Contaminant Flux. Numerical hydrodynamic and sediment transport modeling conducted as part of the EFS predicted that approximately 26 percent of the fine-grained sediment would escape from the immediate vicinity of the dredging operation (Teeter, 1988). Results of this analysis were used with the contaminant release estimates at the dredge to estimate the flux of contaminants out of the upper estuary during dredging.

No elevated levels above background of suspended solids were measured at the Coggeshall Street Bridge (i.e., the southern boundary of the estuary for the purposes of this study) during dredging operations, except for one sampling event immediately

following a storm. Pre-operational monitoring conducted for the pilot study indicated that background mean suspended solids concentrations at the Coggeshall Street Bridge ranged from 6.4 to 10.2 milligrams per liter (mg/l) (EPA-NRL, 1988). Suspended solids measured during the dredging operations, at sampling stations located approximately 300 feet from the dredge, ranged from 3.8 to 11.4 mg/l (Otis, 1989).

Water column sampling was conducted during the pilot study at a sampling station located just east of the pilot study cove and at a sampling station located at the Coggeshall Street Bridge. The mean total PCB concentration measured during the preoperational period was 0.77 ppb. The mean total PCB concentration measured during dredging operations was 1.53 ppb at the sampling station east of the cove, and 0.67 ppb at the Coggeshall Street Bridge (Otis, 1989).

Efficiency of Contaminant Removal. All three hydraulic dredges used during the pilot study were able to remove contaminated sediment while minimizing sediment resuspension and overdredging. Contaminant levels after dredging were in the 10-ppm range, and generally less than 1.5 feet of sediment was removed.

Dredge Controls. Swing anchors are used on the cutterhead and matchbox dredge to allow the dredge to pivot laterally about its spud anchor. During the pilot study operations, these anchors

frequently slipped in the soft bottom sediment, resulting in a plume of suspended sediment. Small boats used to set the anchors also stirred up bottom sediment, compounding the problem. USACE recommended setting the swing anchors on land.

Silt curtains, designed to prevent migration of a suspended sediment plume, do not appear to be justified because monitoring did not detect a significant sediment plume moving away from the dredge. In fact, installation, movement, and removal of the silt curtain in the shallow water conditions of the estuary caused a considerable amount of sediment resuspension. This would negate any beneficial effects of using a silt curtain.

5.3.1.2 Summary

Based on results of the pilot study, USACE concluded that all three dredge types were equally effective in removing contaminated sediment with a minimum of sediment resuspension and contaminant migration. However, USACE has recommended the cutterhead dredge for use in New Bedford Harbor, including the Hot Spot area. The cutterhead dredge exhibited advantages over the matchbox and the mudcat in the following areas (Otis, 1989):

- Dredgehead sampling indicated that sediment resuspension at the point of dredging was minimized with the cutterhead.

- Downtime due to clogging of the suction line with sediment and debris was less of a problem with the cutterhead.
- Worker exposure to contaminated sediment was minimized when clearing the clogged suction line.
- Dredging operations were not impacted by windy conditions which was a problem with the mudcat.
- Dredge movement and repositioning was more efficient, as compared to the mudcat.

Operational procedures developed for the cutterhead dredge during the pilot study will help to ensure efficient removal of contaminated sediment with minimal sediment resuspension and contaminant release. Monitoring of suspended solids and PCB levels indicate that movement of contaminants away from the point of dredging is likely to be minimal. No elevated levels above background of suspended sediment or PCBs was detected at the Coggeshall Street Bridge during dredging operations.

5.3.2 Treatment

Ten sediment treatment and four water treatment technologies were retained from the initial screening process for detailed evaluation (Table 5-1). In evaluating those factors associated with implementating a treatment technology, demonstrated performance on a bench-scale, pilot-scale, or full-scale was used as a key indicator of the level of development and therefore the ability of a given technology to be implemented at New Bedford Harbor.

5.3.2.1 Sediment Treatment

A few sediment treatment technologies (e.g., incineration) have been thoroughly demonstrated as full-scale systems. Incineration is the most widely practiced and permitted method of destroying organic hazardous wastes. Three types of incineration systems were considered applicable for treating PCBs in New Bedford Harbor sediment and were therefore retained for remedial alternative development (E.C. Jordan Co./Ebasco, 1987c): infrared, rotary kiln, and fluidized bed. All three systems achieve similar results but differ in materials handling and hardware design. The selection of a specific incineration system for New Bedford Harbor would depend largely on the ability of the equipment to meet design specifications developed for New Bedford Harbor and the availability of equipment at the time of implementation. Detailed descriptions

of each incineration system are in the E.C. Jordan Co./Ebasco report (1987c).

The available bench- and pilot-scale performance data for many of the other sediment treatment technologies appeared promising for New Bedford Harbor, although the site- and waste-specific conditions under which the tests were run were often dramatically different from conditions found at New Bedford. Based on these results, six bench-scale tests and one pilot-scale treatment test were conducted to provide performance data specifically for New Bedford Harbor sediment. No treatment tests were conducted for the three incineration options. The specific sediment treatment technologies tested are listed in Table 5-2. An overview of the treatment test program has been presented by the Allen and Ikalainen report (1988). Details of the treatment test protocols are in Jordan/Ebasco (1988e).

Results of the sediment treatment tests conducted for the New Bedford Harbor project were used to determine the following:

- effectiveness of the treatment technologies on treating PCB and metal contaminated sediment and water from New Bedford Harbor

- potential material handling problems and process rate limiting features that might develop during

TABLE 5-2
 BENCH- /PILOT-SCALE TESTS OF SEDIMENT TREATMENT TECHNOLOGIES
 NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

TECHNOLOGY	SCALE	VENDOR	CONTACT
Solidification/Stabilization	Bench	Test conducted by U.S. Army Corps of Engineers Waterways Experiment Station Vicksburg, MI	Tommy Myers (601)-634-3939
Solvent Extraction			
BEST Process	Bench	Resources Conservation Co. 3006 Northup Way Bellevue, WA	Lanny Weimer (301)-465-2887
Liquified Gas Extraction	Pilot	CF Systems Corporation 140 Second Avenue Waltham, MA	(617)-890-1200
Alkali Metal Dechlorination			
KPEG Process	Bench	Galson Research Corporation 6601 Kirkville Road East Syracuse, NY	Edwina Millisic (315)-463-5160
Vitrification (Modified In-situ)	Bench	Battelle Pacific Northwest Laboratories Richland, WA	Craig Timmerman (509)-376-2252
Advanced Biological Treatment (Aerobic)	Bench	Radian Corporation 5103 W. Beloit Road Milwaukee, WI	Chuck Applegate (414)-643-2768
Sediment Dewatering			
Plate & Frame Filter Press	Bench	OH Materials Corp. 1090 Cinclare Drive Port Allen, LA	Chuck Bearden (504)-389-9596

scale up of the treatment technology

- refined cost estimates for treating New Bedford Harbor sediment

Results of the sediment treatment test program are in Table 5-3. A brief description of each sediment treatment technology and general comments regarding test results are discussed in the following paragraphs.

Solvent Extraction - BEST Process. Resource Conservation Company (RCC) conducted a bench-scale study of their BEST solvent extraction process on a sample of New Bedford Harbor sediment (RCC, 1988a). The BEST process employs the inverse miscibility property of the solvent triethylamine (TEA) to separate PCB-contaminated sediment into PCB/oil, water, and solids fractions. Sediment containing PCBs is mixed with TEA at a temperature of about 40 degrees Fahrenheit. At this temperature, the TEA freely mixes with the water and the PCB/oil fraction of the sediment matrix. After a suitable reaction period, the extracted solids are removed from the reaction mixture by centrifugation. The remaining liquid containing water, TEA, and PCB/oil is then heated to 150 degrees Fahrenheit. At this elevated temperature, the water separates from the TEA/PCB/oil fraction. The TEA solvent is recovered by steam stripping from the PCB/oil fraction and reused. The PCB/oil fraction is disposed of, usually by incineration at a

TABLE 5-3
RESULTS OF BENCH- AND PILOT-SCALE TESTS OF TREATMENT TECHNOLOGIES
CONDUCTED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

TECHNOLOGY	RESULTS OF TREATMENT TEST	ADVANTAGES	DISADVANTAGES	RETAINED
Solvent Extraction (B.E.S.T. Process)	<ul style="list-style-type: none"> ● 99.1% reduction in PCBs in low level (780 ppm) sediment after 3 extraction stages ● 99.4% reduction in PCBs in high level (4,300 ppm) sediment after 3 extraction stages ● 94% reagent recovery ● 90% solids recovery ● Apparent immobilization of metals 	<ul style="list-style-type: none"> ● High PCB removal ● Not limited by moisture content ● Energy efficient ● Proven in field test ● Commercial units available 	<ul style="list-style-type: none"> ● TEA solvent is flammable ● Secondary treatment for metals may be required 	Yes
Alkali Metal Dechlorination (KPEG process)	<ul style="list-style-type: none"> ● 99.8% removal of PCBs in low level (440 ppm) sediment after 9 hours ● 99.8% removal of PCBs in high level (7,300 ppm) sediment after 12 hours ● 75% reagent recovery (min) ● 43% solids recovery (dry wt) 	<ul style="list-style-type: none"> ● High PCB removal ● Biphenyl ether end product not acutely toxic, and does bioaccumulate. 	<ul style="list-style-type: none"> ● Low reagent/sediment recovery suggests material handling problems need to be overcome ● Secondary treatment necessary for metals ● Moisture inhibits dechlorination reaction ● No commercial process available at present time 	No
Solidification/ Stabilization	<ul style="list-style-type: none"> ● Chemical stabilization properties of the three technologies tested were similar ● Hardened material exceeded 50 psi USEPA-OWSER standard ● PCB leachability reduced by 10X to 100X (depending on formulation) 	<ul style="list-style-type: none"> ● Effective stabilization of PCBs ● Effective stabilization of cadmium and zinc ● Numerous commercial processes available 	<ul style="list-style-type: none"> ● Apparent mobilization of certain heavy metals ● No information or data on long-term structural integrity of solidified material 	Yes

TABLE 5-3 (Continued)
 RESULTS OF BENCH- AND PILOT-SCALE TESTS OF TREATMENT TECHNOLOGIES
 CONDUCTED FOR NEW BEDFORD HARBOR

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

TECHNOLOGY	RESULTS OF TREATMENT TEST	ADVANTAGES	DISADVANTAGES	RETAINED
Solidification/ Stabilization (continued)	<ul style="list-style-type: none"> ● Cadmium and zinc leachability significantly reduced; eliminated in one process ● Copper and nickel apparently mobilized 			
Vitrification	<ul style="list-style-type: none"> ● 99.94% destruction of PCBs ● 99.9985% DRE (soil-to-offgas) ● Metal concentrations in TCLP extract below regulatory limits 	<ul style="list-style-type: none"> ● Effective destruction of PCBs and encapsulation of metals 	<ul style="list-style-type: none"> ● High energy requirements ● No commercial units available at this time 	No
Liquified gas extraction (propane)	<ul style="list-style-type: none"> ● 97% reduction of PCBs in low level (<400 ppm) sediment after 10 passes through unit ● 96% reduction of PCBs in high level (>2,000 ppm) sediment after 6 passes through unit ● 93% solids recovery 	<ul style="list-style-type: none"> ● High PCB removal 	<ul style="list-style-type: none"> ● Further development needed to address problems with materials and system operating parameters experienced during pilot test ● No commercial units available at this time 	Yes
Advanced Biological Methods (aerobic)	<ul style="list-style-type: none"> ● Limited degradation of lower chlorinated congeners (di- and trichlorobiphenyls) ● No degradation of higher chlorinated PCB isomer groups 	<ul style="list-style-type: none"> ● Insufficient data to assess advantages of this relative to other treatment processes 	<ul style="list-style-type: none"> ● Incomplete destruction of PCBs ● Insufficient data to determine process rates and process design parameters 	No
Plate and Frame Filter Press	<ul style="list-style-type: none"> ● 38% solids sample dewatered to 62% solids cake 	<ul style="list-style-type: none"> ● Effective method of sediment dewatering ● Commercial units readily available 	<ul style="list-style-type: none"> ● None identified 	Yes

permitted, offsite facility.

Results of the BEST test are summarized in Table 5-3. PCB removal efficiencies of +99% were achieved after three extraction stages for both high-level and low-level sediment samples tested (initial PCB concentrations of 5,800 and 420 ppm, respectively). PCB concentration in the treated residue of the low-level sediment was 11 ppm. However, the concentration of PCBs in the treated residue of the high-level sediment was 130 ppm. As a result of this finding, RCC conducted an additional bench test on New Bedford Harbor sediment to further optimize process parameters. In this second test, a sediment sample containing 11,000 ppm of PCBs was reduced to 16 ppm after six extraction stages (RCC, 1988b).

Similar PCB extraction efficiencies using the BEST process were obtained in other tests. A bench test of PCB-contaminated soil was conducted by RCC for a northern New England utility. Three types of PCB-contaminated soil were tested: clay-silt, fill, and sandy loam. Initial PCB concentrations in these samples were 4,400, 1,010, and 21,700 ppm, respectively. Analysis of the treated soil showed residual PCB concentrations of 2.6, 5.9, and 19.0 ppm, respectively, after three extraction stages (RCC, 1989a).

An EP Toxicity test was conducted by RCC on the treated New Bedford Harbor sediment. Results indicated that leachate

concentrations of heavy metals were well below the allowable maximum concentrations. This apparent immobilization of the metals is presumed to be due to the alkaline (i.e., pH greater than 9) nature of the treated residue. RCC observed similar results in bench tests of a wide range of soil and sediment samples containing heavy metals (RCC, 1989b). The implication of this finding is that secondary treatment (e.g., solidification) of the solvent-extracted sediment may not be necessary to immobilize the heavy metals. Further bench/pilot tests to verify this phenomenon is warranted if the BEST process is implemented at New Bedford Harbor.

The hazardous nature of TEA and its reported toxicity to fish has raised questions about public/worker health and safety, and environmental impacts of the BEST process. TEA is a standard industrial solvent with a flash point of 25 degrees Fahrenheit and is thus flammable. With a vapor pressure of 53.5 mm/HG at 68 degrees Fahrenheit, TEA is also mildly volatile. RCC uses several precautions in its system to minimize hazards: (1) air monitoring is conducted to detect TEA/air concentrations outside safety limits; (2) all process equipment is maintained in a positive pressure nitrogen blanket to ensure that no in-leakage of air will occur; and (3) explosion-proof equipment, properly installed wiring, and non-sparking tools are used.

TEA is listed in CERCLA, but only at the CWA maximum reporting level (5,000 pounds), and then only because it is a flammable

liquid. TEA is not regulated by RCRA (i.e., the RCRA Solvents List) nor by TSCA (i.e., the TSCA Reporting Chemical List).

Toxicity studies have been conducted with TEA on laboratory rats by the National Institute for Occupational Safety and Health in Cincinnati, Ohio. No adverse effects were observed in rats exposed to 250 ppm TEA vapor for six hours per day, five days per week, for six months. When TEA levels were raised to 1,000 ppm for six hours per day for ten days, the rats showed damage to mucous membrane in nasal passages, trachea, and lungs. In none of these studies was there evidence of carcinogenic properties.

RCC bench test protocols were developed to simulate the process dynamics of their 100-ton-per-day pilot-scale treatment unit, which was used successfully to remediate a Georgia Superfund site. Therefore, it is expected that these bench-scale results can be achieved in a full-scale unit deployed for New Bedford Harbor. At the present time, RCC is testing a different method of processing using LittlefordTM rotary washer-dryer units. These units are readily available and are used extensively in the chemical processing industry. One major advantage of this processing system is that sediment-solvent mixing is more uniform, thereby increasing the extraction efficiency per stage (or wash cycle). In addition, the sediment is not moved from one reaction stage to the next, which simplifies material handling.

Costs for treating New Bedford Harbor sediment using the BEST process were estimated by RCC to be \$70 per ton and \$143 per ton, based on 450,000 cy and 46,000 cy of sediment treated, respectively.

The BEST process was retained as a viable solvent extraction technology for treating New Bedford Harbor sediment. Results of the solvent extraction bench test indicate that efficient removal of PCBs is possible. This technology is also commercially available at the present time.

Solvent Extraction - Liquified Gas Extraction. In July 1988, the EPA Superfund Innovative Technology Evaluation (SITE) program selected New Bedford Harbor as the demonstration site for a pilot-scale test of CF System's liquified gas extraction process (SAIC, 1988). The demonstration took place at New Bedford Harbor during the fall of 1988. CF Systems uses propane, which is heated and compressed to a liquid state. The combined properties of gas diffusivity and liquid solvency allow the liquified propane to mix readily with PCB-contaminated sediment, extracting the PCBs.

Results of the pilot test are summarized in Table 5-3. Although PCB removal efficiencies of +96 percent were achieved, multiple

passes (up to ten) were required to obtain these results. Based on the test data, it was estimated that six passes would be required to treat a 2,450-ppm sediment to a level of 100 ppm. An additional nine passes would be required to achieve a level of 10 ppm, the apparent lower limit of treatment for the CF Systems process based on current operating conditions and equipment configuration (SAIC, 1989). Multiple passes to achieve high removal efficiencies would significantly reduce throughput rates for this extraction technology. A material balance of the system indicated that 93 percent of the total solids mass was recovered, but only 44 percent of the known mass of PCBs was accounted for in effluent streams (SAIC, 1989).

A number of equipment and materials handling problems were experienced during the pilot demonstration, including the following (SAIC, 1989):

- plating of PCBs on the internal surfaces of the extraction vessels and piping
- foaming of propane
- carry over of solids in the extract samples
- fluctuations in solvent flow and solvent/feed rates

- mean operating capacity of approximately two (55-gallon) barrels per day versus a claimed feed capacity of 20 barrels per day

Costs for treating New Bedford Harbor sediment using the liquified gas extraction process are not available at this time.

Liquified gas extraction was retained as a possible option to the BEST process for treating New Bedford Harbor sediment using solvent extraction. The pilot system constructed by CF Systems and used for the New Bedford Harbor demonstration was successfully demonstrated on refinery wastes. CF Systems constructed a commercial-scale unit for treating hazardous waste, which has not yet been field-proven. Problems with materials handling, system operating parameters, extraction efficiencies, and low throughput rates observed during the New Bedford pilot demonstration need to be resolved. However, if these problems can be addressed prior to full-scale implementation, this solvent extraction technology may be able to meet performance specifications developed for New Bedford Harbor.

Alkali Metal Dechlorination. Galson Research Corporation (Galson) conducted a bench-scale study of their KPEG process (Galson, 1988a). In the KPEG process, potassium

hydroxide/polyethylene glycol (KPEG) reagent is mixed with PCB-contaminated sediment to form a slurry. The mixture is heated, causing the dechlorination of PCBs to biphenyl ether. The reaction products of this process are reportedly nontoxic and nonmutagenic (Galson, 1988a).

Results of Galson's bench test, summarized in Table 5-3, indicate that PCB removal efficiencies of +99 percent were achieved for both the high- and low-level sediment samples tested (initial PCB concentrations of 7,300 and 440 ppm, respectively). PCB concentration in the treated residue was 3.5 ppm for the high-level sediment sample after 12 hours of treatment, and 0.7 ppm for the low level sediment sample after 9 hours (Galson, 1988a). These results, however, are based on a sediment-solids recovery averaging only 43 percent. Reagent recoveries ranged from a high of 110.8 percent for the polyethylene glycol (PEG) reagent to a low of 75.5 percent for the dimethylsulfoxide reagent. The relatively low reagent and sediment-solids recovery suggests that material handling problems would have to be addressed in a full scale operation.

Costs for treating New Bedford Harbor sediment using the KPEG process were estimated by Galson to be \$98 per ton and \$120 per ton, based on 500,000 cy and 50,000 cy of sediment treated, respectively.

A pilot-scale study of Galson's KPEG process was conducted at the Wide Beach Superfund Site in Irving, New York, in October 1988 (Galson, 1988b). Processing rates for this study were based on 200 pounds of soil per batch run. Initial PCB concentrations for two runs were 30 ppm (Run 1) and 260 ppm (Run 2). Final PCB concentrations were 0.7 ppm (Run 1) and 1.7 ppm (Run 2). No data on reagent or solids recovery were provided in the preliminary report.

In general, the KPEG process has been demonstrated to be effective at removing PCBs from soil matrices at the bench-scale level. However, there are several unresolved issues concerning this process: (1) other than the reagents, no data or information exist on the chemical composition of the reaction products which could potentially be hazardous; (2) toxicity testing of these products needs to be investigated further; (3) materials handling would appear to be a major problem in terms of solids and solvent recovery; (4) the lengthy reaction times for this process (hours) raise questions regarding throughput rates; and (5) unlike the CF Systems pilot demonstration, the KPEG process has not been demonstrated on a pilot-scale level that simulates an integrated system of reactor hardware and material handling.

Alkali metal dechlorination was not retained for New Bedford Harbor. The disadvantages of this process, particularly the

lack of information and data from a well-designed pilot study, outweigh the bench-scale performance achieved for New Bedford.

Solidification. A bench-scale study of solidification/stabilization was conducted by USACE as part of their EFS (Myers and Zappi, 1989). Composite sediment samples containing PCBs and metals were processed using three solidification/stabilization technologies: (1) Portland cement; (2) Portland cement with Firmex proprietary additive; and (3) Silicate Technology Corporation proprietary additive. The treated sediment was subjected to physical strength and chemical leach tests to evaluate the effectiveness of solidification/stabilization.

Results of the solidification/stabilization study are presented in Table 5-3. In general, solidification/stabilization was found to be an effective method for immobilizing PCBs, cadmium, and zinc in New Bedford Harbor sediment. The apparent mobilization of copper and nickel may be due to changes in the interphase transfer processes for these two metals; however, this has not been confirmed. It is anticipated that, given the numerous commercial processes available, a formulation of solidifying agents is available to immobilize all heavy metals.

Costs for treating New Bedford Harbor sediment using solidification/stabilization range from approximately \$82 per ton to \$97 per ton, based on 440,000 cy and 24,000 cy of sediment treated, respectively (E.C. Jordan Co./Ebasco, 1987c).

Solidification/stabilization was retained as a viable sediment treatment technology for New Bedford Harbor. This technology could be applied as a primary treatment for PCB and metal contaminated sediment, or as a secondary treatment for metals following a technology such as incineration or solvent extraction, which would remove PCBs.

Vitrification. Battelle Pacific Northwest Laboratories conducted a bench-scale test of modified in-situ vitrification of New Bedford Harbor sediment (Battelle, 1988). In the vitrification process, electric current is applied to molybdenum electrodes inserted in PCB-contaminated sediment. Temperature in excess of 3,600 degrees Fahrenheit destroys the organics (PCBs) and encapsulates the metals in a glass-like solid matrix.

Results of Battelle's vitrification bench test are summarized in Table 5-3. Vitrification was found to be a highly efficient method of destroying PCBs in New Bedford Harbor sediment. In addition, vitrification provided an effective method of immobilizing heavy metals by encapsulating them in the glass-like residue.

Costs for treating New Bedford Harbor sediment using vitrification were estimated by Battelle to be \$310 per ton and \$290 per ton, based on 50,000 cy and 500,000 cy of sediment treated, respectively.

Although results of the bench test were favorable, vitrification was not retained as a viable technology for treating New Bedford Harbor sediment. Modified in-situ vitrification has not been demonstrated on a pilot- or full-scale for sediment or other high-moisture-content materials. Because vitrification could not be applied as an in-situ treatment method at New Bedford Harbor, a processing system would have to be developed to vitrify batches of sediment. Currently, there has been no hardware design completed. This fact, coupled with the very high costs of treatment, make vitrification less attractive than incineration.

Advanced Biological Treatment. Radian Corporation conducted a bench-scale study of aerobic advanced biological treatment of New Bedford Harbor sediment containing PCBs (Radian, 1989). In their study, cultures from saltwater microbial communities in New Bedford Harbor were acclimated to biphenyl and sewage as carbon substrates. The enriched cultures were then switched to PCB-contaminated sediment for test purposes. Presumptive testing was done to determine if there was a net loss of PCBs within the treatment system. Confirmation testing was done to determine if any net loss observed was due to microbial metabolism.

Preliminary results of these tests indicate that biodegradation of dichlorobiphenyls and trichlorobiphenyls does occur, albeit

at a relatively slow rate. No biodegradation of higher chlorinated PCB isomer groups was observed. These results are currently being reviewed and a final report is expected by June 1989.

Costs for treating New Bedford Harbor sediment using advanced biological methods are unavailable due to insufficient data on these processes.

Based on preliminary results, advanced aerobic biological treatment was not retained as a viable treatment technology for New Bedford Harbor. Considerable research and process development is needed to understand the mechanisms and kinetics that are prerequisites to designing and implementing a full-scale operation. Lack of specific information makes it difficult to compare the effectiveness, implementation, and cost of biological treatment with other treatment technologies that are further developed.

Sediment Dewatering. OH Materials (OHM) Corporation conducted a bench-scale dewatering test on New Bedford Harbor sediment collected in the upper estuary (OHM, 1988). Although dewatering technologies are proven, this test was conducted to determine if existing equipment could effectively dewater New Bedford Harbor sediment as a precursor step to treatment or disposal. The test was conducted using a bench-scale chamber plate and frame

press. This device simulates the full-scale, trailer-mounted units commercially available.

Results of the dewatering test, summarized in Table 5-3, indicate that New Bedford Harbor sediment can be effectively dewatered up to approximately 50 percent solids using conventional technologies. Dewatering New Bedford Harbor sediment would be a necessary first step prior to implementation of treatment technologies (e.g., incineration).

The costs for dewatering New Bedford Harbor sediment was estimated by OH Materials to be \$45 per cubic yard (\$31 per ton) based on 600,000 cy in situ.

5.3.2.2 Water Treatment

Treatment of liquid wastestreams generated as a result of remedial activities (e.g., dredging and sediment dewatering prior to treatment) at New Bedford Harbor will be necessary to remove PCB and metal contaminants prior to discharge. These contaminants will exist both in the dissolved phase and be absorbed to suspended solids.

Water treatment technologies such as chemical clarification and carbon absorption have been proven at full-scale. Most of these technologies were developed for the treatment of municipal and

industrial wastewater and are therefore considered applicable for treating the liquid wastestreams that would be generated at New Bedford Harbor. Detailed descriptions of water treatment technologies are presented in the E.C. Jordan Co./Ebasco report (1987c).

As part of their EFS, USACE conducted bench- and pilot-scale studies of procedures to improve the quality of effluent, generated from the placement of dredged sediment in a CDF, prior to discharge (Wade, 1988). These studies consisted of bench-scale settling tests, chemical clarification tests, and pilot-scale tests of wastewater treatment.

Settling tests were conducted in laboratory columns to develop data for predicting the settling behavior of New Bedford Harbor sediment. Sediment that remains in the water column as suspended solids constitute a significant source of PCB and metal contamination absorbed to the sediment particles. In addition, the suspended solids can interfere with the water treatment process itself. The settling tests were conducted on three sediment types: (1) a composite sediment sample collected from the upper estuary; (2) sediment collected from the Hot Spot; and (3) potential capping sediment. Compression and flocculant settling tests were run on all three sediment types; zone settling tests were run on the estuary composite sample only. Details of test procedures are presented in the Wade report (1988).

Chemical clarification jar tests were conducted to evaluate the effectiveness of various polymers for the removal of suspended solids in the CDF effluent that would not settle by gravity. The tests were conducted only on the upper estuary sediment sample using numerous cationic and anionic polymers in liquid, emulsion, and dry forms. Details of the polymers used and the test procedures are presented in the Wade report (1988).

Based on results of the bench-scale settling and chemical clarification tests, USACE concluded the following (Wade, 1988):

- Settling behavior for all three sediment types is typical of other marine sediment tested.
- Sediment from the Hot Spot is not expected to settle to the same density as the upper estuary composite or potential capping sediment.
- Effluent total suspended solids concentrations after 24 hours of settling were 140, 151, and 150 mg/l for the upper estuary composite, Hot Spot, and potential capping sediment, respectively.
- Chemical clarification using polymers is an effective treatment for removing suspended solids from CDF effluents. Best polymer performance was achieved using

Magnifloc 1586C, which removed 82 percent of the suspended solids (42.5 mg/l TSS residual).

- Low-viscosity, highly cationic emulsion polymers were found to be the most effective, economical, and simplest to use in order to achieve reduction of suspended solids.

Four cationic polymers were selected for further evaluation in the pilot dredging and disposal study (Wade, 1988): Betz 1167L (Betz); Pol-EZ-7736 (Calgon); Magnifloc 1586C (Cyanamide); and Nalco 7126 (Nalco). These polymers were added to the effluent in the secondary cell of the CDF. Preliminary results of the tests indicate that none of the polymers were as effective in removing suspended solids from CDF effluent compared with results obtained during the bench tests (Averett, 1989). Additional sample analyses are currently being conducted to verify this result. USACE recommends that inorganic coagulants (e.g., alum, ferric chloride, and lime), alone or in combination with polymers, should be evaluated for potential application in removing suspended solids from New Bedford wastewaters (Averett, 1989).

Pilot-scale tests of carbon adsorption and ultraviolet (UV)/peroxide treatment to remove dissolved PCBs and metals from the CDF effluent were conducted during the USACE pilot dredging and disposal study. Commercial carbon and UV/peroxide treatment

units were installed and maintained by Peroxidation Systems of Tucson, Arizona. Effluent from the CDF was passed through a coarse sand filter to remove suspended solids prior to carbon or UV/peroxide treatment.

Preliminary results based on available data indicate that carbon adsorption appears to be effective in reducing the dissolved concentrations of PCBs. In one test, an influent PCB concentration of 10 ppb was reduced to approximately 2 ppb (Averett, 1989). Additional sample analyses are currently being done to verify this result. USACE noted that flow rate and contact time are critical parameters in maximizing the effectiveness of carbon adsorption. In addition, adsorption isotherms generated during laboratory tests indicate that adsorption of PCBs onto carbon will be a relatively inefficient process for treating New Bedford Harbor wastewaters (Averett, 1989). The significance of this finding is that high doses of carbon may be required to bring effluent PCB concentrations down to or below the 1-ppb level. A possible explanation for the low efficiency may be that a substantial fraction of the PCBs remains adsorbed to colloidal particles, which pass through the sand filters and the carbon columns (Averett, 1988). Removal of this colloidal fraction using microfilters may result in greater efficiency of the carbon columns. Further tests are warranted before final design of the water treatment system.

The UV/peroxide system appeared to be effective in reducing dissolved PCB concentrations. An influent PCB concentration of approximately 10 ppb was reduced to 1.5 ppb following treatment (Averett, 1989). Additional sample analyses are currently being conducted to verify this result.

5.3.2.3 Summary

Three sediment treatment technologies were retained for the development of alternatives: incineration, solvent extraction, and solidification. Sediment dewatering using a plate and frame, or belt-filter press, appears to be effective for New Bedford Harbor sediment and will be retained as a supporting technology. Dewatering might also be used to reduce the volume of dredged sediment prior to final disposal in CDFs.

Chemical clarification was retained as a method of reducing suspended solids in wastewater streams generated during remedial action at New Bedford Harbor. Although the polymers that were effective in bench scale studies were not effective at full scale, it is assumed that additional bench- and/or pilot-scale tests will identify inorganic coagulants that are effective in removing suspended solids and associated absorbed PCBs and metals.

Carbon adsorption and UV/peroxide appear to be effective methods for the removal of dissolved PCBs and metals in wastewater streams. Additional tests are needed to optimize the efficiency of carbon adsorption and to address potential adverse effects to biota from peroxide residuals.

5.3.3 Disposal

Four types of disposal technologies and/or siting options were retained from the screening process for further evaluation: in-harbor disposal technologies such as CAD cells; shoreline (i.e., within the influence of normal tidal fluctuations) disposal technologies such as CDFs; upland (i.e., areas not influenced by tidal waters or located at a distance from the harbor area) disposal sites; off-site disposal facilities (at permitted facilities).

In-harbor and shoreline disposal of contaminated sediment in CDFs and CADs was thoroughly evaluated by USACE as part of the EFS. An overview of the WES laboratory tests is presented by Averett and Francingues (1988). An overview of the pilot disposal study is presented by Otis and Averett (1988).

Disposal of PCB and metal contaminated sediment in upland disposal locations in the New Bedford Harbor area but away from the harbor, or in offshore (i.e., ocean) disposal locations was

eliminated from further consideration. Although these disposal options are technically feasible, lack of suitable sites, permitting conflicts, and discussions with representatives of EPA Region I, Massachusetts Department of Environmental Quality Engineering (DEQE), and members of the New Bedford Harbor Community Work Group indicate that neither disposal option would be acceptable. Both options are actively being discouraged in the current regulatory environment.

Off-site disposal of contaminated sediment at permitted landfill facilities was retained for alternative development. However, use of off-site disposal would depend on the available capacity and permit status of the disposal facility receiving the material.

5.3.3.1 USACE Laboratory Studies

Laboratory tests were conducted to provide data and information to assess the CDF/CAD volume required for the disposal of dredged sediment, and to determine the efficiency of the CDFs and CADs in containing the contaminants. These tests and the results are described in the following paragraphs.

Settling tests on composite sediment samples collected from the upper estuary were conducted to evaluate the consolidation characteristics of the dredged sediment. These tests were

described in detail by Wade (1988). This information is important in determining the storage capacity of the CDF and CAD facilities and the feasibility of depositing dredged sediment in a CAD cell. USACE used results of these tests to determine that the CDF volume required for dredged sediment storage would be approximately 1.4 times the in-situ sediment volume. Maximum consolidation of the sediment would occur three to five years after placement (Averett and Francingues, 1988).

Capping effectiveness tests were conducted to determine the thickness of clean material that would have to be placed over contaminated sediment in CADs to isolate contaminants from the overlying water column. Results of these tests indicated that a cap thickness of 35 cm would provide an adequate chemical seal (Sturgis and Gunnison, 1988). An additional 20 cm would be required to prevent breaching of the cap by burrowing organisms (i.e., bioturbation). The required total cap thickness of 55 cm does not take into consideration erosion and resuspension of cap material due to hydrodynamic forces.

Elutriate and saltwater batch leaching tests were conducted on composite and Hot Spot sediment samples to predict the quality of water (leachate) that would potentially be released through the bottom and sides of an unlined CDF containing contaminated sediment from these areas (Averett, 1988). These tests were also used to predict the release of contaminants into the water column as a result of dredging operations. Results indicated

that the mean elutriate dissolved PCB concentration was 0.11 mg/l. This concentration exceeds the marine water quality criteria (0.01 mg/l). Heavy metal concentrations for copper (0.057 mg/l) and cadmium (0.11 mg/l) also exceeded marine water quality criteria (0.0029 mg/l for copper and 0.043 mg/l for cadmium) (Averett, 1988).

Surface runoff water tests were conducted to predict the quality of the surface runoff water from a CDF containing contaminated sediment. The tests were conducted on wet unoxidized sediment, and air-dried oxidized sediment. Details of these tests are presented by Skogerbee, Price, and Brandon (1988). Results of these tests indicated that proper management of a CDF to remove particulates from surface runoff would remove 90 to 99 percent of all contaminants (PCBs and metals) in the surface runoff. Concentrations of dissolved heavy metals (notably copper and zinc) were found to equal or exceed EPA criteria. This finding indicates that runoff treatment, capping, or immobilization of the contaminants may be required to eliminate soluble heavy metals in the surface runoff.

5.3.3.2 Conceptual Disposal Alternatives

Based on findings in the laboratory studies, USACE developed and evaluated conceptual disposal alternatives for New Bedford Harbor. The effectiveness, technical feasibility, and cost of

various design options for the deposition of dredged contaminated sediment in CDFs and CADs located in the upper estuary were evaluated using the EPA CERCLA criteria for evaluating remedial alternatives prescribed for Superfund sites. A thorough presentation of this work is given by Averett and Palermo (1988). Further discussion of these design options as remedial alternatives for the estuary will be presented in the FS of remedial alternatives for the estuary and lower harbor/bay, which is currently being prepared.

5.3.3.3 USACE Pilot Study of Disposal Alternatives

A CDF and a CAD cell were constructed during the pilot study in order to evaluate the effectiveness of these disposal options in containing contaminated sediment. A monitoring program is currently underway to assess the long-term effectiveness of these disposal option, however, no data or information is available at this time.

5.3.3.4 Summary

Off-site disposal of contaminated sediment in permitted landfill facilities, and disposal of contaminated sediment in in-harbor CADs and shoreline CDFs, were retained for the development of remedial alternatives. Studies conducted by USACE indicate that CDFs and CADs appear to be viable technologies for long-term

storage of contaminated sediment. The long-term effectiveness and technical feasibility of CDFs and CADs will depend on the selection of appropriate siting locations with respect to geotechnical properties of underlying strata; operational procedures to minimize sediment resuspension during construction, filling, and capping of the CDFs and CADs; and proper management of CDFs and CADs in terms of long-term monitoring of structural integrity and potential leachate migration, and treatment of any effluents (Averett and Francingues, 1988).

5.3.4 Containment and In-situ Treatment

Two containment options, capping and hydraulic controls, and two in-situ treatment options, biodegradation and solidification, were retained from the initial screening process for further evaluation. Details of the evaluation of these technologies are presented in E.C. Jordan Co./Ebasco (1987c). Results are briefly summarized in the following paragraphs.

Capping of waste piles, impoundments, and abandoned uncontrolled hazardous waste sites has been a widely accepted practice for controlling infiltration of precipitation and subsequent leaching of wastes, or as a final remedial action, usually in combination with other technologies. Subaqueous application of caps is still considered experimental due to the difficulties of cap material placement and long-term maintenance of cap

integrity. Cap placement in subaqueous environments can be accomplished using either hydraulic or mechanical methods. The long-term structural integrity of the cap will depend on the cap material selected and the local hydrodynamic forces that cause scouring and resuspension of cap material. Capping was retained as a viable technology for the in-situ containment of contaminated sediment in New Bedford Harbor.

Hydraulic controls are barriers, constructed of granular material or sheet pile, which are placed around areas of contaminated sediment to achieve a maximum permeability of 10^{-7} cm/sec. These barriers effectively isolate contaminants from surface water flow. Hydraulic controls would be implemented in conjunction with other technologies, such as dredging, deposition of sediment in CADs, or placement of subaqueous capping material. In these instances, hydraulic controls would serve to mitigate, if not eliminate, the migration of contaminated sediment resuspended during these operations. However, results of the USACE pilot dredging and disposal study indicate that the use of hydraulic controls will not be necessary, provided operational procedures designed to minimize sediment-contaminant resuspension are implemented. Therefore, hydraulic controls were eliminated from further consideration.

In-situ biodegradation relies on nutrient enhancement for indigenous microbes and/or exogenous sources of microbes to

degrade organic compounds. In-situ biodegradation was successfully applied for the treatment of groundwater and soil contaminated with volatile aliphatic and aromatic hydrocarbons. However, in-situ biodegradation of PCBs in marine sediment has not been successfully demonstrated. The logistics of controlling physiochemical parameters in unconfined sediment make it unlikely that any significant biodegradation could be accomplished. In Situ biodegradation was eliminated from further consideration.

In-situ solidification is accomplished by injecting slurried cement into the sediment and mixing through rotary action utilizing specially designed drilling equipment. To date, in-situ solidification has been employed only in Japan to solidify and strengthen sediment. The method has been effective for its intended purposes; however, it has not been used to treat hazardous wastes in sediment. In-situ solidification of contaminated sediment at New Bedford Harbor does not appear to be practical for the following reasons (Jordan/Ebasco, 1987d). The operation is usually conducted from a floating vessel with a draft of at least 10 feet. This would eliminate the use of this technology in the upper estuary where shallow (less than 6 feet) water conditions exist. The available performance data indicate that strengthening of the sediment increases with depth. This finding suggests that contaminants in the upper layers of sediment might not be completely immobilized. Quality control monitoring in a subaqueous environment would pose substantial

problems and probably could not be ensured. This implies that immobilization of the contaminants might not be achieved. For these reasons in-situ solidification of contaminated sediment was eliminated from further consideration.

In summary, no in-situ treatment technologies were retained for New Bedford Harbor. Only capping was retained as a viable containment technology. Capping of contaminated sediment would most likely be implemented in select areas of New Bedford Harbor not subjected to strong hydrodynamic forces. Studies conducted by USACE indicate that capping is technically feasible with proper operational procedures designed to minimize sediment resuspension.

5.4 REMEDIAL TECHNOLOGIES APPLICABLE TO THE HOT SPOT

Figure 5-3 presents the technologies that were selected for the development of remedial alternatives for the Hot Spot. The cutterhead dredge will be the only option for remedial alternatives employing removal of Hot Spot sediment as the first remedial step. Options for alternatives employing sediment treatment as a remedial component will consist of solvent extraction, solidification (both as a primary and secondary treatment step), and incineration. Process wastewater will be treated using settling, chemical assisted clarification, carbon adsorption, and/or UV/peroxide. Disposal options for treated or

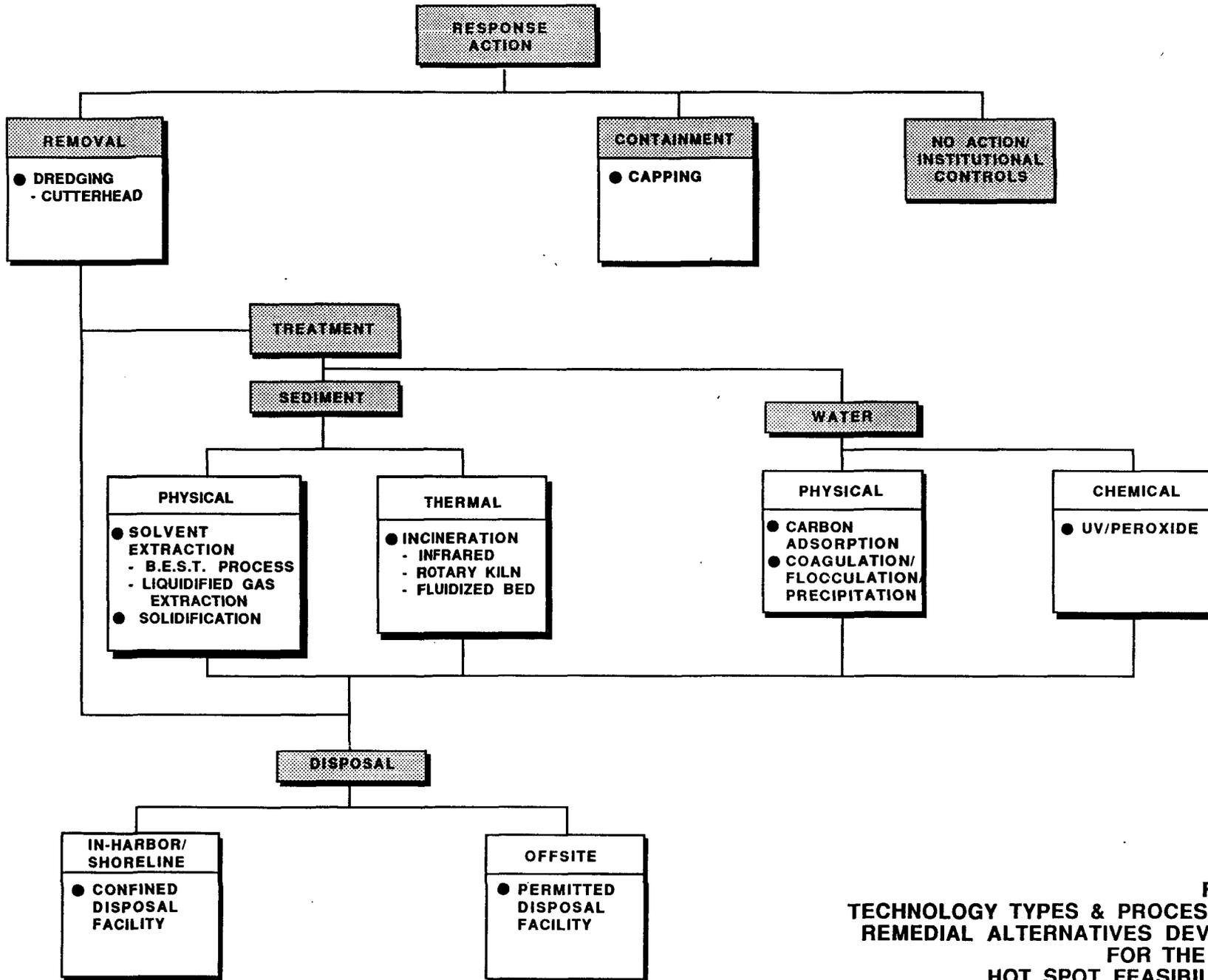


FIGURE 5-3
 TECHNOLOGY TYPES & PROCESS OPTIONS
 REMEDIAL ALTERNATIVES DEVELOPMENT
 FOR THE HOT SPOT
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR

untreated sediment will either be in shoreline CDFs, or off-site at permitted disposal facilities. Capping will be the only option considered for remedial alternatives employing containment as the general response action.

6.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section describes the development and screening of remedial alternatives for the Hot Spot area in the Acushnet River Estuary of New Bedford Harbor. The development of remedial alternatives is the final step in Phase I of the FS process, as outlined in the EPA OSWER Directive (EPA, 1988). The screening of remedial alternatives comprises Phase II of the FS process. The alternatives remaining after the screening step will be carried into Phase III of the FS process, which is the detailed evaluation of alternatives (see Section 7.0).

6.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Using information presented in Section 5.0, applicable combinations of technologies were developed into remedial alternatives capable of meeting the response objectives outlined in Section 4.0. In accordance with SARA, the range of alternatives to be developed and screened should include:

- the no-action alternative

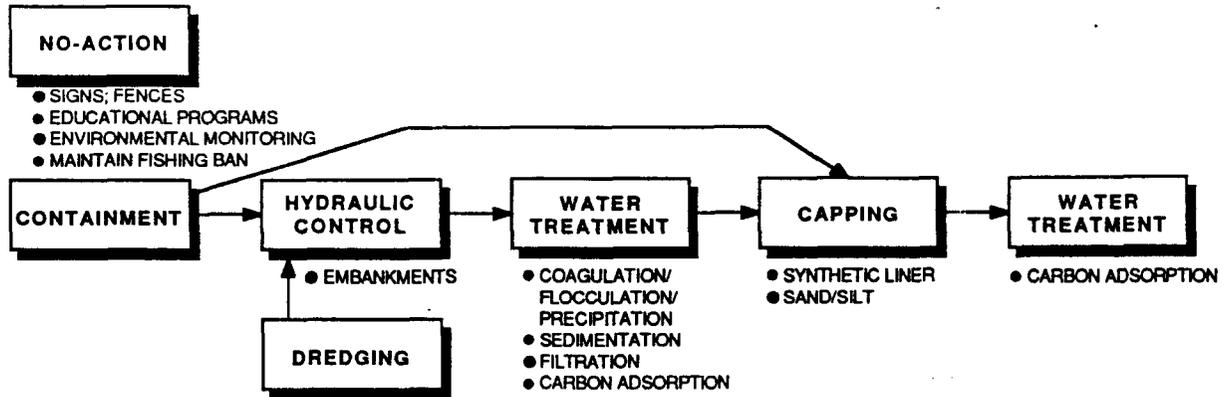
- an alternative that permanently and significantly reduces the mobility, toxicity, or volume of hazardous waste

- an alternative that stores, destroys, treats, or disposes waste at an approved Resource Conservation and Recovery Act (RCRA) facility
- an alternative that does not require long-term management of the site
- an alternative that involves on-site containment
- an alternative that attains federal and public health and environmental ARARs

For ease of analysis, the alternatives developed were subdivided into nonremoval and removal alternatives. Nonremoval alternatives, which leave the source material in-place, include no-action and containment. Removal alternatives require PCB-contaminated sediment to be removed before treatment and/or disposal.

Flow diagrams were prepared to enable visualization of the development of alternatives and to summarize results of the alternative development step. Figure 6-1 illustrates the range of nonremoval alternatives that are potentially applicable to the Hot Spot area. Figure 6-2 presents the range of removal alternatives potentially applicable to the Hot Spot area. The removal alternatives can be subdivided into disposal and

**FIGURE 6-1
DEVELOPMENT OF NONREMOVAL ALTERNATIVES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



HS-NA-1 NO-ACTION ALTERNATIVE

This alternative consists of maintaining signs, fences, and local PCB-related educational programs. In addition, environmental monitoring will need to be conducted to assess contamination movement and natural attenuation.

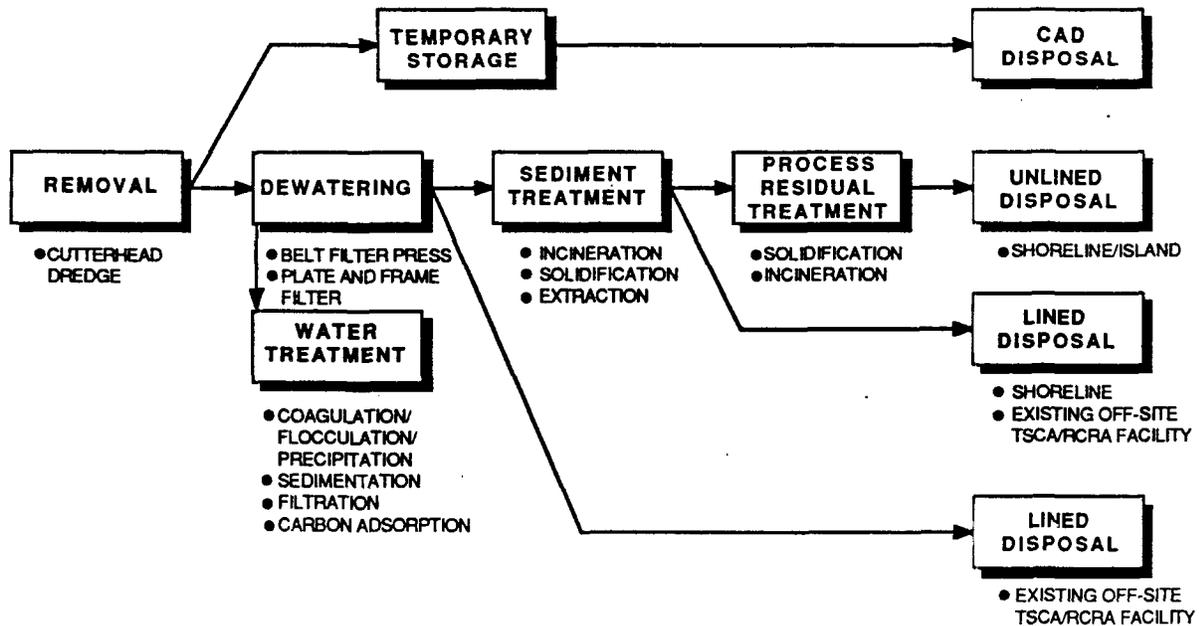
HS-CONT-1

Cover contaminated sediment with a 3-foot layer of sand/silt or clean sediment. Armor erosional area with graded rip-rap.

HS-CONT-2

Dredge the soft sediment (12 feet deep; 155,000 cy: 26,000 cy. PCB-contaminated sediment) around the Hot Spot area, construct an embankment around the Hot Spot, treat contaminated water, stabilize sediment with sand; install a synthetic cap, and treat contaminated water.

**FIGURE 6-2
DEVELOPMENT OF REMOVAL ALTERNATIVES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



HS-DISP-1

Dredge the Hot Spot sediment; temporarily store the contaminated sediment; dredge the clean sediment below the Hot Spot; temporarily store clean sediment; dispose contaminated sediment in-harbor in a contained aquatic disposal (CAD) site.

HS-DISP-2

Dredge and dewater Hot Spot sediment; treat process water; dispose of sediment in an out-of-state TSCA/RCRA landfill.

HS-TREAT-1

Dredge the Hot Spot sediment; dewater the sediment; incinerate the Hot Spot sediment on-site; solidify the ash to prevent leaching of metals. Shoreline/island disposal of detoxified, solidified ash, water treatment of process water.

HS-TREAT-2

Dredge the Hot Spot sediment; dewater the sediment; solidify the sediment; dispose of solidified sediment off-site in an existing TSCA/RCRA landfill; treat process water.

HS-TREAT-3

Dredge the Hot Spot sediment; dewater the sediment (if needed); treat sediment by solvent extraction; incinerate solvents off-site; solidify treated sediment to immobilize inorganic metals; shoreline /island disposal of detoxified, solidified sediment; water treatment of process water.

HS-TREAT-4

Dredge the Hot Spot sediment; dewater the sediment; transport off-site to a licensed incinerator; incinerate and dispose of ash in an out-of-state RCRA facility.

treatment alternatives. Disposal alternatives include removal of the contaminated sediment and disposal without sediment treatment. Treatment alternatives include treatment of the sediment and, in some cases, treatment of the process residual (e.g., solidification of incinerator ash), followed by disposal of residuals.

The alternatives are described briefly in Figures 6-1 and 6-2. Detailed descriptions for each of the alternatives are in Subsection 6.3.

6.2 CRITERIA FOR SCREENING REMEDIAL ALTERNATIVES

The remedial alternatives developed in Subsection 6.1 were screened based on the evaluation criteria described in Section 121 of SARA. The objective of this screening step is to eliminate from further consideration any alternatives that are undesirable with respect to effectiveness, implementability, and costs, while still preserving a range of options. The evaluation criteria for each category (i.e., effectiveness, implementability, and cost) are described in the following subsections.

6.2.1 Effectiveness

Each alternative was judged for its ability to effectively protect public health and the environment by reducing the

mobility, toxicity, or volume of contaminants. Short-term protectiveness involves reducing existing risks to the community and workers during implementation of remedial actions. The ability of an alternative to meet ARARs, as well as comply with other criteria, advisories, and guidelines, was also considered. Time required for the remedial alternative to achieve the desired result was also considered, including the potential length of exposure to which the local populace may be subjected. Long-term protectiveness criteria considered the magnitude of residual risk and the long-term reliability associated with the alternative. The alternative was evaluated for its effectiveness in preventing further exposure to residual contamination and reduction in the potential for PCB migration.

6.2.2 Implementability

Each alternative was evaluated in terms of implementability, technical feasibility, administrative feasibility, and resource availability. Each criterion was again divided into short- and long-term categories. Factors considered for short-term technical feasibility were the ability to construct the given technology, short-term reliability of the technology, and compliance with action-specific ARARs. Long-term technical feasibility factors considered the ease of undertaking additional remedial action if necessary, the ability to monitor

effectiveness of the given remedy, and the ability to perform O&M functions. Administrative feasibility for implementing a given technology addressed the ability to obtain approvals from other agencies, the likelihood of favorable community response, the need to coordinate with other agencies, and the need to comply with location-specific ARARs.

The extent to which a given technology could be implemented was also dependent on the availability of treatment, storage, and disposal services and capacities, and on the availability of necessary equipment and specialists.

6.2.3 Cost

The final criterion for the initial screening of alternatives was the cost associated with the given remedy. Short-term costs included development and construction costs, operating costs for implementing the remedial action, and other capital and short-term costs associated with completing the alternative. Long-term costs considered were O&M for the required duration, five-year reviews, and potential future remedial action.

For each alternative, a matrix was developed highlighting its advantages and disadvantages with respect to effectiveness, implementability, and cost. The alternative evaluation matrix presents a clear, concise procedure for screening potential

remedial alternatives. Based on this matrix, a decision was made to either retain the alternative for detailed evaluation or eliminate the alternative from further consideration. This decision is documented in Subsection 6.4.

6.3 SCREENING OF REMEDIAL ALTERNATIVES

Each alternative developed in Subsection 6.1 was screened against criteria presented in Subsection 6.2 to determine whether it should be carried into detailed evaluation. For each alternative, the following four items are provided:

- description
- evaluation against the screening criteria
- alternative evaluation matrix
- conclusion

6.3.1 No-Action Alternative HS-NA-1

Description. The no-action alternative consists of leaving the Hot Spot sediment in place. A site perimeter fence would be located along the eastern shore of the Acushnet River and warning signs would be posted at appropriate intervals to limit public access to the Hot Spot area. Warning signs would be posted in English and Portuguese; the latter to assist the local population of Portuguese-Americans. Institutional controls

would be required to place restrictions on future site development. Institutional controls would be drafted, implemented, and enforced in cooperation with state and local governments.

To determine contaminant migration and natural attenuation, and to assess exposure risks over time, an environmental monitoring program would be implemented. Monitoring would include periodic surface water, biota, and sediment sampling in the Acushnet River Estuary. Data collected as part of the environmental monitoring program would be evaluated during the required five-year review, with recommendations made for further remedial action at that time.

Effectiveness. The no-action alternative would have minimal short-term effects because the sediment within the Hot Spot area would remain accessible to environmental receptors and transport mechanisms. Worker safety associated with the installation of signs and fences would not be a factor because workers would not be exposed to the contaminated sediment. Workers collecting samples as part of the five-year reviews would be required to wear appropriate health and safety equipment. There would be minimal long-term effectiveness with the no-action alternative. The PCB-contaminated sediment would remain in the estuary and continue to act as a source for the rest of the harbor. Public health and environmental risks would not be mitigated.

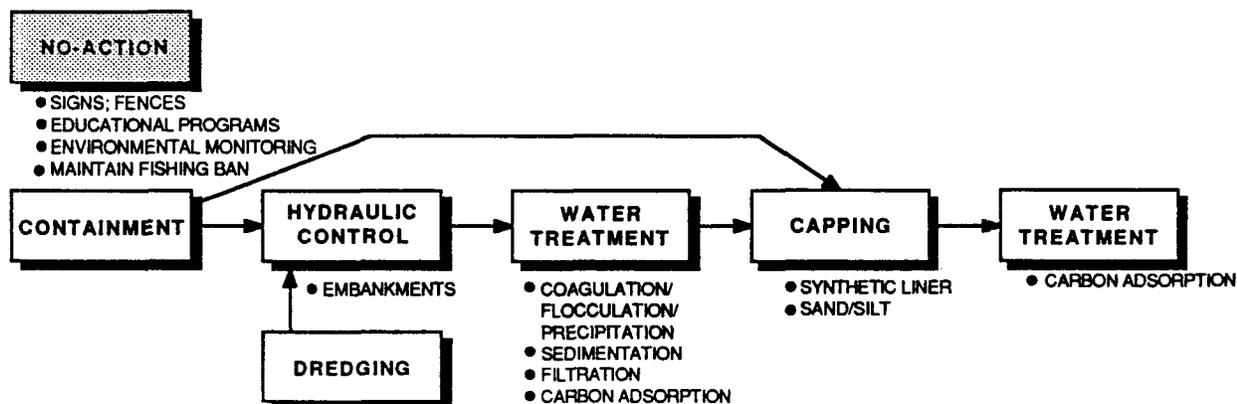
Implementability. The no-action alternative would be easy to implement from a technical viewpoint. Signs, fences, educational programs, and environmental monitoring programs are all common technologies and readily available. The administrative feasibility of this alternative, however, is expected to be poor. The no-action alternative would likely raise opposition from the Commonwealth of Massachusetts, as well as the local community. In addition, the institutional controls necessary to ensure the effectiveness of this alternative are expected to be difficult to establish and maintain.

Cost. The no-action alternative would require minimal capital and/or construction costs; however, costs would be incurred for long-term environmental monitoring, administration associated with implementing institutional controls, five-year reviews mandated by SARA, and potentially, future remedial action cost increases. The cost for this alternative is estimated to be \$450,000.

Figure 6-3 summarizes the screening evaluation for the no-action alternative.

Conclusion. The no-action alternative will be carried into detailed analysis as required by the NCP. It will serve as the baseline for comparison of the other Hot Spot alternatives.

FIGURE 6-3
SCREENING OF NONREMOVAL ALTERNATIVES
HS-NA-1: NO-ACTION ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR



Effectiveness

Advantages

- Minimal short-term effects in implementing alternative

Disadvantages

- No reduction of existing risks
- Does not comply with ARARs
- Does not comply with pertinent criteria, advisories, and guidance
- Does not prevent future exposure
- Does not permanently or significantly reduce toxicity, mobility, or volume of PCB contamination

Implementability

Advantages

- Little effort to implement

Disadvantages

- Administrative feasibility expected to be poor
 - * Likelihood of unfavorable community response
 - * Expected inability to obtain approvals from other agencies

Cost

Advantages

- Low capital and construction costs

Disadvantages

- Continual costs for O+M of environmental monitoring systems
- High potential for future remedial action costs

6.3.2 Containment Alternative HS-CONT-1

Description. This alternative consists of covering PCB-contaminated sediment with a 3-foot layer of sand/silt or uncontaminated material collected from Buzzards Bay and transported to the Hot Spot area. USACE recommended a cap thickness of 3 feet to provide a chemical seal and ensure isolation of contaminated sediment from burrowing organisms (i.e., bioturbation). Construction of this cap is estimated to require approximately 25,000 cy of uncontaminated material. If dredged material from Buzzards Bay is used, this alternative would be inexpensive when compared to the other alternatives. Rip-rap and other erosion protective devices (e.g., fabric filter blankets) would be required in Hot Spot areas, subject to erosion by local hydrodynamic forces.

To determine contaminant migration and natural attenuation, and to assess exposure risks over time, an environmental monitoring program would be implemented. Monitoring would include periodic surface water, biota, and sediment sampling in the Acushnet River Estuary. Data collected as part of the environmental monitoring program would be evaluated during the required five-year review, with recommendations made for further remedial action at that time.

Effectiveness. The implementation of this alternative is expected to have significant short-term impacts to the estuary

and the rest of New Bedford Harbor. Studies by USACE have shown that boat traffic and associated propeller wash have caused release of floating oil sheen containing PCBs from the Hot Spot sediment (Teeter, 1988). Cap construction, including the associated transport of the capping materials to the Hot Spot, is expected to cause release of PCB-contaminated sediment. Environmental control measures (e.g., silt curtains and oil booms) would be necessary to mitigate this release. However, results of the pilot study indicated that the installation, position, and removal of a silt curtain used during the study caused significant sediment resuspension (Otis, 1989).

Worker safety is not considered a concern with this alternative because the majority of the workers will be working in boats or using health and safety protective gear and will not be exposed to contaminated sediment. Short-term impacts to public health are also expected to be minimal, although routine air monitoring will need to be performed to verify that significant amounts of PCBs are not being released to the air during the remedial action.

The long-term effectiveness of this alternative is questionable. The bearing strength of the underlying sediment is not believed to be adequate to support a cap. It is very likely that during cap installation the cap material will mix readily with the contaminated sediment. Resuspension of

contaminated sediment during placement of cap material may also occur.

If the cap is effective in covering the Hot Spot sediment, the sediment would remain in-place and could be re-exposed by future events, either natural (e.g., floods) or manmade (e.g., development). As long as sediment remains capped, the transport of PCBs from this area should be reduced; however, institutional controls and an aggressive monitoring program would be needed to verify cap integrity.

Implementability. The equipment, technologies, and personnel required to implement this alternative are readily available. The administrative feasibility of this alternative, however, is expected to be poor. Leaving PCB-contaminated sediment in place is expected to draw opposition from both the Commonwealth of Massachusetts and the New Bedford community. Institutional controls and a long-term monitoring program would need to be implemented to verify cap integrity. Because PCB-contaminated sediment is left in-place, a five-year review program would need to be established. Raising the estuary by 3 feet in this area would be expected to adversely affect the adjacent wetlands area. In addition, this alternative is not expected to comply with Section 404 of the Clean Water Act (CWA) because there will be filling of a river area when other suitable alternatives exist.

Cost. Costs for this alternative were developed assuming the cover material is clean sediment dredged from Buzzards Bay. Construction costs associated with this alternative are for dredging, transporting, and placing the cap material, and for installing the rip-rap and other erosion control measures. Long-term O&M costs are associated with implementation of the institutional requirements, the long-term monitoring program, and mandatory five-year reviews. This alternative is anticipated to cost approximately \$5 million. Figure 6-4 summarizes the screening evaluation for this capping alternative.

Conclusion. This alternative will be eliminated for further analysis. This alternative is inconsistent with the requirements of SARA to permanently reduce the mobility, toxicity, or volume of wastes. Implementation of this alternative is expected to cause an increase in PCB mobility. In addition, this alternative has questionable long-term reliability and does not comply with CWA ARARs. This alternative is expected to have an impact on adjacent wetland areas.

6.3.3 Containment Alternative HS-CONT-2

Description. This alternative consists of dredging the sediment around the perimeter of the Hot Spot area, constructing an

embankment on the perimeter, capping the sediment within the cell created by the embankments, and treating contaminated water within the cell. In this alternative, the embankment would be constructed to permanently contain the PCB-contaminated sediment and prevent subsequent release during cap installation.

To ensure embankment stability, the soft sediment in the area of the proposed embankment would be excavated down to the stable underlying strata. The embankments would be constructed in lifts out from the shoreline, with 2.5V:1H (vertical to horizontal) side slopes. The embankment slope facing the Acushnet River would be armored with rip-rap to prevent erosion.

Approximately 155,000 cy of sediment would need to be dredged from the estuary prior to embankment construction. Of this sediment, approximately 26,000 cy is contaminated with PCBs in the range of 500-4,000 ppm and would require treatment prior to disposal. After construction of the embankment is completed, clean sand would be brought in and placed over the contaminated sediment. If required, a synthetic cap could be placed over the sand, thereby containing the sediment in place. Contaminated water within the cell would be treated to remove the PCBs prior to discharge back into the Acushnet River.

Effectiveness. This alternative would have a short-term impact to the estuarine environment than HS-CONT-1 because an embankment would be constructed around the Hot Spot area prior to cap emplacement. Some PCB release, however, is expected during the sediment dredging and embankment construction. This release would be minimized by careful construction controls during both the dredging process and embankment construction. Results of the USACE pilot test indicate that dredging and construction can be accomplished with minimal sediment resuspension.

As with HS-CONT-1, PCB-contaminated sediment is not removed from the estuary but left in place. The long-term effectiveness of this alternative is greater than HS-CONT-1 because the Hot Spot is contained within the embankment, and PCB migration away from the Hot Spot resulting from a failure of the cap would be reduced if not eliminated. This alternative does not permanently treat the waste, and potential exists for both cap and embankment failure from natural or manmade causes; however, this potential appears to be minimal.

Implementability. This alternative is technically feasible to implement at the New Bedford Harbor site. The technology, equipment, and trained personnel are all available. As in HS-CONT-1, leaving PCB-contaminated sediment in-place is expected to draw opposition from both the state and community.

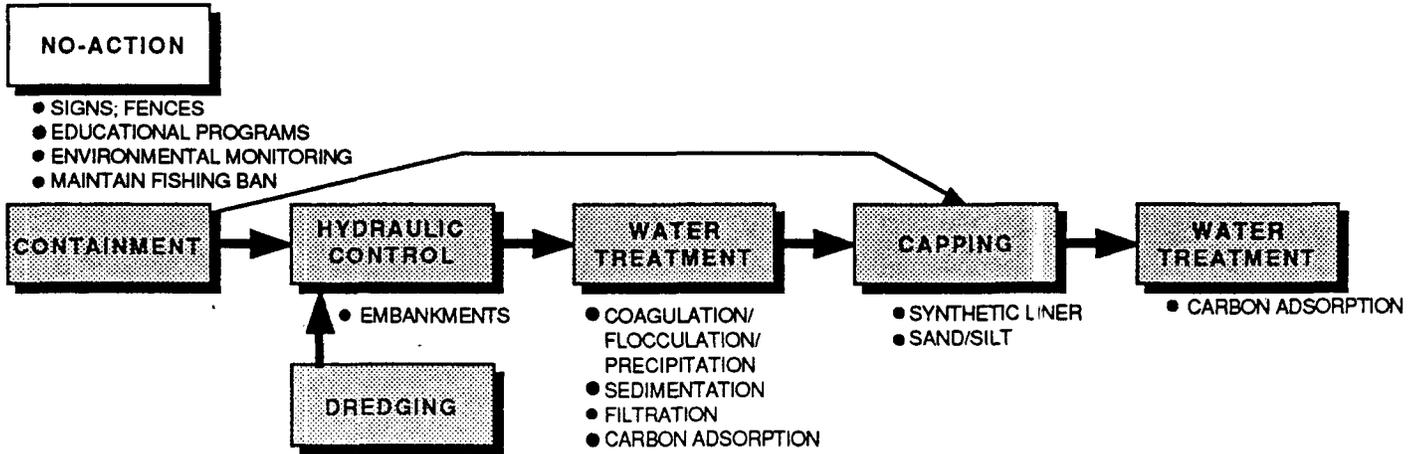
Because this is not a permanent remedy, a five-year review program would be required. In addition, institutional controls and long-term monitoring would be required. Compliance with Section 404 of the CWA would not be achieved with this alternative.

Cost. Costs for this alternative were developed assuming that the cover material is clean sediment dredged from Buzzards Bay and that a synthetic liner would be required. Construction costs are associated with dredging, embankment construction, cap installation, cover installation, water treatment, and disposal of uncontaminated sediment. Long-term O&M costs are associated with implementation of the institutional requirements, a long-term monitoring program, and five-year reviews. This alternative is anticipated to cost approximately \$43 million, assuming in-harbor disposal of uncontaminated sediment. Figure 6-5 summarizes the screening evaluation for this containment alternative.

Conclusion. This alternative will be eliminated from further analysis for the following reasons:

- failure to permanently and significantly reduce toxicity and volume of Hot Spot area sediment

**FIGURE 6-5
SCREENING OF NONREMOVAL ALTERNATIVES
HS-CONT-2: CONTAINMENT AND CAPPING ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Will reduce mobility of Hot Spot sediments
- Will reduce short-term existing risk

Disadvantages

- Will not attain all federal/state ARARs
- Short-term risk to workers during remedial action (liner installation)
- Moderate potential for replacement
- Will not permanently and significantly reduce toxicity and volume of Hot Spot PCB sediment
- Dredging of sediment outside the Hot Spot, construction of the embankment, and potential sediment scour outside the embankment may increase PCB sediment mobility in Upper Estuary

Implementability

Advantages

- Embankments constructed on firm soil/sediment are technically feasible to construct around the Hot Spot
- Embankments and impermeable liners are proven technologies
- Equipment, personnel, and technologies are readily available

Disadvantages

- Liner on stabilized sediment and venting of liner will require accurate installation
- Dredging of sediment and embankment construction will require approximately two years to complete
- Will require institutional controls

Cost

Advantages

- None

Disadvantages

- Long-term embankment/liner maintenance will be required
- Potential for future remedial action costs
- 5-year review costs

- high cost of dredging and construction that must be performed to contain the sediment when compared to costs of several of the treatment alternatives
- long-term monitoring and maintenance
- moderate potential for future remedial action
- potential difficulties in disposing of uncontaminated sediment
- noncompliance with CWA ARAR

6.3.4 Disposal Alternative HS-DISP-1

Description. This alternative consists of dredging the Hot Spot sediment with a cutterhead dredge and temporarily storing the contaminated sediment in a CDF. After this is accomplished, the uncontaminated sediment remaining below the Hot Spot would be removed and stored in a CDF. The contaminated sediment would then be replaced in the dredged area, and the uncontaminated sediment would be placed on top of the redeposited contaminated sediment. Details of this disposal alternative, called CAD, have been presented elsewhere (Otis and Averett, 1988; and E.C. Jordan Co./Ebasco, 1987c).

Effectiveness. Preliminary results of the pilot study indicate that dredging with a cutterhead dredge can be performed with minimal resuspension and subsequent PCB migration (Otis, 1989). The majority of the sediment resuspension was associated with the anchor lines of the dredge. To minimize this disturbance, anchor lines for dredging in the Hot Spot area will be shore-mounted. In addition, pilot test results indicate that CAD cells can be constructed without significant sediment resuspension. Short-term impacts to workers and the community should be minimal because there would be minimal contact with the dredged material and minimal resuspension. An air monitoring program would need to be established to verify compliance with PCB air standards.

The long-term effectiveness of this alternative is unknown due to a lack of historical data. As with the containment alternatives, the PCB-contaminated sediment remains within the estuary and is subject to future natural or manmade disturbances. A long-term monitoring program would need to be established to monitor effectiveness of this alternative. This alternative would not comply with the TSCA ARAR that specifies the requirements for a TSCA landfill.

Implementability. The use of CAD cells is an innovative approach to disposing of or containing contaminated sediment. As discussed previously, this technology was pilot-tested by

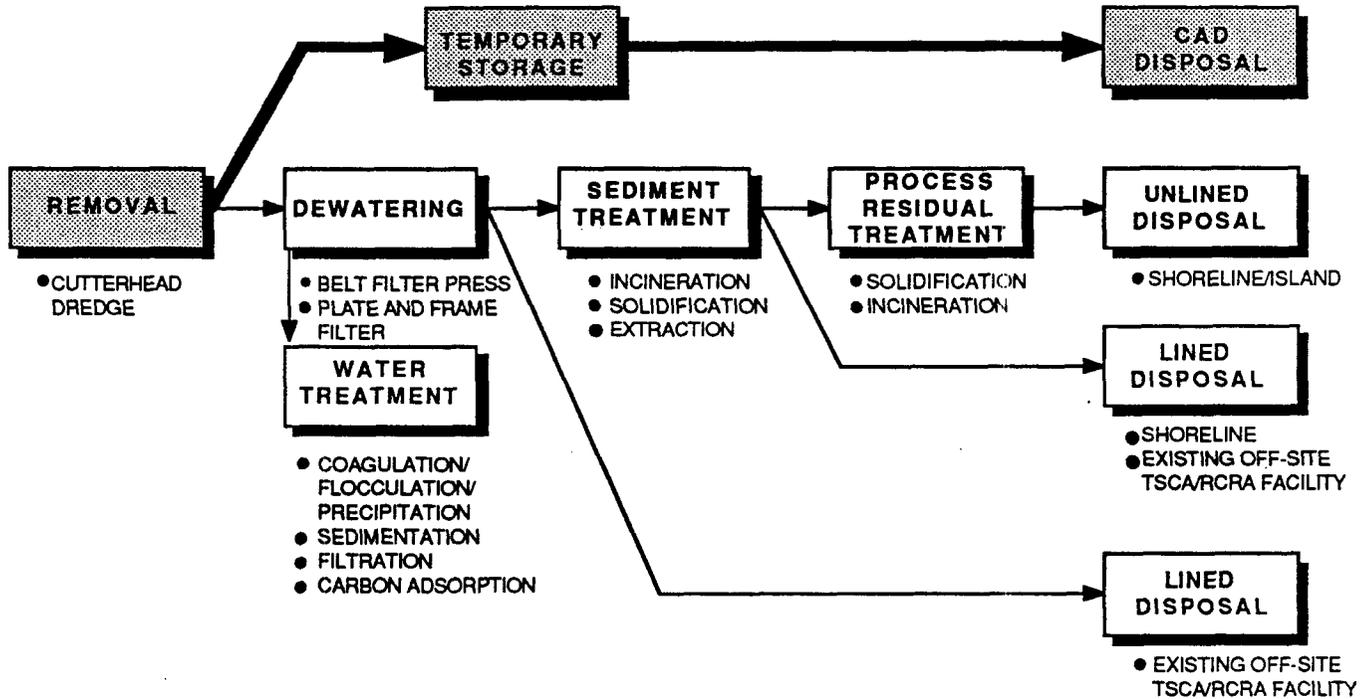
USACE and proven to be technically feasible for New Bedford Harbor sediment. Equipment and personnel capable of constructing CAD cells are available.

The CAD alternative does not remove or treat PCB-contaminated sediment. Therefore, opposition from both the state and community is expected. Long-term monitoring and institutional controls would be required to verify the long-term effectiveness of this alternative and to minimize disturbances to these cells. However, this alternative is expected to comply with wetlands location-specific ARARs because minimal disturbances are expected to the wetlands during implementation of this alternative.

Cost. Costs associated with this alternative include construction costs for the CAD cells and long-term O&M costs associated with implementation of institutional controls, long-term monitoring, and the mandatory five-year review. This alternative is anticipated to cost approximately \$9 million. Figure 6-6 summarizes the screening evaluation for this disposal alternative.

Conclusion. This alternative will be eliminated from further analysis. The rationale for elimination is that it has questionable long-term reliability in containing the more contaminated Hot Spot sediment. In addition, the potential exists for PCB leaching from these cells with time. This

**FIGURE 6-6
SCREENING OF REMOVAL ALTERNATIVES
HS-DISP-1: CAD DISPOSAL ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Will reduce short-term mobility of Hot Spot sediment once CAD is in place

Disadvantages

- Does not permanently and significantly reduce toxicity, volume, and potentially the mobility of Hot Spot sediment
- Potential for cell replacement and/or future exposure to Hot Spot sediment
- Unproven long-term reliability
- May increase PCB mobility during construction of CAD

Implementability

Advantages

- USACE conducted a pilot study in the estuary to determine the implementability of a CAD system in New Bedford Harbor
- Land availability for the CAD cell is not a concern

Disadvantages

- Will require long-term monitoring
- Will require institutional controls

Cost

Advantages

- Minimum construction costs
- Least costly of all disposal alternatives

Disadvantages

- Potential for future remedial action costs
- Long-term costs for environmental monitoring and five-year reviews

alternative does not permanently reduce the toxicity and volume of Hot Spot sediment and, potentially, the mobility of Hot Spot sediment.

6.3.5 Disposal Alternative HS-DISP-2

Description. This alternative consists of dredging Hot Spot sediment, dewatering the sediment to 50-percent solids, treating the process water, and disposing of the sediment in a TSCA/RCRA-licensed landfill.

As with the other dredging alternatives, a cutterhead dredge would be used to dredge the sediment. Dewatering would be achieved by conventional equipment (e.g., belt-filter press, and plate and frame filter). Transportation of the dewatered sediment would occur via containerized trucks or by rail, depending on the specific disposal site selected. Process water would be treated prior to discharge into New Bedford Harbor.

Effectiveness. This alternative would be effective in reducing the long-term mobility of PCBs in the Hot Spot by removing them from the estuary and disposing of them in a secure landfill. The toxicity and volume of the PCB-contaminated sediment would not be changed by this alternative. Short-term mobility of PCBs is expected to be minimal during implementation of this alternative, as verified by results of the USACE pilot study.

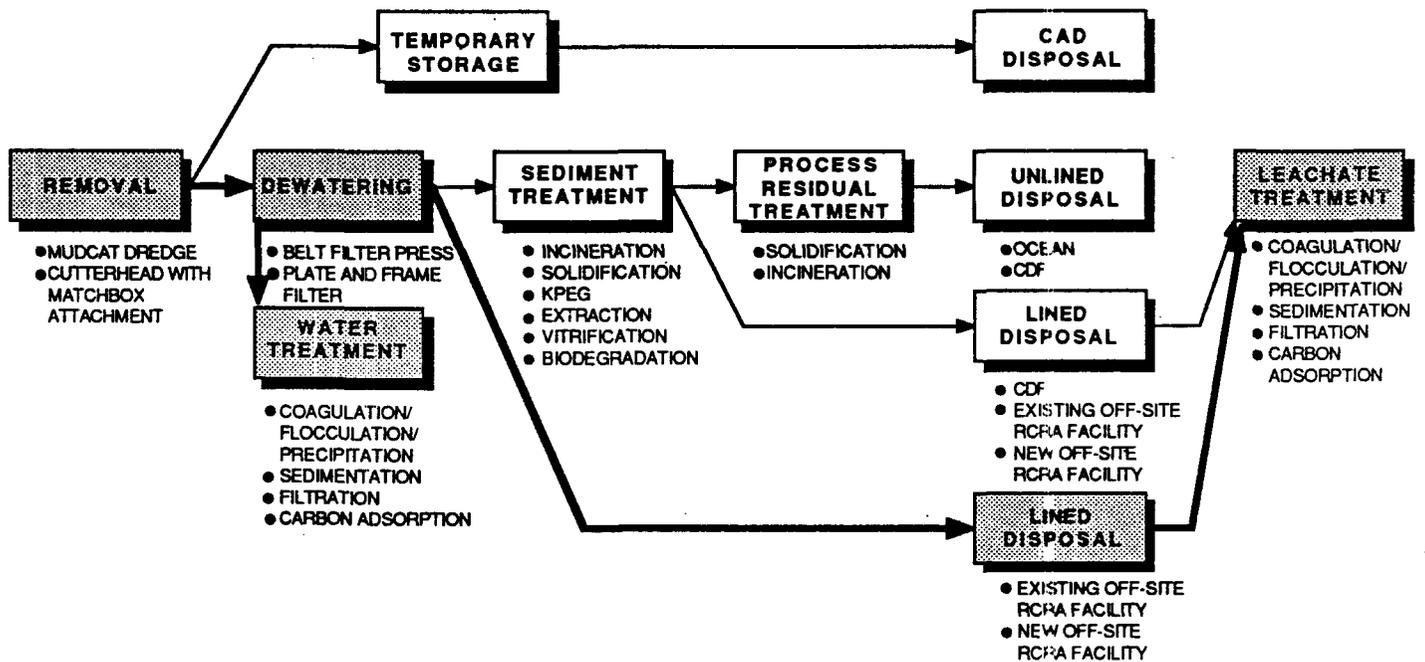
Therefore, environmental controls (e.g., silt curtains) are not proposed.

Implementability. This alternative is technically feasible. Equipment and trained personnel are readily available to dredge, dewater, and transport sediment to a licensed landfill. Landfill regulatory compliance would need to be verified prior to implementing this alternative to ascertain available capacity and permit conditions. Currently, there are only a few landfills that will accept contaminated sediment with PCB concentrations exceeding 500 ppm.

This alternative would likely draw minimal opposition from the state and community. Minimal opposition is also anticipated from other regulatory agencies if a suitable, licensed facility capable of accepting this waste could be identified.

Cost. Costs for this alternative are primarily associated with transportation and disposal of the sediment. Long-term monitoring and institutional controls are not anticipated for this alternative because PCB-contaminated sediment is physically removed from the harbor. The cost of this alternative is anticipated to be approximately \$19 million. Figure 6-7 summarizes the screening evaluation for this disposal alternative.

**FIGURE 6-7
SCREENING OF REMOVAL ALTERNATIVES
HS-DISP-2: OFF-SITE DISPOSAL ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Permanently reduces mobility of PCBs in Hot Spot area of New Bedford Harbor
- Reduction of existing and future risks associated with the Hot Spot area

Disadvantages

- Does not permanently treat/reduce the volume or toxicity of PCB sediment

Implementability

Advantages

- TSCA/RCRA facility will be in ARAR compliance
- High technical feasibility
- High likelihood of favorable community response

Disadvantages

- Availability of disposal services/capacity is a concern
- Land disposal restrictions will affect disposal date

Cost

Advantages

- More cost-effective treatment step not required

Disadvantages

- Potential for future remedial action costs at TSCA/RCRA facility

Conclusion. This alternative will be eliminated from further consideration for the following reasons:

- failure to permanently treat or reduce the volume or toxicity of PCB sediment
- landfilling of untreated PCB material in excess of 500 ppm or halogenated organic carbons in excess of 1,000 ppm will no longer be allowed under the provisions of the 1986 land disposal restrictions

6.3.6 Treatment Alternative HS-TREAT-1

Description. This alternative consists of dredging the contaminated Hot Spot sediment, dewatering the sediment, treating the process water, incinerating the dewatered sediment on-site and (if necessary) solidifying the incinerated ash to immobilize inorganic metals and disposing of the solidified sediment in a shoreline disposal site.

The first three steps of this alternative are similar to the initial steps for the disposal alternatives and will not be repeated. This alternative employs a two-step process to treat Hot Spot sediment. The first step, incineration, is a proven technology for destroying PCBs. Following incineration, the heavy metals (i.e., copper, cadmium, chromium, and lead) would

be immobilized in a solidified matrix to prevent potential future leaching of the metals. The detoxified, solidified ash could then be disposed of in a shoreline disposal area.

Effectiveness. This alternative would permanently reduce the toxicity and mobility of Hot Spot sediment by removing it from the estuary and destroying it by incineration. Incineration is a proven treatment technology for PCBs and is expected to achieve greater than 99-percent PCB destruction efficiency. This alternative is consistent with the SARA preference for permanent treatment and would comply with TSCA and other action-specific ARARs.

Implementability. This alternative is technically feasible. Incineration is a proven technology for PCB destruction and mobile incinerators and trained personnel are readily available. The dredging and dewatering processes were field- or bench-tested on harbor sediment and this equipment is readily available.

With respect to administrative feasibility, this alternative is expected to have both state and community support. This alternative is also expected to be supported by other federal agencies.

Cost. Costs associated with this alternative are estimated to be \$20 million. Figure 6-8 is a summary of the screening evaluation for this alternative.

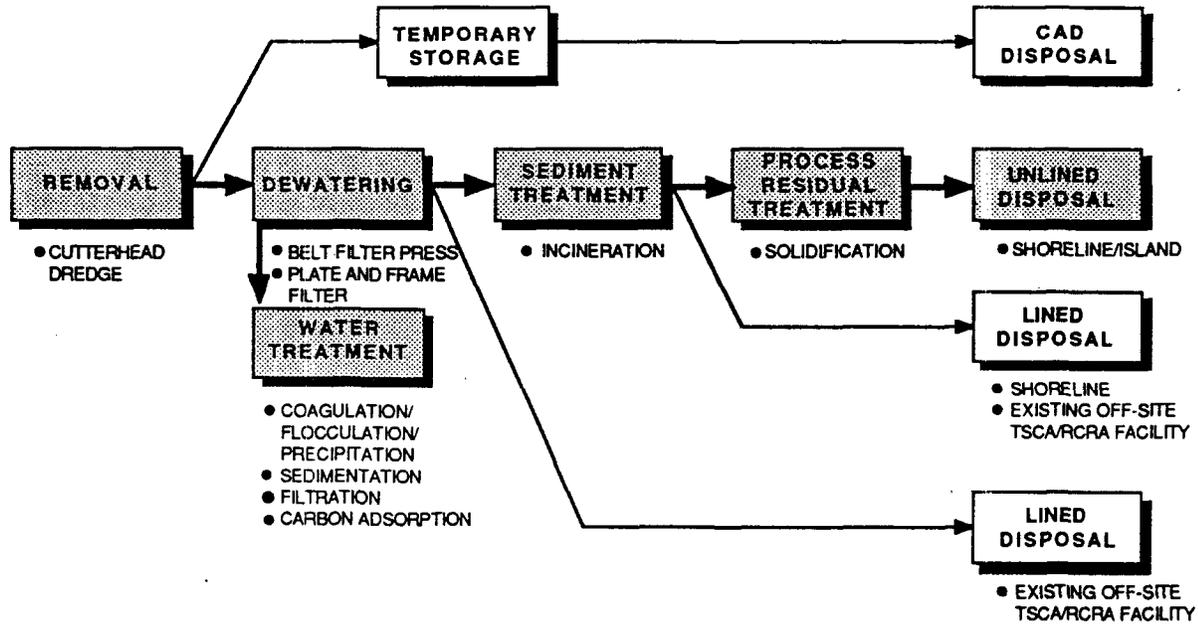
Conclusion. This alternative will be retained for detailed analysis. It complies with SARA requirements by permanently reducing the mobility, toxicity, and volume of contaminated sediment. In addition, the costs for this alternative are within the same order of magnitude as costs for other alternatives discussed.

6.3.7 Treatment Alternative HS-TREAT-2

Description. This alternative consists of dredging, dewatering, and solidifying contaminated sediment, and disposing of the solidified sediment in an existing out-of-state TSCA/RCRA landfill. This alternative is similar to HS-DISP-2, except that the solidification step has been added to facilitate handling/transportation of the sediment and to reduce the PCB mobility to the point where treated sediment can be accepted by a licensed TSCA/RCRA landfill.

Effectiveness. Bench-scale tests by USACE showed that PCB mobility can be reduced by 80 to 90 percent by solidifying the Hot Spot sediment in a controlled environment. The resulting solid product can range from a soil-like product to a solidified block. This alternative permanently reduces the mobility of the

**FIGURE 6-8
SCREENING OF REMOVAL ALTERNATIVES
HS-TREAT-1: INCINERATION ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Permanent and significant reduction in volume, toxicity, and mobility of hazardous waste
- Attains state/federal ARARs
- Reasonable time until protection is achieved

Disadvantages

- None

Implementability

Advantages

- Proven technology; high technical feasibility
- Excellent equipment availability

Disadvantages

- Will require coordination with other agencies

Cost

Advantages

- Low potential for future remedial action costs
- Will not require 5-year review
- Will not require long-term environmental monitoring

Disadvantages

- None

PCB contamination; however, the volume of contaminated sediment would be increased through solidification. As with other dredging alternatives, minimal short-term effects are anticipated due to the sediment dredging.

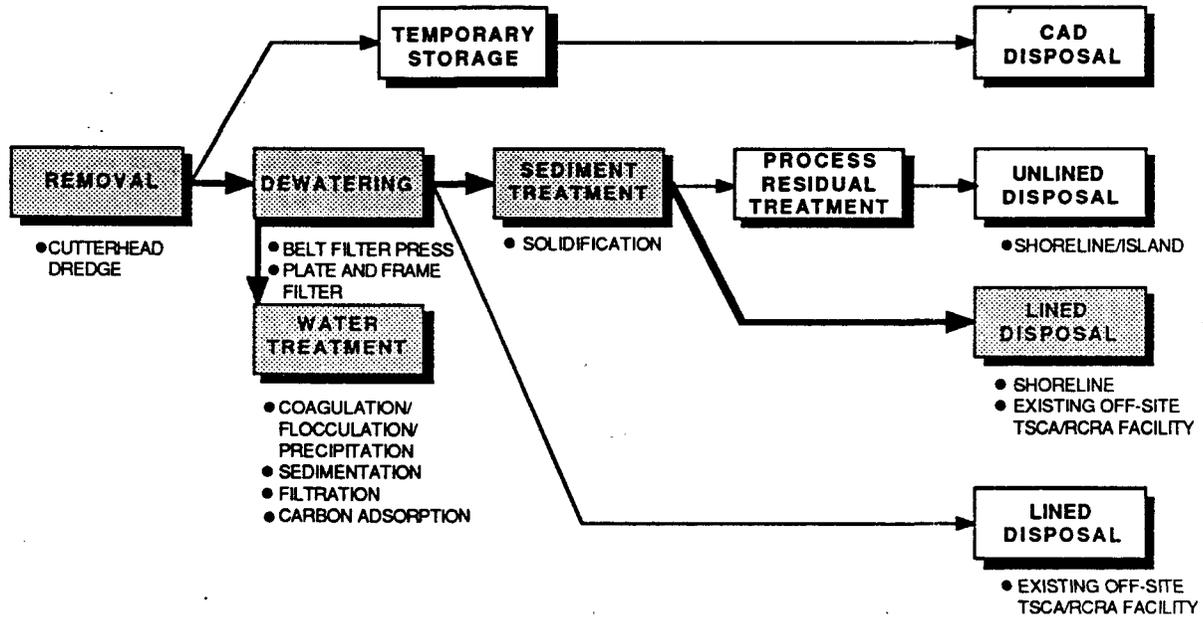
Implementability. This alternative is technically feasible. The equipment, personnel, and expertise to dredge, dewater, and solidify the sediment are available within the eastern U.S. Landfill capacity is currently available for this volume of sediment; however, available capacity and permit compliance are subject to change and would need to be verified prior to alternative implementation.

Administrative feasibility is expected to be good. It is anticipated that the Commonwealth of Massachusetts, local community, and other federal agencies would support this alternative.

Cost. The cost for this alternative is approximately \$25 million. Figure 6-9 illustrates the screening evaluation for this alternative.

Conclusion. This alternative will be retained for detailed analysis.

**FIGURE 6-9
SCREENING OF REMOVAL ALTERNATIVES
HS-TREAT-2: SOLIDIFICATION ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Permanent and significant reduction in mobility; increase in volume
- Complies with most federal/state ARARs
- Will reduce existing and long-term risk associated with Hot Spot sediment

Disadvantages

- Not anticipated to be completely effective in immobilizing PCBs

Implementability

Advantages

- No need for long-term maintenance at the site as the solidified sediment will be disposed of off-site.
- Bench-scale tests have been conducted
- Good potential for favorable community response

Disadvantages

- May require follow-up testing after bench-scale tests
- Will require coordination with several other federal and state agencies

Cost

Advantages

- Limited potential for future remedial action costs
- Will not require 5-year review

Disadvantages

- Costs are highly variable depending on disposal facility selected

6.3.8 Treatment Alternative HS-TREAT-3

Description. This alternative consists of dredging the Hot Spot sediment, dewatering the sediment and treating the process water, treating the sediment by solvent extraction, incinerating the PCB-enriched solvent extract off-site, solidifying the treated sediment to immobilize the metals, and disposal of the detoxified, solidified sediment in a shoreline disposal facility.

Solvent extraction is an innovative technology. This technology, combined with incineration of the solvent extract and solidification of the treated sediment, would significantly reduce the mobility, toxicity, and volume of the PCB-contaminated sediment.

Effectiveness. This alternative is expected to be effective in permanently reducing the mobility and toxicity of the Hot Spot sediment. Pilot-scale tests on the Hot Spot sediment have shown that greater than 99 percent of the PCBs can be removed from the sediment. In addition, the USACE pilot dredging tests demonstrated that PCBs can be removed from the harbor with minimal environmental impact. Because this alternative would remove and treat PCB sediment, long-term monitoring and institutional controls would not be required for the Hot Spot area.

Implementability. Based on results of bench-scale tests, this alternative appears technically feasible. At least two vendors have solvent extraction systems that are available for full-scale operation at the present time or in the near future.

The administrative feasibility of this alternative is expected to be good. This alternative is expected to receive support from the state and local community, as well as other federal agencies.

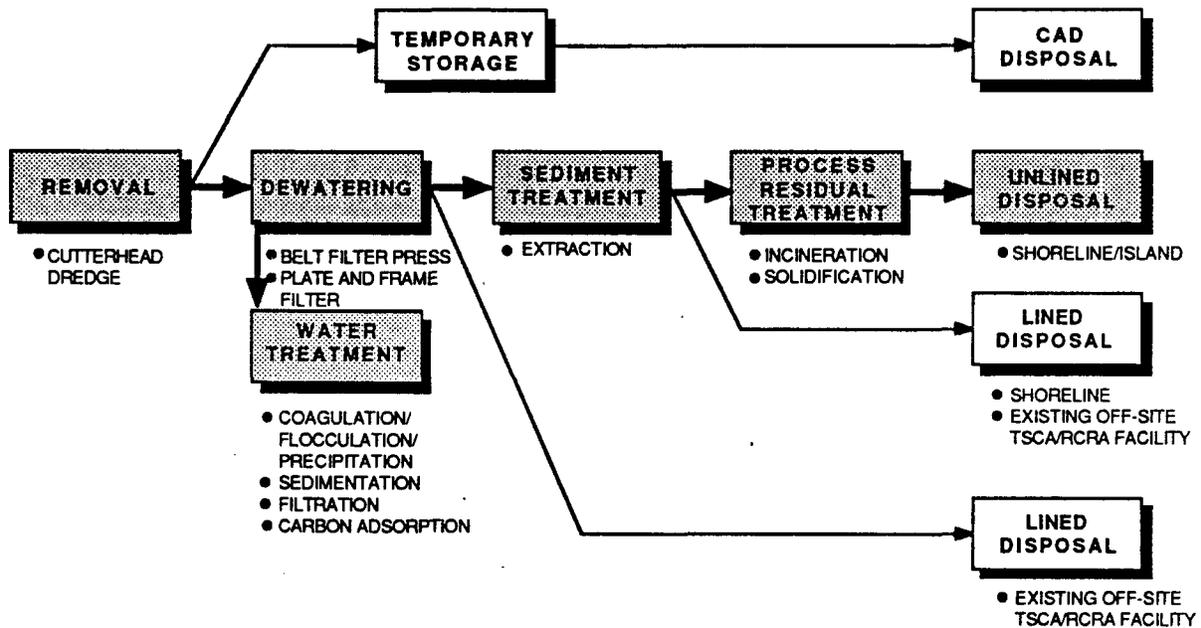
Cost. Costs for this alternative are estimated to be \$16 million. Figure 6-10 is a summary of the screening evaluation.

Conclusion. This alternative will be retained for detailed analysis. It meets SARA requirements for permanent reduction of contamination, uses an innovative technology, and is expected to have higher community acceptance than incineration.

6.3.9 Treatment Alternative HS-TREAT-4

Description. This alternative has the same unit processes as HS-TREAT-1 (i.e., on-site incineration), except that dewatered sediment is incinerated off-site at a licensed incinerator.

**FIGURE 6-10
SCREENING OF REMOVAL ALTERNATIVES
HS-TREAT-3: SOLVENT EXTRACTION ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Permanent and significant reduction in mobility and volume. Toxicity is increased during the extraction step but permanently reduced following incineration
- Attains federal/state ARARs

Disadvantages

- None

Implementability

Advantages

- Innovative technology; bench-scale tests performed on New Bedford Harbor sediment
- No need for long-term management at the site
- Equipment available
- Good potential for favorable community response

Disadvantages

- May require follow-up testing after bench-scale tests
- Will require coordination with several other federal and state agencies

Cost

Advantages

- Will not require long-term maintenance at the site
- Limited potential for future remedial action costs
- Will not require five-year review

Disadvantages

- Higher costs anticipated; unproven technology

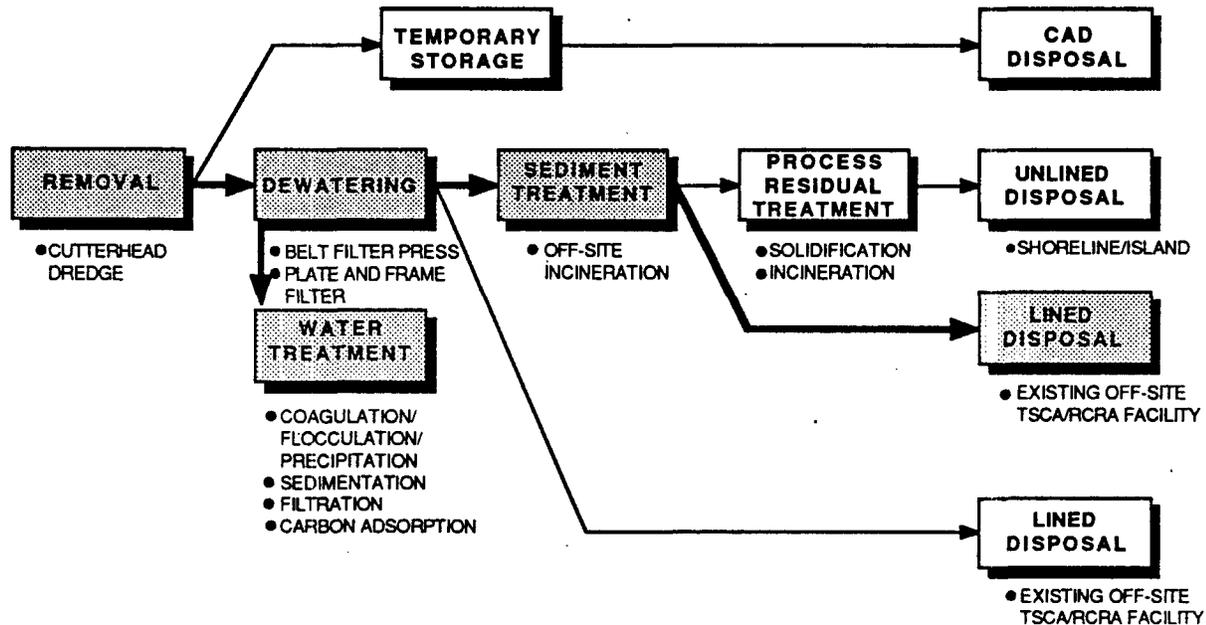
Effectiveness. The effectiveness for this alternative is the same as that for HS-TREAT-1. This alternative would permanently reduce the mobility, toxicity, and volume of the PCB contamination.

Implementability. This alternative would be less implementable than HS-TREAT-1 (on-site incineration) because of the added difficulties associated with transportation and available capacity at licensed off-site incinerators. Mobile incinerators (HS-TREAT-1) are available and are projected to have increased availability as more companies bring incinerators on-line to treat hazardous waste. In contrast, licensed incinerators have limited capacity and are projected to have increasingly less available capacity as more hazardous waste is removed and sent to incinerators.

Cost. Costs for this alternative are higher than the other alternatives, primarily due to transportation costs to the nearest available licensed incinerator. The cost for this alternative is estimated to be \$67 million. Figure 6-11 is a summary of the screening evaluation for this alternative.

Conclusion. This alternative will be eliminated from further analysis for the following reasons:

**FIGURE 6-11
SCREENING OF REMOVAL ALTERNATIVES
HS-TREAT-4: OFF-SITE INCINERATION ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Permanent and significant reduction in mobility, toxicity, and volume of hazardous waste
- Attains state and federal ARARs

Disadvantages

- PCB sediment has to be transported great distances. Higher probability for PCB release via accidents and/or air volatilization

Implementability

Advantages

- Proven technology
- Good potential for favorable community response

Disadvantages

- Availability of incineration capacity is limited
- Will require coordination with several federal and state agencies

Cost

Advantages

- No need for long-term management at the site
- Negligible potential for future remedial action costs
- Will not require five-year review

Disadvantages

- Costly; material has to be transported excessive distances.

- it provides the same level of treatment as HS-TREAT-1, but at a significantly higher cost
- there are additional safety hazards associated with transporting PCB-contaminated sediment
- incineration capacity at licensed incinerators is limited

6.4 CONCLUSIONS

Table 6-1 summarizes results of the alternative screening for the Hot Spot alternatives. Nine alternatives were developed: five were eliminated during the screening step, leaving four alternatives to be carried into detailed analysis.

The four containment and disposal alternatives were eliminated for the following principal reasons:

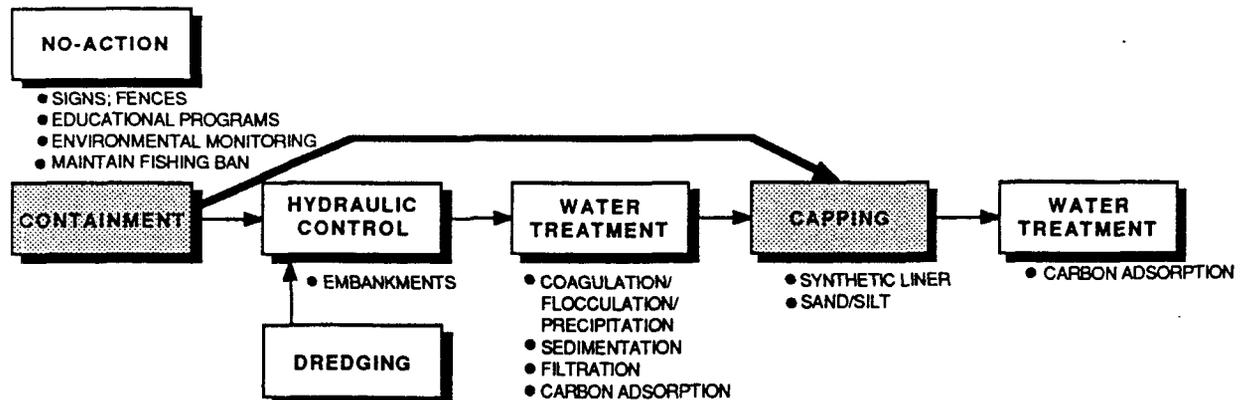
- They were inconsistent with SARA's preference for permanent treatment.
- They did not provide long-term effectiveness.
- They did not comply with several action- and/or location-specific ARARs.

TABLE 6-1
SUMMARY OF HOT SPOT ALTERNATIVES

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ALTERNATIVE DEVELOPMENT (SUBSECTION 6.1)		ALTERNATIVES ELIMINATED DURING SCREENING (SUBSECTION 6.3)	ALTERNATIVES REMAINING FOR DETAILED EVALUATION
HS-NA-1	No-action		HS-NA-1 (HS-1)
HS-CONT-1	Capping	HS-CONT-1	
HS-CONT-2	Embankment/Capping	HS-CONT-2	
HS-DISP-1	Confined Aquatic Disposal	HS-DISP-1	
HS-DISP-2	Out-of-State TSCA/RCRA Disposal	HS-DISP-2	
HS-TREAT-1	On-site Incineration		HS-TREAT-1 (HS-2)
HS-TREAT-2	Solidification		HS-TREAT-2 (HS-3)
HS-TREAT-3	Solvent Extraction		HS-TREAT-3 (HS-4)
HS-TREAT-4	Off-site Incineration	HS-TREAT-4	

**FIGURE 6-4
SCREENING OF NONREMOVAL ALTERNATIVES
HS-CONT-1: CONTAINMENT ALTERNATIVE
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



Effectiveness

Advantages

- Reduces mobility of Hot Spot sediment
- Reduces existing risk to public health and environment

Disadvantages

- Does not permanently and significantly reduce toxicity, mobility, or volume of PCB sediments
- Does not reduce magnitude of residual risk
- Is not reliable as a long-term solution
- High potential for replacement
- Will require long-term maintenance
- Will disturb and resuspend adjacent PCB-contaminated sediment
- Does not provide long-term reliability; will require long-term monitoring
- Does not comply with all state/federal ARARs

Implementability

Advantages

- Good availability of equipment, personnel, materials
- Ease of undertaking additional remedial action (i.e., dredging)

Disadvantages

- Potential for restricting flow in estuary
- Will require environmental controls during construction
- Will require institutional controls
- Low technical feasibility-existing sediment may not be able to support cap

Cost

Advantages

- Development and construction costs for this alternative are well-defined

Disadvantages

- Cap will require long-term maintenance
- High potential for future remedial action costs
- Costs for 5-year review

The off-site incineration alternative was eliminated due to the anticipated lack of incinerator capacity and excessive costs for the same level of treatment as achieved by an on-site incinerator.

To eliminate subsequent misidentification in the detailed evaluation of alternatives, the Hot Spot alternatives will be renumbered HS-1 through HS-4.

The four alternatives that will be carried into detailed analysis are as follows:

<u>New Alternative Number</u>	<u>Previous Alternative Number</u>	<u>Alternative Description</u>
HS-1	HS-NA-1	No-Action
HS-2	HS-TREAT-1	On-site Incineration of Hot Spot Sediment
HS-3	HS-TREAT-2	Solidification and Disposal of Sediment in an Off-site TSCA RCRA Landfill
HS-4	HS-TREAT-3	Solvent Extraction of Hot Spot Sediment

7.0 DETAILED ANALYSIS OF ALTERNATIVES

7.1 INTRODUCTION

The detailed analysis of alternatives is intended to provide decision-makers with sufficient information concerning a range of proposed remedial actions in order to select a single remedy that meets the following CERCLA requirements:

- protective of public health and the environment
- attains ARARs (or provides grounds for invoking a waiver)
- cost-effective
- preference for permanent solution that uses treatment technologies or resource recovery techniques to the maximum extent practicable
- preference for treatment that reduces mobility, toxicity, or volume as a principal element

This section contains a detailed evaluation of the four alternatives that passed the screening process described in Section 6.0. Each alternative evaluation includes a detailed description emphasizing the technologies used, their specific

components, and proposed design specifications. Anticipated work activities are summarized and graphics are included to depict process flows of equipment. The description is followed by an assessment of the following nine evaluation criteria:

- short-term effectiveness
- long-term effectiveness and permanence
- reduction of mobility, toxicity, or volume
- implementability
- cost
- compliance with ARARs
- overall protection of public health and the environment
- state acceptance
- community acceptance

The first five criteria address technical, cost, institutional, and risk concerns. Compliance with ARARs and overall protection of public health and environment are threshold criteria that reflect statutory requirements. The final two criteria, state and community acceptance, were evaluated based on information received from the state during review of previous drafts of this report, and are based on community concerns expressed during monthly meetings of the New Bedford Harbor Citizens Advisory Group.

7.2 ALTERNATIVE HS-1: NO-ACTION

7.2.1 General Description

The development of a no-action alternative is required under the NCP. The no-action alternative serves as the baseline remedial alternative which assesses impacts on public health and the environment if no measures are taken to remediate current site conditions. However, the no-action alternative may include administrative/institutional methods to reduce the potential for exposure to site contaminants.

Implementation of a no-action alternative for the 5-acre Hot Spot would only be logical and practical in conjunction with a no-action alternative for the Upper Estuary because the two areas are intimately linked. However, for the Hot Spot FS, the no-action alternative is presented as a separate alternative.

The no-action alternative for the Hot Spot area would not involve any direct activities (e.g., dredging and treatment) conducted to remediate the PCB- and metal-contaminated sediment. Instead, the no-action alternative would consist of administrative and institutional methods to reduce human exposure to the Hot Spot sediment, including the following:

- warning signs posted in the immediate vicinity
- installation of a chainlink fence

- environmental monitoring of the Hot Spot area
- conducting site reviews every five years
- continuation of public awareness programs

Warning signs in both English and Portuguese are currently in place along the western and eastern shorelines of the Upper Estuary. These signs warn the public that swimming and the harvesting of shellfish and finfish are prohibited in this area. Additional warning signs would be placed in the immediate vicinity of the Hot Spot area, along the western shoreline, indicating the presence of highly contaminated sediment which poses a public health hazard as a result of direct dermal contact.

Public access to the Hot Spot area from land is currently difficult because it is adjacent to private property owned by commercial/industrial New Bedford enterprises. To further restrict public access, a 1,000-foot-long, 6-foot-high chain-link fence with three-strand barbed wire would be installed along the western bank of the estuary and extending north and south away from the Hot Spot area. This fence, however, would not restrict access to the Hot Spot from the water.

A long-term environmental monitoring program will be implemented to assess migration and natural attenuation of sediment contaminants. Sediment samples from the Hot Spot area will be collected annually and analyzed for PCBs and metals.

Because the no-action alternative will result in contaminants remaining on-site, CERCLA legislation requires that the site must be reviewed every five years. Data collected as part of the environmental program will be evaluated during the five-year reviews. Recommendations for potential remedial actions will be formulated at that time.

Public awareness programs would be implemented to educate the public on the potential health hazards associated with the Hot Spot area sediment. These programs would include periodic meetings and presentations in local neighborhoods, and bilingual pamphlets. These programs would be coordinated through the New Bedford Health Education Office, which was opened in October 1985 to address PCB contamination in New Bedford Harbor and its potential impact on public health.

7.2.2 Reduction in Mobility, Toxicity, and Volume

Because no sediment treatment processes are employed, this alternative would not result in any reduction in the mobility, toxicity, or volume of contaminants in the Hot Spot area sediment.

7.2.3 Short-term Effectiveness

This evaluation criterion addresses the effects of implementing remedial action. Because the no-action alternative involves

only minimal site activities (i.e., installation of warning signs and fences and environmental monitoring), it is not expected that these activities would pose a threat to workers or to the local community. However, a health and safety plan would be implemented for workers conducting the environmental monitoring. This plan would contain details for sampling and handling of contaminated sediment, including the level of protective clothing to be worn by the workers.

7.2.4 Long-term Effectiveness and Permanence

The no-action alternative for the Hot Spot will not provide a long-term permanent remedy that would reduce the nature and magnitude of risk to public health and the environment within the New Bedford Harbor area. A discussion of the fate and transport of PCBs, under a no-action scenario, was presented in Subsection 2.4.

With no remedial action, it is expected that the Hot Spot area will continue to serve as a source of PCBs to the estuary and ultimately the lower harbor.

Data on PCB levels in biota suggest that no action to remediate contaminated sediment in New Bedford Harbor will result in no significant reduction in biota PCB levels, which are currently in excess of the 2 ppm FDA tolerance limit.

Physical and chemical processes such as volatilization, hydrolysis, photo-oxidation, and biodegradation are not expected to significantly reduce the mass of PCBs in Hot Spot sediment. Although these processes are acknowledged as naturally occurring phenomena, the available information is insufficient to provide a reliable estimation of decay rates necessary to make long-term projections for New Bedford Harbor.

7.2.5 Implementation

Technical Feasibility. Installation of fencing and posting of warning signs are simple construction tasks. Local contractors and necessary materials are readily available. Restricting access to the Hot Spot would not interfere with the ability to perform future remedial action. Maintenance and repair of the fence and warning signs and an environmental monitoring program are tasks that are easily implemented.

Administrative Feasibility. Considerable long-term institutional management would be associated with the no-action alternative because the sediment contaminants would remain on-site and review would be necessary every five years.

Availability of Services and Materials. Fencing, signs, and security services are locally available in the New Bedford area.

7.2.6 Cost

The total 30-year present-worth cost of the HS-1 Alternative is estimated at \$455,000 (Table 7-1). This includes an initial capital cost of \$48,000. Annual operating costs are the predominant cost for this alternative, and include annual fence maintenance, site inspection, public information programs and environmental monitoring. Environmental monitoring includes sampling and analysis costs for 10 Hot Spot sediment PCB samples and 10 PCB water column samples in the same location. The present worth of the annual operating costs are estimated at \$361,000. In addition, a biota sampling program may be required. This program would monitor PCB levels in biota in Areas I, II, and III. The costs for such a program have not been included in this alternative.

Five-year review costs are associated with data interpretation, reassessment of risks, and public meetings. Five-year review costs are estimated at \$16,500.

7.2.7 Compliance with ARARs

Under HS-1, the no-action alternative, limited activity (e.g., fences and institutional controls) will take place at the Hot Spot. These activities attempt to restrict access to the Hot Spot to minimize public health risks. Access to the Hot Spot

TABLE 7-1
 COST ESTIMATE: ALTERNATIVE HS-1
 NO-ACTION

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

ACTIVITY	COST (\$)
I. CAPITAL COSTS	
A. FENCE AND SIGN INSTALLATION	\$ 15,000
B. PUBLIC AWARENESS PROGRAM	\$ 10,000
C. INSTITUTIONAL CONTROLS	\$ 10,000
TOTAL DIRECT COSTS	<u>\$ 35,000</u>
D. HEALTH AND SAFETY (5%)	\$ 750
E. LEGAL, ADMINISTRATION, PERMITTING (5%)	\$ 1,750
F. ENGINEERING SERVICES (10%)	\$ 3,500
G. CONTINGENCY (20%)	\$ 7,000
TOTAL INDIRECT COSTS	<u>\$ 13,000</u>
TOTAL CONSTRUCTION COSTS	<u><u>\$ 48,000</u></u>
II. ANNUAL OPERATING COSTS	
A. ENVIRONMENTAL MONITORING	\$ 15,000
B. FENCE MAINTENANCE	\$ 1,000
C. ANNUAL INSPECTION	\$ 5,000
D. PUBLIC INFORMATION	\$ 2,500
TOTAL ANNUAL COSTS	\$ 23,500
PRESENT WORTH OF ANNUAL OPERATING COSTS (30-YEAR PERIOD, 5% DISCOUNT RATE)	<u><u>\$ 361,000</u></u>
III. FIVE-YEAR REVIEW COSTS	
A. DATA ANALYSIS AND REPORT WRITING	\$ 12,500
B. PUBLIC MEETINGS	\$ 4,000

TABLE 7-1
(continued)

COST ESTIMATE: ALTERNATIVE HS-1
NO-ACTION

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ACTIVITY	COST (\$)
TOTAL FIVE-YEAR REVIEW COSTS	\$ 16,500
PRESENT WORTH OF FIVE-YEAR COSTS (30-YEAR PERIOD, 5% DISCOUNT RATE)	<u>\$ 46,000</u>
TOTAL PRESENT WORTH OF ALTERNATIVE	<u>\$ 455,000</u>

could still be obtained by boat from the Acushnet River Estuary. The chemical-specific ARARs for this alternative are the Massachusetts Surface Water Quality Standards (310 CMR 4.00), the federal AWQC and the federal Food, Drug, and Cosmetic Act. This alternative would not comply with these ARARs because the Hot Spot would remain untreated within the estuary and continue to act as a source of PCBs for the rest of the harbor.

Because there will be no activity in the wetlands or floodplains of the Acushnet River Estuary, the location-specific ARARs identified in the report, "Regulation Assessment for New Bedford Harbor, Massachusetts" (E.C. Jordan Co./Ebasco, 1988) are not appropriate.

Potential action-specific ARARs associated with this alternative pertain to the Occupational Safety and Health Administration (OSHA) worker protection standards, and the DEQE MCP.

In addition to these regulations, the Commonwealth of Massachusetts has the following three separate right-to-know regulations:

- DPW - Hazardous Substance Right-to-Know (105 CMR 67)
- DOI - Hazardous Substance Right-to-Know (441 CMR 21)
- DEQE - Hazardous Substance Right-to-Know (310 CMR 33)

These regulations are applicable to installation of the fence and will be attained during remedial action. OSHA requirements would also be met during fence installation. The no-action alternative will not comply with requirements of the MCP because the total site risk of the Hot Spot area will exceed 1×10^{-5} .

Appendix B outlines the potential chemical- and action-specific ARARs for this alternative and specifies the corresponding remedial actions that would be required to attain the specific ARARs, if the ARAR can be attained.

7.2.8 Overall Protection of Public Health and the Environment

This alternative would not result in a significant improvement to the protection of public health and the environment over baseline conditions, as described in Subsection 1.4. A security fence would not completely eliminate human exposure to sediment, and would not prevent exposure to sediment migrating out of the Hot Spot area. Aquatic organisms would continue to be exposed to sediment contaminants, and the Hot Spot would continue to act as a source of PCBs to the remainder of the estuary and New Bedford Harbor.

7.2.9 State Acceptance

This alternative does not comply with requirements of the MCP and would not be accepted by the Commonwealth of Massachusetts.

7.2.10 Community Acceptance

Comments received from the New Bedford community during presentations to the Citizen Advisory Group indicate the public feels strongly that the Hot Spot should be removed from the estuary. The community would likely not accept the no-action alternative.

7.3 ALTERNATIVE HS-2: INCINERATION

7.3.1 General Description

Alternative HS-2 will consist of dredging the Hot Spot sediment, dewatering of the sediment and treatment of all process waste waters produced during dewatering, and on-site incineration of the dewatered sediment to destroy the PCBs. The incinerated residue will be subjected to leaching tests (e.g., EP Toxicity or TCLP) to determine if heavy metals in the ash will exceed maximum allowable concentrations in any leachate generated. If it fails the leaching test, the ash will be solidified to immobilize the heavy metals. The incinerated residue will be disposed of in an unlined shoreline facility. Figure 7-1 is a block diagram of Alternative HS-2. Figure 7-2 is a process flow diagram of Alternative HS-2.

The volume of Hot Spot sediment (with PCB concentrations greater than 4,000 ppm) was estimated to be 10,000 cy (in-situ).

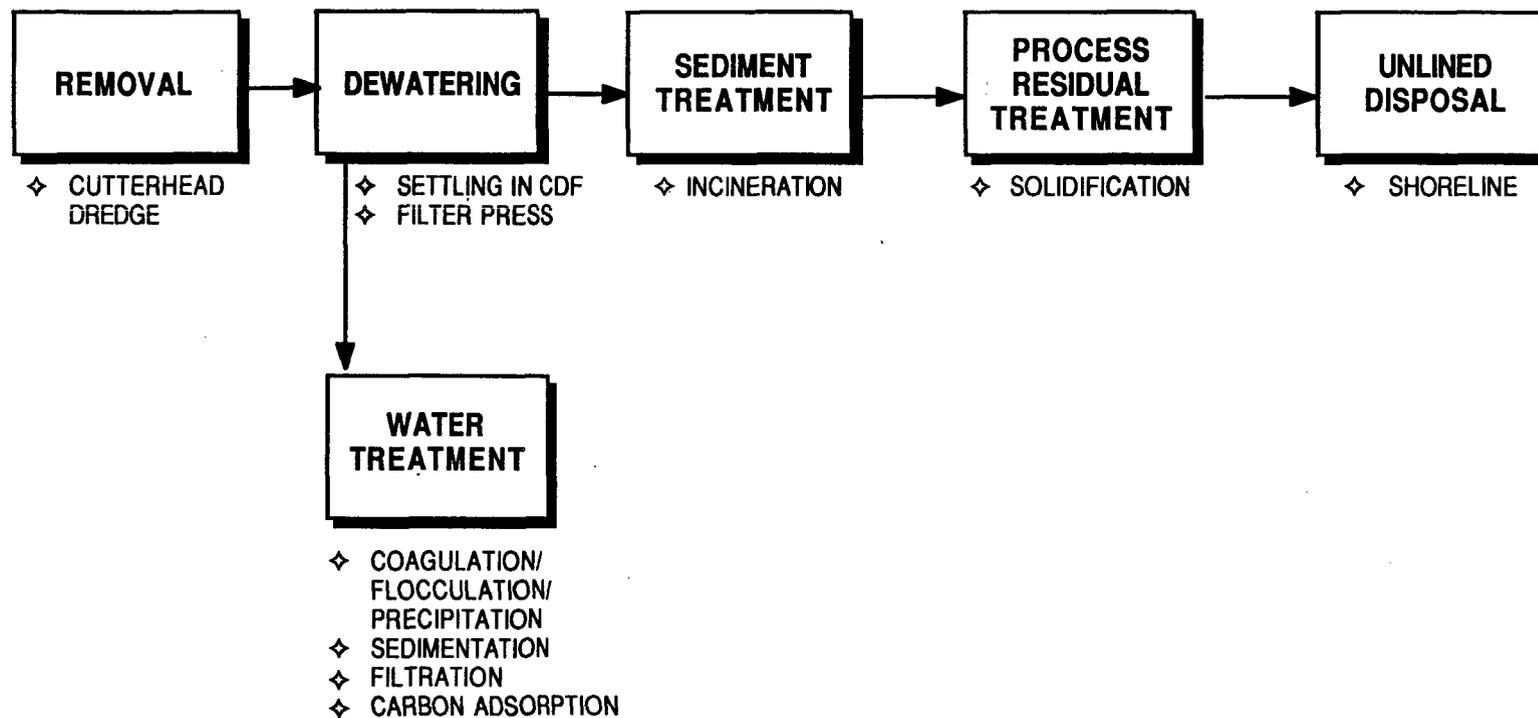
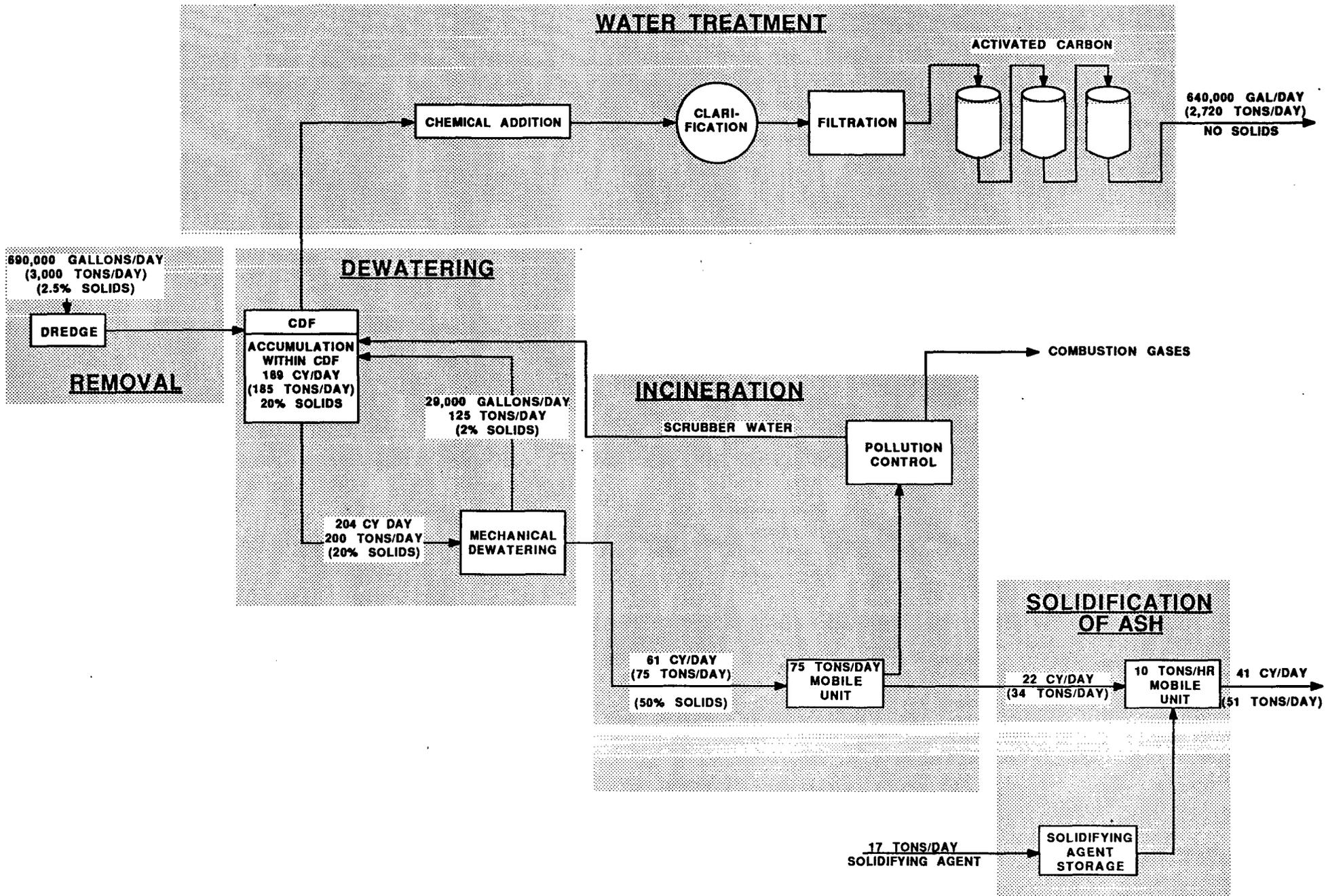


FIGURE 7-1
ALTERNATIVE HS-2
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

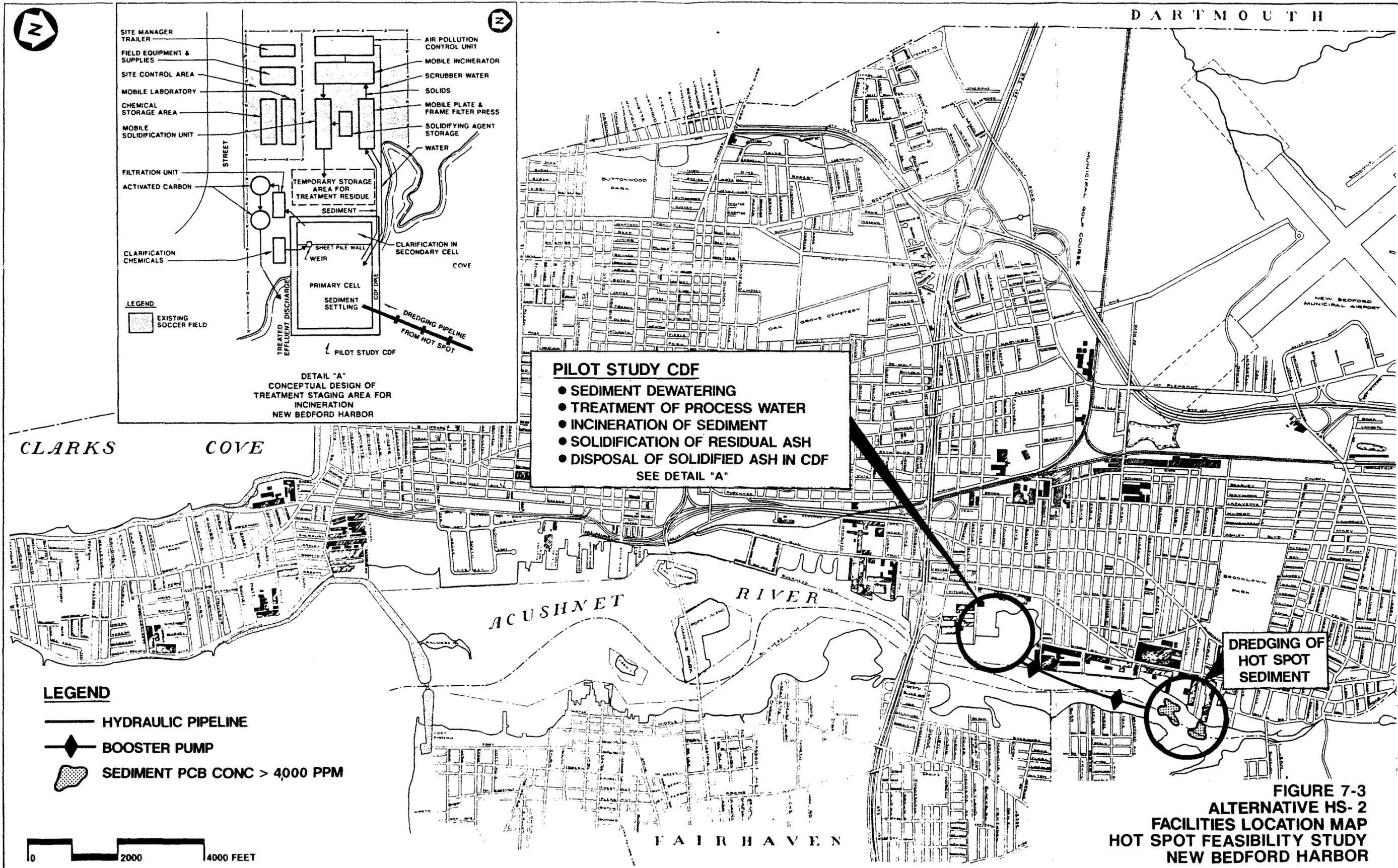


**FIGURE 7-2
ALTERNATIVE HS-2
PROCESS FLOW DIAGRAM
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

Results of the USACE Pilot Dredging and Disposal Study indicate that overdredging will not be necessary to ensure removal of contaminated sediment (Otis, 1989). Therefore, 10,000 cy (in-situ) of sediment removed from the Hot Spot area will require treatment.

The pilot study area, located in a cove on the western side of the Acushnet River Estuary and north of the Coggeshall Street Bridge, will be utilized for siting the treatment facilities (Figure 7-3). In addition, the CDF constructed during the pilot study will be used to dispose of the solidified treatment residue. Other locations, such as the Conrail railyard and the New Bedford Municipal Landfill, were considered. However, the advantages of using the pilot study site include the following:

- EPA has already acquired the site through a lease arrangement with the City of New Bedford.
- The site is ready to be used. Activities associated with the pilot study have been completed. Utilities and fencing are in place, air and groundwater monitoring systems are installed, and there is ample area for staging all the treatment processes and volume in the CDF for disposing of the treated residue.
- Remedial activities for the Hot Spot will be confined to the Upper Estuary. Dredged sediment can be

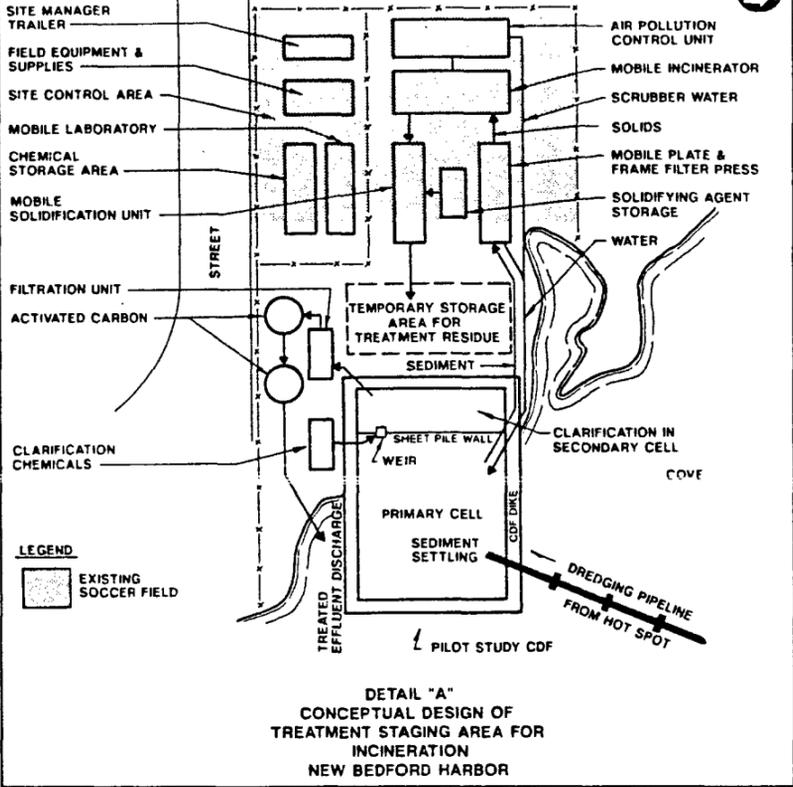


PILOT STUDY CDF

- SEDIMENT DEWATERING
- TREATMENT OF PROCESS WATER
- INCINERATION OF SEDIMENT
- SOLIDIFICATION OF RESIDUAL ASH
- DISPOSAL OF SOLIDIFIED ASH IN CDF

SEE DETAIL "A"

**DREDGING OF
HOT SPOT
SEDIMENT**



LEGEND

- HYDRAULIC PIPELINE
- ◆ BOOSTER PUMP
- ▨ SEDIMENT PCB CONC > 4000 PPM

0 2000 4000 FEET

**FIGURE 7-3
ALTERNATIVE HS-2
FACILITIES LOCATION MAP
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

transported by pipeline directly to the pilot study without interfering with harbor and land-based activities.

- There is a substantial reduction in the cost of Hot Spot remediation because new treatment and disposal sites will not have to be constructed. Use of this area will also reduce the overall cost of the Pilot Dredging and Disposal Study.

The following paragraphs present detailed descriptions of the remedial actions comprising Alternative HS-2. These descriptions are presented in the order shown in Figure 7-1.

Dredging. Hot Spot sediment will be removed using a small cutterhead dredge. The cutterhead dredge is recommended for use in the Hot Spot based on results of the pilot dredging study (Otis, 1989).

Operational procedures were developed by USACE during the pilot dredging study. These procedures optimize various factors associated with dredging (e.g., cutterhead speed and swing speed) and the resuspension and subsequent migration of contaminated sediment. USACE recommended that the following operating procedures for the cutterhead dredge be used when removing Hot Spot sediment (Otis, 1989):

Operating Time:	3 to 4 hours/day
Number of Passes:	3
Width of Cut:	60 feet (approximately)
Rate of Advance:	11 feet/hour (first two passes) 25 feet/hour (third pass)
Production Rate:	35 cy/hour (first two passes)
Flow Rate:	2,100 gallons per minute
Percent Solids:	2 to 3 percent

(in slurry)

Contamination in the Hot Spot sediment to be removed extends to 4 feet deep in some areas. Therefore, three passes with the cutterhead dredge will be necessary. The initial two passes would remove material at the production rate stated previously. The third pass would skim the bottom, removing little additional sediment (Otis, 1989).

Silt curtains as an additional dredging control in preventing migration of resuspended sediment will not be necessary based on results of the pilot dredging study (Otis, 1989). No significant sediment plumes were observed moving away from the dredgehead. However, resuspension of a considerable amount of sediment was observed during installation, positioning, and removal of the silt curtain (Otis, 1989).

Based on the recommended operating procedures for the cutterhead dredge, approximately 80 operational (3 to 4 hours) days would be required to remove 10,000 cy of sediment from the Hot Spot. This estimate assumes no downtime due to inclement weather or mechanical problems, such as clearing obstructions from the cutterhead.

The dredged sediment would be transported to the pilot study area by a floating hydraulic pipeline. This pipeline would be approximately 1 mile long and may require one or two booster pumps to move the dredged material. USACE recommended using standard polyethylene dredge pipe to transport the dredged sediment (Otis, 1989).

The dredged sediment will be discharged as a 2- to 3-percent solids slurry into the CDF for temporary storage before subsequent treatment and disposal. A diffuser submerged below water and attached to the effluent end of the pipeline will be used to facilitate settling of the dredged sediment by reducing the exit velocity and, therefore, the turbulence of the material.

The design capacity of the primary cell of the CDF was 26,500 cy. During the pilot study, only 6,500 cy of dredged sediment was deposited in the primary cell, leaving approximately 20,000 cy of potential storage volume. Based on the daily production

rate specified earlier, the primary cell has the capacity to store 8 days worth of dredged sediment from the Hot Spot before exceeding this capacity (Otis, 1989). However, it is anticipated that treatment of the dredged sediment would be conducted concurrently with the dredging operation (factoring in a 1 to 2 day retention period in the primary cell for gravity settling to occur), thereby providing ample storage capacity during the dredging period.

Dewatering. The dredged slurry discharged to the primary cell of the CDF will be allowed to settle out. Results from settling and chemical clarification tests conducted on Hot Spot sediment by USACE indicate that gravity settling will produce a 20-percent solid sediment over a one- to two-day retention period (Wade, 1988).

The settled sediment in the CDF will be pumped to a nearby secondary dewatering facility. This facility will consist of a skid or trailer-mounted filter press unit (e.g., belt, or plate and frame) with a throughput capacity of approximately 10 tons per hour of dry solids. The sediment will be dewatered to a minimum of 50-percent solids by weight. Bench-test results of dewatering New Bedford Harbor sediment using the plate and frame filter press technology indicate that a process effluent solids content of 50 percent is achievable (OHM, 1988). Effluent from the dewatering system will be recycled to the primary cell of the CDF for eventual water treatment.

Water Treatment. Treatment of the CDF effluent and process wastewaters will be required, prior to discharge back into New Bedford Harbor, to remove PCB and heavy metals present in the dissolved and absorbed phases. Elutriate and saltwater batch leaching tests conducted by USACE on composite estuary and Hot Spot sediment samples predicted dissolved PCB concentrations in the CDF effluent from the primary cell of 110 and 460 ppb, respectively (Averett, 1988). Concentrations of PCBs measured during the pilot study in the filtered water component (solids) of the primary cell CDF effluent averaged 6.7 ppb (Otis, 1989). These results indicate that additional treatment of the CDF effluent (with process wastewaters, which would be expected to have higher contaminant loadings) may be necessary prior to discharge back to the harbor.

Effluent (i.e., excess water) from the CDF will flow over a weir structure separating the primary cell from these secondary cells. As the water flows over the weir, coagulants will be added to promote flocculation and settling of suspended sediment. USACE tested cationic polymers as coagulants during the pilot study. Suspended solids levels measured at the weir averaged 97.3 mg/l total suspended solids (TSS) with a range of 9.9 to 895.4 mg/l TSS (Otis, 1989). Results of these tests indicated that the polymer was effective in reducing suspended solids levels when the influent levels were high (i.e., in the 800-mg/l TSS range), but appeared to have only minimal impacts when the influent levels were low (i.e., in the 100-mg/l TSS

range) (Otis, 1989). This suggests that use of cationic polymers may only be appropriate for periods of high influent solids, such as when the CDF has reached its volume capacity and there is minimal retention time for settling of the dredged material slurry. USACE recommended that inorganic coagulants such as alum, ferric chloride, and lime be evaluated prior to final design of the water treatment system (Averett, 1989). These coagulants could be used alone or in conjunction with polymers.

USACE estimated that a solids content of 70 mg/l could be achieved in the CDF effluent following chemical clarification and treatment prior to discharge back to the harbor. TSS measured during the pilot study in the CDF discharge effluent averaged 75.1 mg/l (Otis, 1989).

CDF effluent from the secondary cell will be treated to remove dissolved PCBs and metals. The treatment system will consist of carbon adsorption or UV/peroxide units preceded by filtration units. The filtration units will be necessary to remove the suspended solids remaining after chemical clarification, thereby preventing clogging of the treatment units. Both carbon adsorption and UV/peroxide treatment of CDF effluent were evaluated during the pilot study. CDF effluent was passed through coarse sand filters prior to treatment. USACE indicated that use of these filters may have contributed to the low efficiency of the carbon adsorption unit by allowing a

substantial fraction of PCBs absorbed to colloidal particles to pass through the filter and the carbon column (Averett, 1989). USACE recommended the use of microfilters to remove this colloidal fraction (Averett, 1989).

Results of the USACE studies indicated that both carbon adsorption and UV/peroxide treatment appear to be effective methods for the removal of dissolved PCBs and metals in wastewater streams down to levels approaching 1 ppb (Averett, 1989). However, additional tests are needed to optimize the efficiency of carbon adsorption and to address potential adverse effects to biota from peroxide residuals.

Incineration. Dewatered sediment will be incinerated to destroy PCBs. Three incinerator technologies are applicable for the destruction of PCBs in sediment: rotary kiln, infrared, and fluidized bed. Descriptions and detailed evaluation of these three technologies were reported by E.C. Jordan Co./Ebasco (1987c). All three incinerators have the same operational characteristics and are capable of achieving 99.9999-percent destruction efficiency, as required by TSCA. The primary difference between these technologies is the material handling mechanism into the incineration chamber. The ultimate selection of an incinerator will depend largely on equipment availability.

One skid or trailer-mounted 75-ton-per-day incinerator unit will be used. Approximately 150 consecutive days will be required to incinerate the Hot Spot area sediment. Sediment entering the incinerator would be 50-percent solids by weight. Approximately 10 percent of the dry solids would be combustible organic material (based on average sediment total organic carbon [TOC] levels of approximately 10 percent). An auxiliary fuel (e.g., fuel oil or natural gas) would be added to the sediment feed to facilitate combustion.

Incineration of PCB-contaminated sediment will be conducted in two stages. In the first stage, sediment will be fed into a primary combustion chamber. The temperature in this chamber is maintained at 1,600 to 1,800 degrees Fahrenheit. Solids residence times vary from 15 to 45 minutes. In the second stage, combustion gases generated in the primary chamber flow to a secondary chamber where the gases are heated to 2,400 degrees Fahrenheit for over 2 seconds. The gases then flow into the air pollution control system. When conducted under proper operating conditions, incineration of PCBs (and the auxiliary fuel) is completed without the formation of potentially hazardous by-products of combustion.

Air pollution control equipment is required for all three incinerator systems to meet air emissions standards for hydrogen chloride and particulates. Both the infrared and rotary-kiln

systems generally use a combination of a packed tower to control hydrogen chloride and a wet venturi scrubber, baghouse, or electrostatic precipitator to control particulates. The fluidized bed process can control hydrogen chloride by introducing a caustic in the reactor bed. Therefore, only a baghouse or electrostatic precipitator is necessary to control particulates. After treatment for hydrogen chloride and particulates, the combustion gases are released to the air through a stack.

The air pollution control system for all three incinerators produces a low-volume wastewater stream containing sodium or calcium chloride and suspended solids. This stream could be recycled back to the primary cell of the CDF for eventual water treatment.

Solidification. Incineration of the PCB-contaminated sediment will produce a large volume of residual ash, which will contain metals at concentrations near those observed in the untreated sediment. These metals may become oxidized as a result of incineration, thereby allowing them to become more mobile. A leaching test will be conducted on the ash to determine if metals leaching from the ash would exceed the maximum allowable leachate concentrations, thereby constituting a hazardous waste. If the ash fails the leaching test, solidification would be necessary as a secondary treatment step to immobilize the metals.

Solidification will be used as a secondary treatment to physically and chemically stabilize the metals by binding them in a solid matrix. USACE demonstrated that solidification is an effective method for immobilizing certain metals (e.g., cadmium and zinc), while other metals (e.g., copper and nickel) appear to be unaffected (Meyers and Zappi, 1988). However, it is anticipated that, given the numerous commercial processes available, a formulation of solidifying agents is available to immobilize all heavy metals. Additional bench tests to determine the correct formulation will be required prior to final design.

Solidification of the incinerator ash would be accomplished using conventional cement-mixing equipment. Based on a 50-percent solids feed containing 10-percent combustible organics in the feed, 34 tons of residual ash will be generated for every 75 tons of sediment incinerated. Adding a half ton of solidifying agent to every ton of incinerator ash would produce approximately 51 tons per day of solidified ash. This is equivalent to approximately 41 cy of residual material, with an assumed density of 1.25 tons per cy (Church, 1981).

Disposal. Solidified ash will be temporarily stored in an area adjacent to the secondary cell of the CDF. Once remedial activities are completed (i.e., all of the Hot Spot sediment from the primary cell and wastewater from the secondary cell has

been treated), the solidified ash will be placed into the secondary cell, which is above the tide line, for final deposition. A cap will be placed over the solidified ash as a final cover. This cap will be graded to the current level of the soccer field and seeded to reduce the infiltration of precipitation.

7.3.2 Reduction in Mobility, Toxicity, and Volume

Incineration of Hot Spot area sediment would permanently destroy PCBs, thereby reducing both toxicity and mobility. Incineration would also reduce the final volume of sediment by approximately 10 percent. However, incineration could potentially result in an increase in the mobility of metals, which would be converted to an oxidized form by this treatment process. Secondary treatment of the incinerator ash, such as solidification, may be required to reduce the mobility of metals.

7.3.3 Short-term Effectiveness

Risk to the community (i.e., local residents) is expected to be minimal during all phases of Hot Spot remediation because the Hot Spot and the treatment/disposal area are located in commercial/industrial zones of New Bedford. The use of fencing and on-site security personnel, to preclude unauthorized entry to the Hot Spot area, would all be effective in preventing direct contact of the community to the contaminated sediment.

Dredging of Hot Spot area sediment, which would be conducted underwater, is not expected to generate airborne or volatilized contaminants to which factory workers in buildings near the Hot Spot area would be exposed. Based on results from the pilot study, shoreline disposal of contaminated sediment from the Hot Spot is likely to increase ambient levels in the vicinity of the CDF. An air monitoring program will be required during operation of the CDF. Methods to reduce emissions will be employed if ambient levels threaten worker safety or public health.

Workers on-site during remedial activities could be exposed to contaminants by dermal contact and the inhalation of airborne particulates or volatilized contaminants. Dermal and inhalation exposure to contaminants could arise as a result of dredging operations (e.g., clearing of debris from or unclogging the dredgehead), dewatering the sediment, and exhaust gases and vapors generated during incineration of sediment. To minimize or prevent such exposure, personal protection equipment (i.e., respirators, overalls, and gloves) would be used. In addition, ambient air monitoring and monitoring of incinerator stack gases would be conducted to ensure worker safety within immediate areas of remedial activity.

No adverse environmental impacts are expected as a result of dredging of Hot Spot area sediment. Results of the USACE pilot dredging study indicate that resuspension of contaminated

sediment will be minimal when proper dredge operating conditions are employed and that additional controls such as silt curtains will not be necessary. Transport of dredge material to the pilot study area via a floating hydraulic pipeline is not expected to impact the environment. However, the pipeline will be continually monitored for leakage.

Based on an incinerator throughput rate of 75 tons per day, approximately 150 to 200 days will be required to complete the remedial activities described in Alternative HS-2 and to meet the remedial response objectives.

7.3.4 Long-term Effectiveness and Permanence

Removal of the Hot Spot area sediment will remove approximately 45 percent of the total mass of PCBs in New Bedford Harbor. This remedial action will also eliminate a major source of PCBs into the estuary and the lower harbor and bay. Therefore, risk to public health and the environment will be reduced by removing the Hot Spot. However, the magnitude of this reduction cannot be determined until an overall risk assessment of remedial action is completed for the entire New Bedford Harbor site. The overall risk assessment will be presented in the FS for the estuary and lower harbor and bay, currently being prepared by E.C. Jordan Co./Ebasco and scheduled to be completed in the early spring of 1990.

Although dredging was demonstrated as an effective technology for removing contaminated sediment in New Bedford Harbor, it is expected that residual PCB and metals concentrations of 10 ppm or less will be left in the Hot Spot area following dredging. A residual PCB sediment concentration of 10 ppm was selected by Jordan as the lower limit of cleanup. This clean-up level represents a technical limitation based on engineering considerations of dredging sediment, rather than a policy decision for a TCL based on protection of human health and biota. The results of the pilot dredging study indicate that the 10-ppm limit is achievable when proper operational controls are used during dredging. However, PCB and metals concentrations in areas immediately adjacent to the Hot Spot would remain in the 1,000-ppm range. The detailed evaluation of remedial alternatives for the estuary and the lower harbor and bay will consider the significance of the residual contamination in the Hot Spot area in terms of whether additional remedial action for the Hot Spot is necessary, in conjunction with remedial action selected for the estuary and lower harbor and bay, to achieve the overall remedial objectives for New Bedford Harbor.

Incineration is a thoroughly proven technology for the destruction of organics, and is therefore expected to provide a complete and permanent remedy for treating PCB-contaminated sediment. Solidification as a secondary treatment for the incinerator ash is expected to provide an effective means of

immobilizing metals if the ash fails the leaching test. The long-term permanence of solidification, however, is uncertain because little long-term performance data exist to address this issue.

Disposal of processed sediment in the unlined CDF is not expected to present long-term risks to public health or the environment. Leaching of metals in the disposed sediment would constitute the only source of contamination that would be reintroduced back into the environment. However, the concentration of metals in any leachate generated is expected to be minimal. Solidification of the incinerator ash would further reduce the leaching potential of residual metals if leaching testing indicated that the mobility of metals would be a potential problem. Placement of a cap on the CDF would reduce the potential for leachate generation due to infiltration of precipitation and surface runoff. Furthermore, attenuation of leachate metals concentrations would be expected as the leachate migrated through the earthen dikes of the CDF. Long-term monitoring and maintenance of the CDF cover and monitoring of the CDF dike will be necessary to assess leachate migration and contaminant concentration.

7.3.5 Implementation

7.3.5.1 Technical Feasibility

Constructibility. The dredging operation that is anticipated to occur is a common operation and has been pilot tested in the cove area of the Acushnet River Estuary. Based on results of this pilot test, a cutterhead dredge is recommended, and the operating parameters of the dredge were established so that sediment resuspension is minimized.

The dewatering and water treatment technologies are well-proven for the intended application. Prior to final design, bench-scale studies will be required to determine equipment size, chemical dosage, and activated carbon requirements.

Incineration is technically feasible and has been proven for destruction of organic compounds, including PCBs in soil over a range of contaminant levels similar to those in Hot Spot area sediment. The Hot Spot sediment is not expected to have significant energy content; therefore, auxiliary fuels will be required to achieve the necessary temperatures.

The solidification process that may need to be used to stabilize the incinerator's ash is a common process for treatment of metals in solid matrices. The USACE bench-scale tests of untreated sediment from the Acushnet River Estuary indicate that

solidification is an effective method for immobilizing PCB and some heavy metals. Additional bench tests are needed to determine if there is a process (e.g., proprietary or formulations of conventional cement mixtures) that will effectively immobilize all other metals of concern within the incinerator ash.

Reliability. Hydraulic dredging with a cutterhead dredge has been demonstrated to be a reliable technology for use in New Bedford. Downtime during operational periods should be limited to clearing debris from or unclogging the cutterhead.

Incineration systems are highly reliable due to the sophistication of the technology employed and the degree of monitoring and control practiced. A destruction removal efficiency (DRE) of 99.9999 percent for various organic compounds and PCBs has been demonstrated. A trial burn will need to be completed prior to implementation to optimize operating parameters. Typical downtime estimates for incinerators are 20 to 30 percent for a system operating 24 hours per day, seven days per week. This time is required for systems maintenance and inspections.

The solidification bench-scale studies were conducted on untreated Hot Spot area sediment. Prior to final design, bench-scale studies will need to be performed on ash resulting from the incineration of sediment during test burns. These

studies will be used to evaluate optimum ash/admixture proportions.

The resulting solidified ash would be disposed of in the pilot study CDF. This facility will be used for both a settling tank for the dredged material and the final disposal area for the treated ash. This facility is already constructed; therefore, disposal in this CDF is readily implemented.

Additional Remedial Action. No remedial actions are anticipated following incineration of the Hot Spot area sediment. Destruction of the organics to achieve TCLs and immobilization of heavy metals in residual ash are expected following treatment operations. Future remedial actions may take place for sediment in the estuary outside the Hot Spot. However, Hot Spot area remediation should not affect the implementation of any of these future actions.

Monitoring Considerations. Environmental monitoring of the dredging operation would include the monitoring of suspended solids around the dredging operation. Frequent inspection of the hydraulic pipeline would also be necessary to monitor pipeline integrity.

Air monitoring would be conducted at predetermined locations near the dredging area and the treatment area throughout the remedial action period.

Monitoring stations would also be set up at predetermined locations within the estuary to assess the degree of sediment/contaminant migration associated with dredging operations. Baseline conditions (e.g., TSS, PCBs, and dissolved metals concentrations) were developed by USACE and will be used during the Hot Spot dredging activities.

Monitoring of the hydraulic pipeline will include at least one crew of workmen in small shallow-draft boats. The crews will be in radio contact with the dredge operator so that appropriate action can be taken in the event of a leak or break in the line. Additional workmen will be required to monitor the operation of the three booster pumps.

Monitoring of operations associated with the dewatering, handling, and transportation of contaminated sediment would need to be implemented for protection of workers and the public.

Periodic sampling of water discharged from the water treatment facility would be necessary to ensure that system performance standards are met.

Incineration systems require sophisticated monitoring instrumentation to control the combustion process and monitor stack emissions. Monitoring instruments provide data on the following parameters:

- fuel feed rates and pressures

- waste feed rates

- primary and secondary combustion chamber temperatures

- operating conditions of air pollution control equipment

- flue gas concentrations of oxygen, carbon monoxide, carbon dioxide, total hydrocarbons, hydrogen chloride, and total particulates

- combustion air flow rates

These data are used to optimize the efficiency of combustion, and should provide adequate information to assess system performance.

7.3.5.2 Administrative Feasibility

Coordination between the lead agency (USACE or EPA), the City of New Bedford, and the Commonwealth of Massachusetts will be important. Coordination would involve active communication, including formal and informal meetings, among these agencies at critical points in the remedial action process. Because there will be no off-site activities, no permits are needed for this alternative.

7.3.5.3 Availability of Services and Materials

Cutterhead dredges are readily available. Personnel to operate the machinery are also available. Contractors and equipment for construction of the dewatering and water treatment plant are also available to respond to requests for proposals in a timely and responsive manner. "Turn-key" clean-up contractors capable of executing the entire alternative are also available, thereby increasing the likelihood of multiple responsive bids.

Mobile incineration units capable of treating 75 tons of sediment per day are currently available. Approximately five infrared incinerators, five rotary kilns, and two fluidized bed units will be available in 1990. One of these units can be mobilized on-site within a two-month period.

7.3.6 Cost

This subsection is a summary of costs associated with dredging, incineration, and disposal of Hot Spot area sediment. Costs associated with each component of the direct costs are listed in Table 7-2. An estimate of indirect costs associated with the remedial action, such as administrative, engineering, and health and safety costs, is included for completeness.

TABLE 7-2
 COST ESTIMATE: ALTERNATIVE HS-2
 ON-SITE INCINERATION

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

ACTIVITY	COST (\$)
I. CAPITAL COSTS	
A. SITE PREPARATION	\$ 345,000
B. DREDGE HOT SPOT SEDIMENTS (\$121/CY)	\$ 1,210,000
C. SECONDARY DEWATERING (\$52/CY)	\$ 575,000
D. WATER TREATMENT	\$ 1,059,000
E. HANDLING OF DEWATERED SEDIMENTS (\$11.5/CY)	\$ 115,000
F. INCINERATOR MOBILIZATION/DEMOBILIZATION, TRIAL BURNS, AND START-UP	\$ 690,000
G. INCINERATION OF SEDIMENTS (\$374/TON)	\$ 4,577,000
H. SOLIDIFICATION OF ASH (\$98/CY)	\$ 350,750
I. DISPOSAL OF SOLIDIFIED ASH IN SHORELINE CDF (UNLINED)	<u>\$ 221,950</u>
TOTAL DIRECT COSTS	\$ 9,143,700
J. HEALTH AND SAFETY (ACTIVITIES B, E, G) LEVEL C PROTECTION (@ 15%)	\$ 885,300
K. HEALTH AND SAFETY (ACTIVITIES A, C, D, F, H, I) LEVEL D PROTECTION (@ 5%)	\$ 162,100
L. LEGAL ADMINISTRATION, PERMITTING SECURITY (@ 6%)	\$ 548,600
M. ENGINEERING (@ 10%)	\$ 914,400
N. SERVICES DURING CONSTRUCTION (@ 10%)	\$ 914,400
O. CONTINGENCY (@ 20%)	<u>\$ 1,828,800</u>
TOTAL INDIRECT COSTS	\$ 5,235,600
TOTAL COST	<u>\$14,397,300</u>

Costs for site preparation, dredging, dewatering, water treatment, sediment treatment, and disposal of treatment residuals include expenses associated with mobilization/demobilization, construction, and O&M of each component. Because this alternative will use the USACE pilot study CDF for primary dewatering and treated sediment disposal, construction costs are not included for these facilities. Incinerator mobilization/demobilization includes costs for the set-up and testing of one mobile incinerator capable of treating 75 tons/day. Sediment incineration costs were developed during the detailed analysis of technologies and are estimated at \$374/ton. Land acquisition costs were not included in the cost for this alternative because the majority of the land required was leased to EPA for the USACE pilot study. Total cost for this alternative is estimated to be \$14,397,300.

A sensitivity analyses was performed to determine which of the alternative components were the most uncertain and therefore, most likely to change the alternative costs. As a pilot study had been performed on the dredging and water treatment components of this alternative, these components were considered to be accurate for the Hot Spot. Total costs for this alternative are most sensitive to the volume of material being treated and the unit costs for incineration. Results of the USACE pilot study indicate that, in order to dredge the sediment without producing sediment redistribution, the dredge head

should take several passes over the sediment and not be buried into the sediment. The disadvantage with this method is that it produces a dredge effluent with a low percent solids (2 to 3 percent). The advantage is that the USACE believes it can dredge the Hot Spot area accurately with minimal over-dredging. As illustrated in Figure 2-1, the boundaries of the Hot Spot area are irregular. Removal of the Hot Spot may require dredging additional areas adjacent to the current Hot Spot boundaries to ensure removal of Hot Spot sediment. This may increase the volume of material to be removed by as much as 20 percent in the top foot of material, and 10 percent in the middle foot, for an additional sediment volume of approximately 1,800 cubic yards. In addition, the accuracy of the volume estimate has been determined to be within this volume range. This increase in volume would increase the cost of this alternative from \$14,397,300 to \$17,071,300.

This alternative is also sensitive to the incineration unit cost because this component contributes the largest fraction of the overall alternative cost. Factors such as moisture content in the sediment fed to the incinerator and increases in fuel costs would both result in increased operating costs. A cost-sensitivity analysis was performed to determine what effect an increase in incineration costs would have on the overall cost of the alternative.

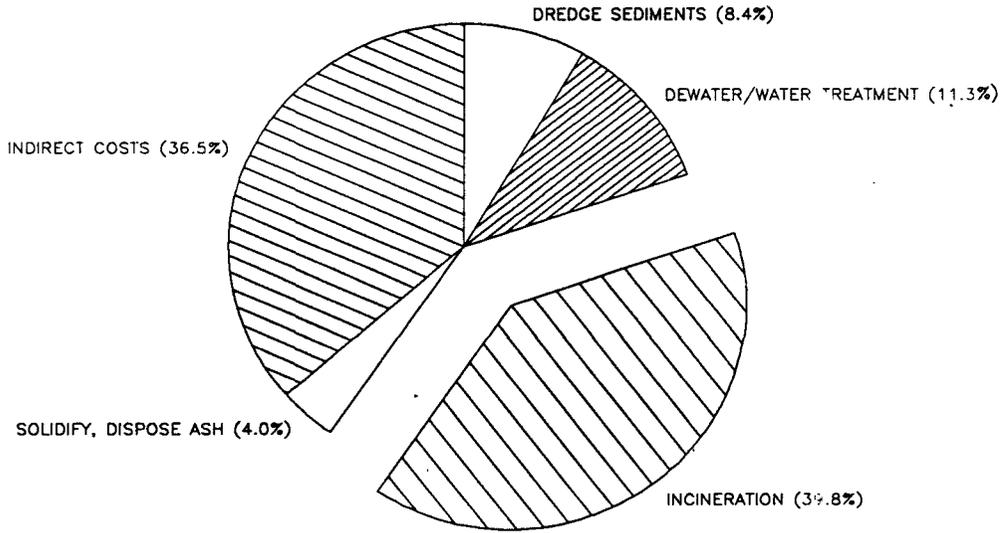
A breakdown of costs associated with the alternative is depicted in a pie-chart in the top half of Figure 7-4. Incineration costs are the largest contributor to the overall costs. Therefore, a sensitivity analysis was undertaken to determine how changes in the incinerator operating costs would affect alternative costs. A graphic showing the result of this analysis is in the lower half of Figure 7-4. These results indicate that a 25-percent increase in incineration costs would increase the total alternative cost from \$14.4 million to \$16.1 million. The highest incineration cost reported is \$575/ton. If the costs for the Hot Spot sediment were to approach this level, the total alternative cost would be approximately \$18.4. This is considered unlikely. The costs for this alternative are expected to range from \$11,500,000 to \$13,500,000.

Solidification of the incinerated ash has been included because it is assumed that the metal concentrations in the ash will be sufficient to fail the leaching test. If this is not the case, however, the solidification step can be omitted, resulting in a savings of approximately \$0.5 million.

7.3.7 Compliance with ARARs

Potential chemical-specific ARARs for the dredging and on-site incineration of PCB-contaminated sediment are divided into two media: surface water and air. Massachusetts Surface Water

ALTERNATIVE HS-2: ON-SITE INCINERATION
 TOTAL COST: \$14,397,300



COST SENSITIVITY ANALYSIS

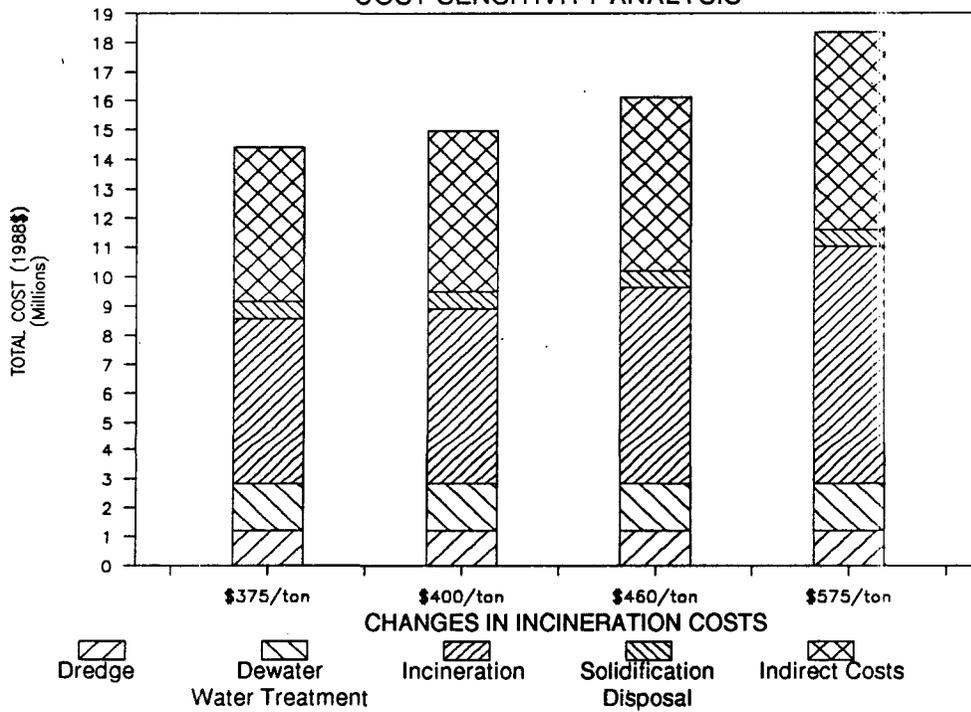


FIGURE 7-4
 COST ANALYSIS: ALTERNATIVE HS-2
 ON-SITE INCINERATION OF SEDIMENTS
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

Quality Standards (310 CMR 4.00) and the federal AWQC are the surface water ARARs for this alternative. In addition to these ARARs, the federal FDA levels is "to be considered" as a regulation as it applies to PCB levels in biota consumed by humans. Removal of the Hot Spot, which constitutes approximately 45 percent of the mass of PCBs in New Bedford Harbor, is not expected to result in reducing PCB water concentrations below these levels. Removal of the Hot Spot is an interim remedy consistent with the overall remedy and, as such, compliance with these ARARs may be waived under SARA.

Federal and state regulations pertaining to air emissions from the incinerator and fugitive dust generated by site activities are as follows:

- Federal National Air Quality Standards (40 CFR 40)
- State DEQE Air Quality Regulations (310 CMR 6.00-8.00)

These ARARs would be attained during site remediation by Best Available Control Technologies (BACT) for treatment of the incinerator air emissions and by fugitive dust control during construction and remedial activities.

Potential location-specific ARARs for this alternative can be divided into three groups: federal and state wetlands regulations, federal floodplain regulations, and federal and state coastal zone regulations (see Appendix B). In this alt

ernative, the wetlands area immediately east of the Hot Spot (IEP, 1988) is not expected to be significantly affected by dredging activities. Dredging would be conducted to minimize sediment resuspension and subsequent PCB migration. In addition, the Hot Spot lies on the opposite side of the estuary so that accidental disruption or dredging of the wetlands areas is unlikely. Federal regulations pertaining to floodplains are as follows:

- RCRA Location Standards (40 CFR 264.18)
- Floodplains Executive Order (EO 11988)

Dredging of the Hot Spot is expected to create a minimal change to the floodplain storage of the Acushnet River Estuary. In addition, compliance with these ARARs would be attained by siting the treatment equipment outside the 100-year floodplain of the Acushnet River.

Federal and state coastal zone management ARARs would be attained by submitting a consistency determination to the Commonwealth of Massachusetts at 90-percent completion of the remedial design. This consistency determination would outline the proposed activities, potential environmental impacts to the coastal zone, and mitigative measures to be used.

Potential action-specific ARARs pertinent to the incineration of sediment can be divided into the following three groups:

- ARARs associated with the construction and operation of an incinerator (RCRA facility and incinerator regulations, TSCA regulations, DEQE hazardous waste regulations)
- ARARs associated with dredging activities (CWA 40 CFR R5, 404; National Environmental Policy Act (NEPA) 40 CFR 6)
- ARARs associated with the regulation of hazardous waste activities or federal work standards (OSHA Federal and Safety Standards, Massachusetts Right-to-Know Regulations)

The ARARs in each group are discussed in the following paragraphs.

The RCRA facility regulations and the DEQE hazardous waste regulations would be attained because these regulations would serve as the basis for remedial design. Incineration performance would be verified prior to full-scale application through the use of test burns. Once the test burns are successful, the incinerators would be operated in compliance with applicable TSCA and RCRA regulations. Incinerated sediment would be tested and disposed of in the pilot study CDF if it is determined nonhazardous according to results of leaching tests.

RCRA technical standards would be relevant and appropriate if process residuals fail EP toxicity. In this case, the incinerated sediment would be solidified prior to disposal in the pilot study CDF.

ARARs pertaining to dredging activities (i.e., CWA and NEPA) would be attained during dredging activities by conducting them to minimize sediment resuspension and subsequent PCB mobilization. This was successfully performed during the USACE pilot test, and similar procedures would be implemented during full-scale dredging.

OSHA regulations and the Massachusetts Right-to-Know Regulations (DPW-105 CMR 67, DOI-441 CMR 21, DEQE-310 CMR 33) would be attained by incorporating the procedural requirements of these regulations into the remedial design phase.

Appendix B includes the potential chemical-, location-, and action-specific ARARs for this alternative in greater detail, and outlines the corresponding remedial actions required to attain each ARAR.

7.3.8 Overall Protection of Public Health and the Environment

The removal of PCBs from the Hot Spot and subsequent destruction by incineration will permanently reduce the mobility, toxicity, and volume of this source area of PCBs. Public health and

environmental risks directly associated with the Hot Spot will be significantly reduced. Removal of the Hot Spot will also serve to reduce PCBs affecting the remainder of the harbor. The exact level of reduction cannot be quantified at this time; however, from a qualitative standpoint, removing approximately half the PCBs in this aquatic environment is expected to have a substantial long-term effect.

7.3.9 State Acceptance

The Commonwealth of Massachusetts commented favorably on this alternative when incineration is accomplished adjacent to the estuary. This alternative complies with requirements of the MCP by using treatment as a prime component. The Commonwealth of Massachusetts is expected to support this alternative.

7.3.10 Community Acceptance

The community is expected to support this alternative. Based on public comments at the Citizens Advisory Committee, citizens see little problem with incinerating this sediment and also favor a location adjacent to the estuary. The use of the USACE pilot study CDF area is expected to gain community acceptance.

7.4 ALTERNATIVE HS-3: SOLIDIFICATION/DISPOSAL

7.4.1 General Description

Alternative HS-3 will consist of dredging the Hot Spot sediment, dewatering of the sediment and treatment of all process wastewaters produced during dewatering, and on-site solidification of the dewatered sediment to immobilize PCBs and heavy metals. Disposal of the solidified material will be off-site in an existing RCRA/TSCA-permitted facility. Figure 7-5 is a block diagram of Alternative HS-3. Figure 7-6 is a process flow diagram of Alternative HS-3.

The volume of Hot Spot sediment (with PCB concentrations greater than 4,000 ppm) was estimated to be 10,000 cy (in-situ). Results of the USACE Pilot Dredging and Disposal Study indicate that overdredging will not be necessary to ensure removal of contaminated sediment (Otis, 1989). Therefore, 10,000 cy (in-situ) of sediment removed from the Hot Spot will require treatment. The total mass of solidified material that will require disposal is approximately 17,400 tons. This solidified mass will occupy a volume of approximately 14,000 cy.

Treatment of the Hot Spot sediment will take place in the pilot study area (Figure 7-7) for the reasons discussed in Alternative HS-2. The solidified material will be transported from the pilot study area to the off-site RCRA/TSCA disposal facility.

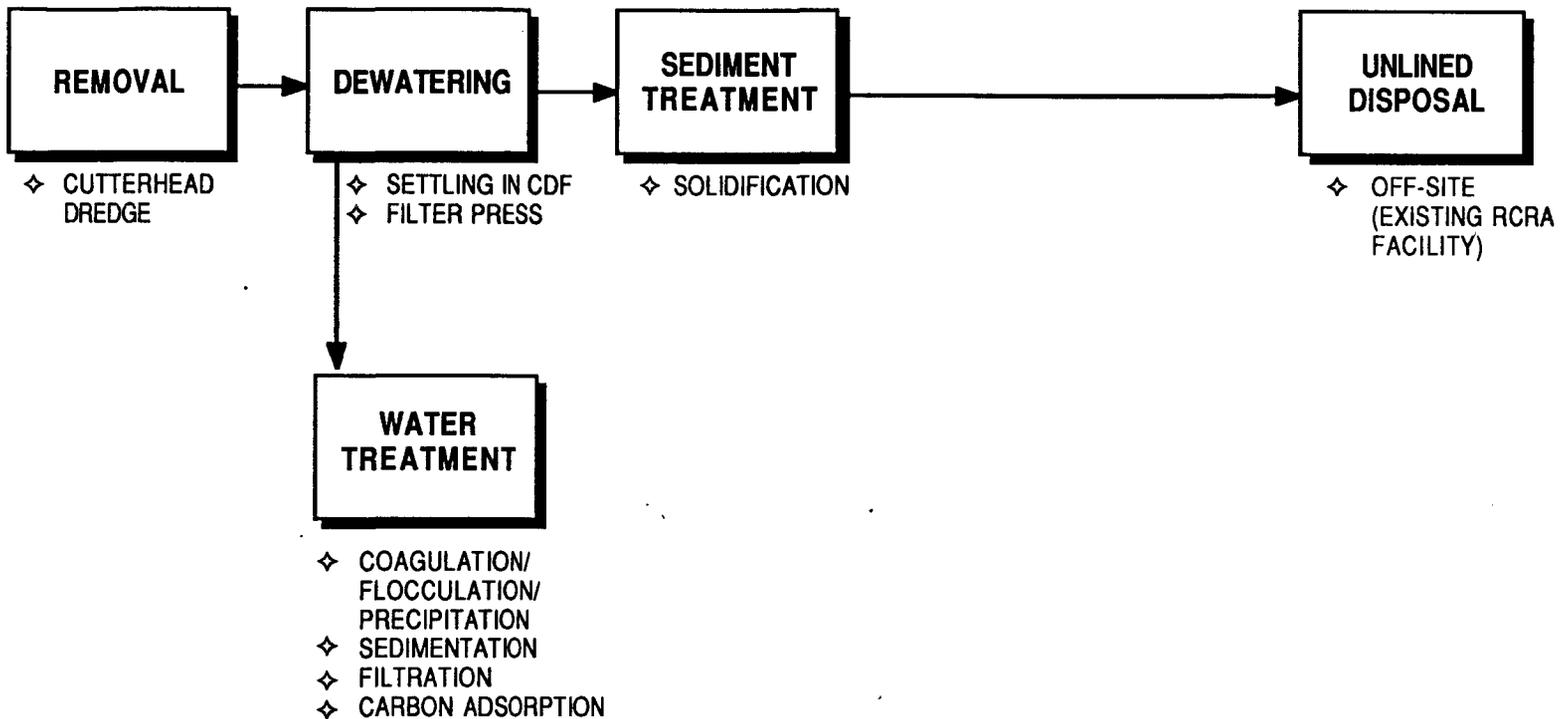


FIGURE 7-5
ALTERNATIVE HS-3
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

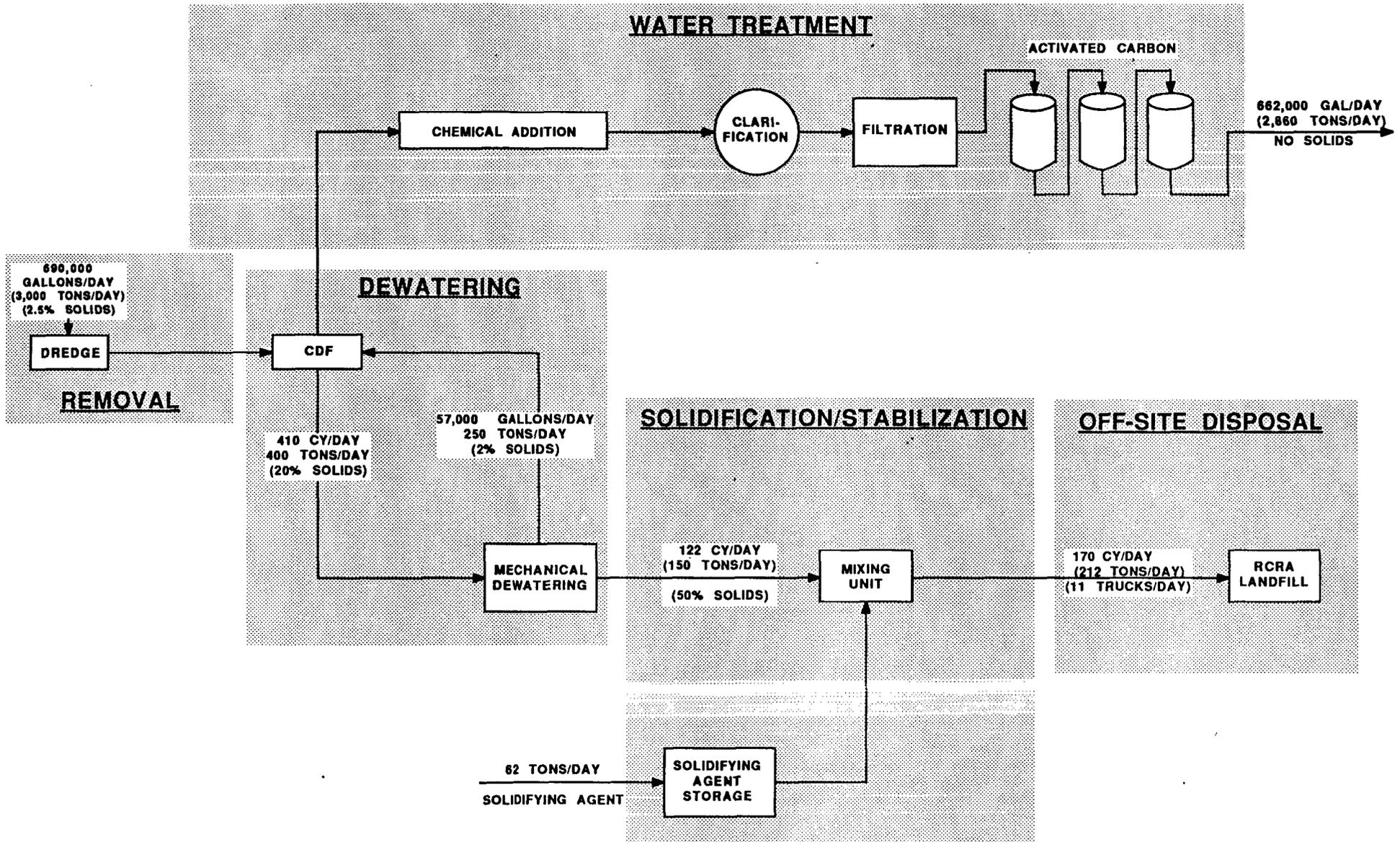
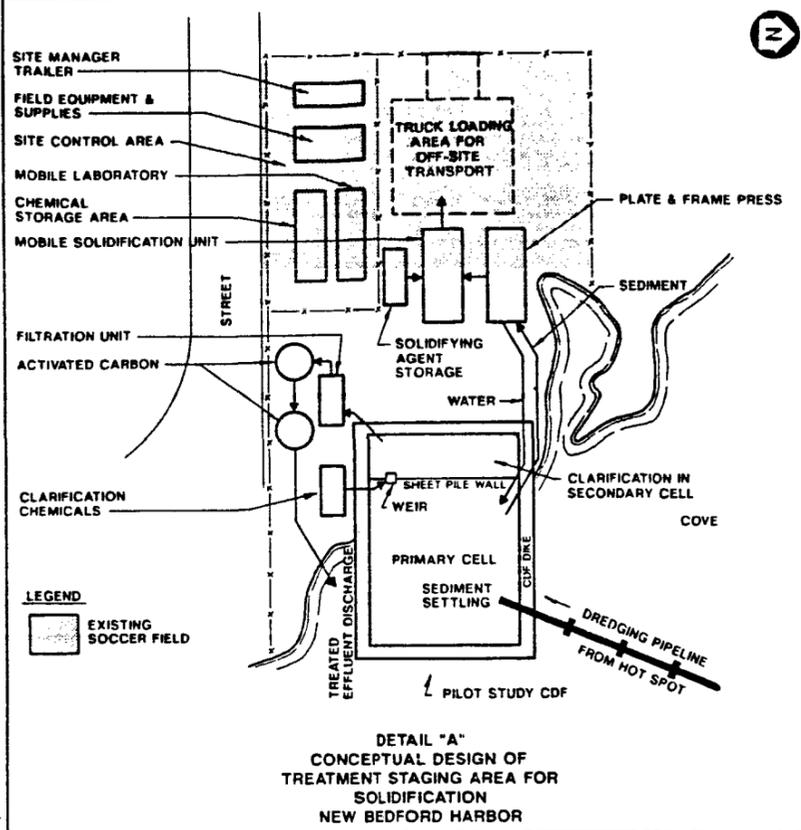
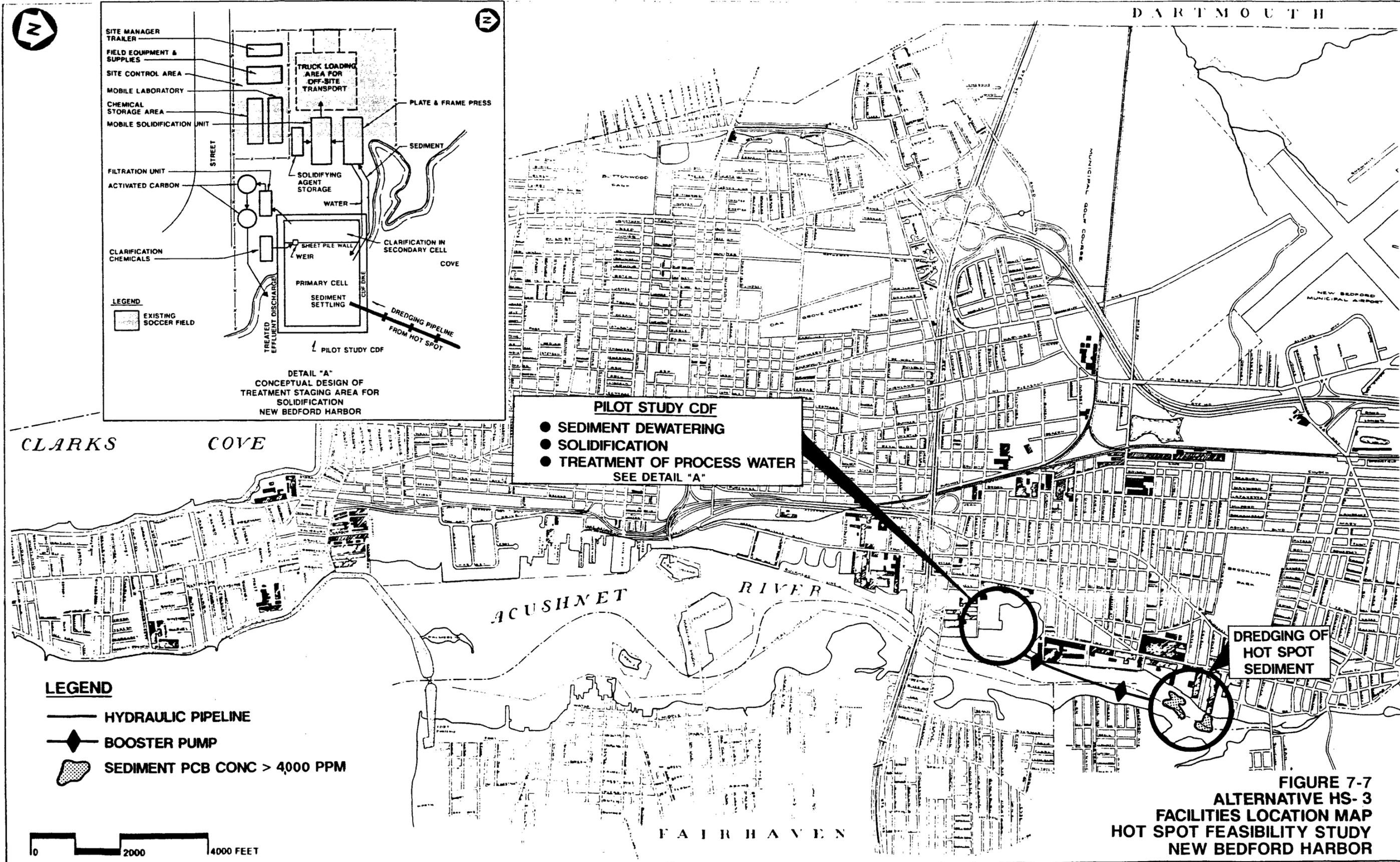


FIGURE 7-6
 ALTERNATIVE HS-3
 PROCESS FLOW DIAGRAM
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR



PILOT STUDY CDF

- SEDIMENT DEWATERING
- SOLIDIFICATION
- TREATMENT OF PROCESS WATER

SEE DETAIL "A"

LEGEND

- HYDRAULIC PIPELINE
- ◆ BOOSTER PUMP
- ▨ SEDIMENT PCB CONC > 4000 PPM

0 2000 4000 FEET

FIGURE 7-7
ALTERNATIVE HS-3
FACILITIES LOCATION MAP
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR

The following paragraphs are detailed descriptions of the response actions comprising Alternative HS-3. (See previous descriptions of those response actions which do not change in Alternative HS-2). Descriptions of the response actions are presented in the order shown in Figure 7-5.

Dredging. Dredging of the Hot Spot sediment and transport to the CDF will be conducted as described in Alternative HS-2.

Dewatering. Primary and secondary dewatering of the Hot Spot sediment will be conducted as described in Alternative HS-2.

Water Treatment. Treatment of CDF effluent and dewatering filtrate will be conducted as described in Alternative HS-2.

Solidification. Solidification/stabilization of waste material is a fairly well-established technology, in use for approximately 20 years. Hazardous waste applications typically involve blending contaminated material with an inorganic cementitious additive (e.g., Portland cement, kiln dust, fly ash, or lime) to facilitate encapsulation of the hazardous constituents. Encapsulation results from a pozzolanic reaction (i.e., aluminous and siliceous compounds that harden in the presence of lime), whereby the cementitious additive forms crystalline calcium silicate hydrates, calcium aluminate hydrates, and calcium aluminosilicate hydrates. These interlocking compounds surround contaminants and, after curing,

form structurally stable, less permeable matrices that inhibit contaminant mobility.

Bench-scale studies of solidification/stabilization (S/S) conducted by USACE indicated that cement-based formulations used as solidifying agents were effective in producing hardened material that significantly reduces the mobility of PCBs and metals. USACE investigated S/S products of three technologies: Portland cement, Portland cement with Firmix proprietary additive, and Silicate Technology Corporation (STC) proprietary additive. Formulations for these tests were all on the order of a few tenths of a part of the additives to one part of wet sediment. USACE tested these S/S formulations on estuary composite and Hot Spot sediment samples.

Results of the USACE work indicated that the three S/S processes can physically stabilize New Bedford Harbor sediment. All the formulations, except one Portland cement/wet sediment formulation, exceeded the minimum 50-pounds per square inch (psi) unconfined compressive strength (UCS) criteria established by the EPA Office of Solid Waste and Emergency Response (OSWER) (Myers and Zappi, 1988). The highest 28-day UCS for any of the S/S processes was 481 psi for the STC process. Solidified/stabilized New Bedford Harbor sediment had strengths above the range normally associated with hard clays (28 to 56 psi) and solidified industrial sludge (8 to 43 psi), but lower than the range normally associated with low-strength concrete

(Meyers and Zappi, 1988). Therefore, solidified New Bedford Harbor sediment would probably not be suitable as building materials to support heavy loads.

Complete chemical stabilization of PCBs and metals was not achieved for the three S/S process formulations tested by USACE. Batch leaching tests performed on ground-solidified sediment samples using distilled ionized water indicated that leaching of cadmium and zinc could be eliminated from processed sediment, and that leaching of lead could be reduced by two to three orders of magnitude. However, the amount of copper and nickel leached from the processed sediment was significantly higher for all three S/S processes than the amount leached from untreated sediment. The release of PCBs from processed sediment was reduced 10 to 100 times (Myers and Zappi, 1988).

The three S/S processes tested by USACE are among nearly two dozen commercial processes available. Additional bench-testing would be necessary, prior to final selection of a S/S process, to determine whether a formulation exists that is more effective in immobilizing PCBs and all heavy metals.

Solidification will be accomplished as a batch process. Dewatered sediment will be mixed with the solidifying additives in an enclosed trailer-mounted mixing unit to ensure uniform mixing and to control potential air emissions of PCBs during the mixing process. Based on the USACE results and pending

additional testing, it is assumed that approximately 0.3 tons of solidifying additive will be required for each ton of wet sediment. Assuming a throughput rate of 100 tons per day, approximately 150 consecutive days will be required to process the 10,000 cy of Hot Spot sediment.

Disposal. The solidified material will be loaded into covered dump trailers and transported to the selected RCRA/TSCA landfill facility for final disposal. Chemical Waste Management, Inc., operates a landfill in Model City, New York, that is currently receiving PCB waste. The landfill, located approximately 500 miles from New Bedford, is the nearest site capable of accepting the contaminated sediment. Selection of the disposal site, however, would need to be made at the time of remedial action for the Hot Spot area to ensure that the selected site has available capacity and is in compliance with all appropriate federal and state regulations.

7.4.2 Reduction in Mobility, Toxicity, and Volume

Solidification disposal of sediment in a landfill is expected to reduce the mobility of PCBs and metals. However, the long-term reduction in mobility cannot be assessed because physical integrity of the solidified sediment over time is unknown. Solidification would increase the volume of the treated sediment by 20 to 40 percent.

7.4.3 Short-term Effectiveness

Risk to the community (i.e., local residents) is expected to be minimal during implementation of Alternative HS-3 for the same reasons discussed in Alternative HS-2 (see Subsection 7.3.3).

Workers on-site during remedial activities could be exposed to contaminants by dermal contact and inhalation of airborne particulates or volatilized contaminants. Dermal and inhalation exposure to contaminants could arise as a result of dredging operations, such as clearing debris from or unclogging the dredgehead, dewatering the sediment, and handling the sediment during solidification operations. To minimize or prevent such exposure, personal protection equipment (i.e., respirators, overalls, and gloves) would be used. In addition, air monitoring would be conducted to ensure worker safety within immediate areas of remedial activity.

No adverse environmental impacts are expected as a result of dredging of Hot Spot area sediment for the reasons discussed in Alternative HS-2 (see Subsection 7.3.3).

Based on a throughput rate of 150 tons per day, approximately 80 to 100 days will be required to complete the remedial activities described in Alternative HS-3 to meet the remedial response objectives.

7.4.4 Long-term Effectiveness and Permanence

The long-term effectiveness of dredging Hot Spot area sediment to remove PCBs was discussed in Alternative HS-2 (see Subsection 7.3.4).

USACE tests of solidification of New Bedford Harbor sediment indicate that solidification can effectively immobilize PCBs and certain heavy metals. The long-term permanence of solidification, however, cannot be assessed because little performance data exist to address this issue.

Disposal of processed Hot Spot sediment in an off-site permitted facility would eliminate any long-term impacts to public health and the environment in New Bedford associated with the Hot Spot.

7.4.5 Implementation

7.4.5.1 Technical Feasibility

Constructability. Few difficulties are expected to be associated with construction and implementation of technologies within this alternative. Dredging is a well-developed operation, and few problems are anticipated with the hydraulic transport of dredge material from the Hot Spot area to the dewatering facility.

The dewatering and water treatment technologies have been used extensively in the wastewater and water treatment industries. Equipment necessary to dewater dredged materials and treat PCB-contaminated filtrate has been bench-tested on Hot Spot area sediment and is readily available.

Bench-scale tests performed by USACE on Hot Spot area sediment determined that S/S processes are capable of reducing the leachability of PCBs and certain metals. Additional bench tests are needed to determine if solidifying formulations exist that will immobilize copper and nickel.

Reliability. Hydraulic dredging with a cutterhead dredge has been demonstrated to be a reliable technology for use in New Bedford Harbor. Potential delays may be encountered in the dredging operation if debris along the shoreline areas is uncovered.

No schedule delays are anticipated in the construction or operation of the dewatering and water treatment operations. Issues pertaining to acquisition of land for construction will not create delays because the CDF is already constructed.

The long-term stability of solidified material containing PCBs and other organic compounds is unknown. However, disposal of the solidified sediment in an off-site TSCA/RCRA-approved

facility should provide adequate containment of any leachable contaminants. Permitted facilities must meet the requirements set forth in TSCA/RCRA; therefore, disposal of sediment in a TSCA/RCRA facility can be considered a reliable technology.

Ease of Undertaking Additional Remedial Action. No additional remedial actions are anticipated for Hot Spot area sediment because the final disposal of treated sediment will be in a secure landfill. However, future remedial actions may be required for sediment in the estuary outside the Hot Spot area. Hot Spot area remedial action should not affect the implementation of any of these future actions.

Monitoring Considerations. Environmental monitoring of the dredging operation would include sampling the water column in the dredging area and frequent inspection of the hydraulic pipeline to ensure pipeline integrity.

Air monitoring would be conducted at predetermined locations near the dredging area and the treatment area throughout the remedial action period.

Monitoring stations would also be set up at predetermined locations within the estuary to assess the degree of sediment/contaminant migration associated with dredging operations. Baseline conditions (e.g., TSS, PCBs, and dissolved

metals concentrations) established during the USACE pilot study will be used as the starting point for Hot Spot area dredging activities.

Monitoring of the hydraulic pipeline would include at least one crew of workmen in small, shallow-draft boats. The crews will be in radio contact with the dredge operator so that appropriate action can be taken in the event of a leak or break in the line. Additional workmen would be required to monitor the operation of the three booster pumps.

Appropriate monitoring of dewatering and solidification operations will be necessary to provide protection to workers and the public. Periodic sampling of the water discharged from the water treatment facility will be necessary to verify that system performance standards are met.

7.4.5.2 Administrative Feasibility

Coordination between the lead agency (USACE or EPA), the City of New Bedford, and the Commonwealth of Massachusetts will be important. Coordination would involve active communication, including formal and informal meetings, among these agencies at critical points in the remedial action process. Because there will be no off-site activities, permits will not need to be obtained for this alternative.

7.4.5.3 Availability of Services and Materials

Cutterhead dredges are readily available. A maximum of 90 days is anticipated for delivery and setup once ordered. Personnel are also available to operate the machinery.

Contractors and equipment for construction of the water treatment plant are also available to respond to requests for proposals in a timely and responsive manner. "Turn-key" clean-up contractors capable of executing the entire alternative are also available.

Equipment required for solidification is readily available. The necessary materials are also generally available. However, the required quantities will result in the need for bulk delivery and on-site storage facilities. Several solidification specialists are available; therefore, multiple bids for the work can be expected.

Availability of off-site disposal services depends on the time of treatment and disposal. Presently, permitted landfills are available for disposal. However, as existing landfills are filled, new ones will need to be constructed and permitted to replace them. Therefore, the final disposal site can only be determined at the time of the removal action.

7.4.6 Cost

This subsection summarizes costs associated with the solidification and off-site disposal alternative; estimated costs are provided in Table 7-3. The direct costs are included for each of the subcomponents: dredging, dewatering, water treatment, solidification, and disposal. Land acquisition costs were not included. An estimate of the indirect costs associated with the remedial action (e.g., administrative, engineering, and health and safety costs) is also included. The total cost of the alternative is \$12,168,000. This cost is based on transporting the solidified sediment to the Chemical Waste Management Landfill located in Model City, New York. Disposal costs include expenses for transporting the solidified sediment to the landfill and the landfill disposal fees.

A sensitivity analysis was performed for this alternative to determine which component(s) had the highest likelihood of hanging and, therefore, affecting the total alternative costs. Though this alternative is sensitive to a change in the amount of sediment to be dredged and treated, it is most sensitive to a change in the disposal facility which can accept the solidified sediment. Therefore, a change in the disposal facilities was chosen for a sensitivity analyses.

TABLE 7-3
 COST ESTIMATE: ALTERNATIVE HS-3
 SOLIDIFICATION AND OFF-SITE DISPOSAL

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

ACTIVITY	COST (\$)
I. CAPITAL COSTS	
A. SITE PREPARATION	\$ 345,000
B. DREDGE HOT SPOT SEDIMENTS (\$121/CY)	\$ 1,210,000
C. SECONDARY DEWATERING (\$52/CY)	\$ 575,000
D. WATER TREATMENT	\$ 1,059,000
E. SOLIDIFICATION OF DEWATERED SEDIMENTS (\$98/CY)	\$ 977,500
F. TRANSPORTATION OF SOLIDIFIED SEDIMENTS TO OFF-SITE LANDFILL (\$5.20/LOADED MILE)	\$ 2,070,000
G. LANDFILL TIPPING FEES (\$200/TON)	<u>\$ 3,502,000</u>
TOTAL DIRECT COSTS	\$ 9,738,500
H. HEALTH AND SAFETY (ACTIVITIES B, E) LEVEL C PROTECTION (@ 15%)	\$ 328,100
I. HEALTH AND SAFETY (ACTIVITIES A, C, D, F) LEVEL D PROTECTION (@ 5%)	\$ 202,500
J. LEGAL ADMINISTRATION, PERMITTING, SECURITY ACTIVITIES (A, B, C, D, E @ 6%)	\$ 250,000
K. ENGINEERING (ACTIVITIES A, B, C, D, E @ 10%)	\$ 416,700
L. SERVICES DURING CONSTRUCTION (ACTIVITIES A, B, C, D, E @ 10%)	\$ 416,700
M. CONTINGENCY (@ 20%)	<u>\$ 1,947,700</u>
TOTAL INDIRECT COSTS	\$ 3,561,700
TOTAL COST	<u>\$13,300,200</u>

A breakdown of the alternative costs is represented by the pie chart in Figure 7-8. It shows that the costs for transportation and disposal of the solidified sediment at the Model City Landfill are about 40 percent of the total cost. Chemical waste landfills periodically have difficulty meeting requirements set forth for the disposal of regulated wastes. Therefore, the ultimate disposal site for the solidified sediment can only be decided at the time of implementation. If at that time the Model City Landfill is not in compliance with appropriate regulations, another landfill will need to be selected. Two other landfills capable of accepting PCB wastes were identified as follows:

- Chemical Waste Management Landfill, Emelle, Alabama
- Envirosafe Services Landfill, Mountain Home, Idaho

The Emelle, Alabama, and Mountain Home, Idaho, landfills are about 1,350 and 2,750 miles from New Bedford, Massachusetts, respectively. Costs associated with the transport and disposal of sediment to these three landfills are compared in the bar chart in Figure 7-8. In this cost comparison, the tipping fees for each landfill were assumed to be \$200/ton, and transportation costs were determined based on travel distance from New Bedford to each of the three landfill sites. Costs

ALTERNATIVE HS-3: SOLIDIFICATION AND OFF-SITE DISPOSAL
 TOTAL COST: \$13,300,200

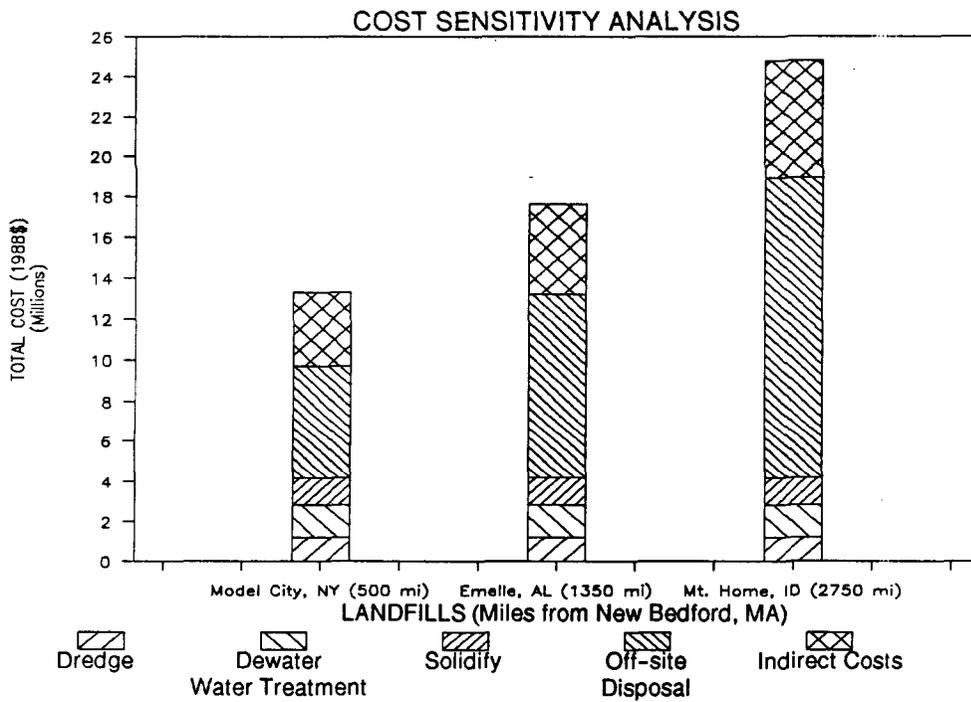
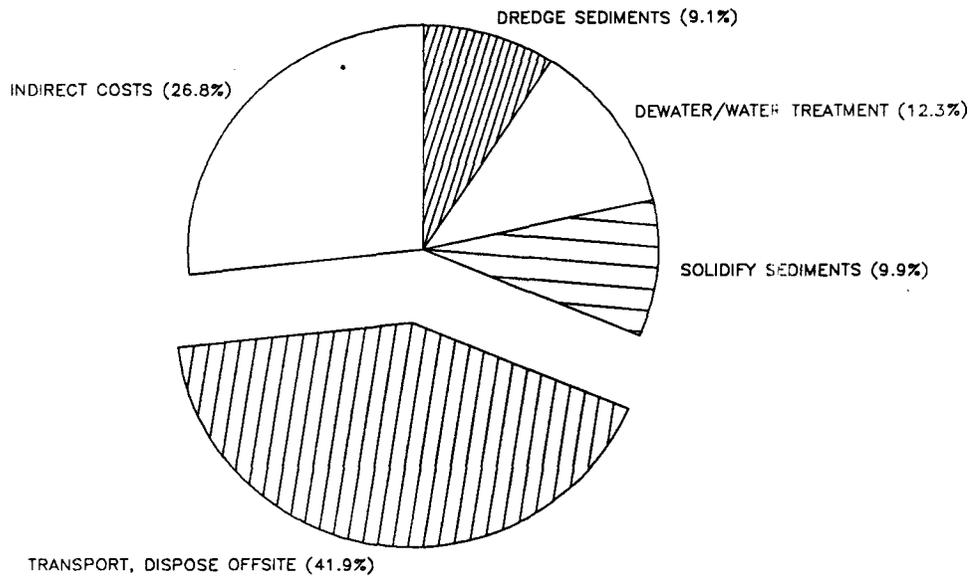


FIGURE 7-8
 COST ANALYSIS: ALTERNATIVE HS-3
 SOLIDIFICATION AND OFF-SITE DISPOSAL
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

associated with the disposal of sediment to the Mountain Home, Idaho, landfill would be nearly twice that of disposal in the Model City, New York, landfill.

Costs for this alternative are expected to range from \$13.3 million to \$24.8 million. This is based primarily on the availability of landfill capacity in a TSCA/RCRA landfill at the time of disposal.

7.4.7 Compliance with ARARs

Chemical-specific ARARs for the dredging, solidification, and off-site disposal of Hot Spot area sediment can be divided into two media: surface water and air. Massachusetts Surface Water Quality Standards (310 CMR 4.00), and the federal AWQC criteria level are the surface water ARARs for this alternative. It is doubtful that removal of the Hot Spot would be successful in attaining the levels outlined in these ARARs. The Hot Spot constitutes approximately 45 percent of the mass of PCBs in New Bedford Harbor. It is suspected that the remaining PCBs would be sufficient to continue the exceedance of these levels. This is an interim remedy and, as such, need not comply with ARARs. In addition, the federal FDA level for PCBs in biota consumed by humans is a chemical-specific regulation "to be considered". The removal of PCBs in the Hot Spot is consistent with the overall objective of ultimately achieving these criteria.

Federal and state regulations pertaining to air emissions from the remedial activities include the following:

- Federal National Air Quality Standards (40 CFR 40)
- State DEQE Air Quality Regulations (310 CMR 6.00 - 8.00)

These ARARs would be attained during site remediation by the application of fugitive dust controls.

Potential location-specific ARARs for this alternative can be divided into three groups:

- federal and state wetlands regulations
- federal floodplain regulations
- federal and state coastal zone regulations

As outlined in Subsection 7.2.3, compliance with wetlands regulations would be attained by minimizing activities in these areas. The floodplain regulations would be attained by locating the treatment facility outside the 100-year floodplain. The actual dredging of sediment is expected to have minimal effect on the Acushnet River floodplain. The federal and state coastal zone management ARARs would be attained by submitting a consistency determination to the Commonwealth of Massachusetts at 90-percent completion of the remedial design. This consistency determination would outline proposed activities,

potential environmental impacts to the coastal zone, and mitigative measures to be used.

Potential action-specific ARARs pertinent to solidification and disposal of sediment can be divided into the following four groups:

- ARARs associated with the construction and operation of a treatment facility (RCRA regulations, TSCA regulations, DEQE hazardous waste regulations)
- ARARs associated with dredging activities (CWA 40 CFR R5, 404; NEPA 40 CFR 6)
- ARARs associated with the storage, transportation and disposal of hazardous wastes (RCRA 40 CFR 268; DOT 49 CFR 107, 171.1 - 172.6)
- ARARs associated with the regulation of hazardous waste activities or federal work standards (OSHA Federal Safety Standards, Massachusetts Right-to-Know Regulations)

ARARs in each group are discussed in the following paragraphs.

The RCRA facility regulations and DEQE hazardous waste regulations would be attained because these regulations would serve as the basis for remedial design. ARARs pertaining to

dredging activities (CWA, NEPA) would be attained during dredging activities by conducting these activities to minimize sediment resuspension and subsequent PCB mobilization. This was successfully demonstrated during the USACE pilot test; similar procedures would be implemented during full-scale dredging.

RCRA land disposal regulations (40 CFR 268) are relevant and appropriate to the treatment and disposal of the Hot Spot area sediment. The DOT Rules for Transportation of Hazardous Materials (49 CFR 171.1 - 172.558) would be attained by incorporating requirements of this regulation into the remedial design.

OSHA regulations and the Massachusetts Right-to-Know Regulations (DPW-105 CMR 67, DOI-441 CMR 21, DEQE-310 CMR 33) would be attained by incorporating the procedural requirements of these regulations into the remedial design phase.

Appendix B presents the potential chemical-, location-, and action-specific ARARs for this alternative in greater detail, and outlines the corresponding remedial actions required to attain each ARAR.

7.4.8 Overall Protection of Public Health and the Environment

The removal, solidification, and off-site disposal of Hot Spot area sediment in a TSCA/RCRA facility will permanently reduce

PCB mobility in the estuary. Public health and environmental risks directly associated with the Hot Spot area will be significantly reduced. The exact level of reduction, however, cannot be quantified at this time. Qualitatively, the removal of approximately half the PCBs in the aquatic environment is expected to have a substantial long-term effect on health and environmental risks.

7.4.9 State Acceptance

Preliminary state comments on earlier drafts of this report indicate that the state does not fully accept this alternative for the following reasons:

- It is not consistent with MCP regulations (310 CMR 40.546) for treatment over land disposal
- Costs and implementability are highly dependent on the availability and capacity of permitted landfills.

Formal comments will be received from the state during review of this document and will be incorporated into the Record of Decision (ROD).

7.4.10 Community Acceptance

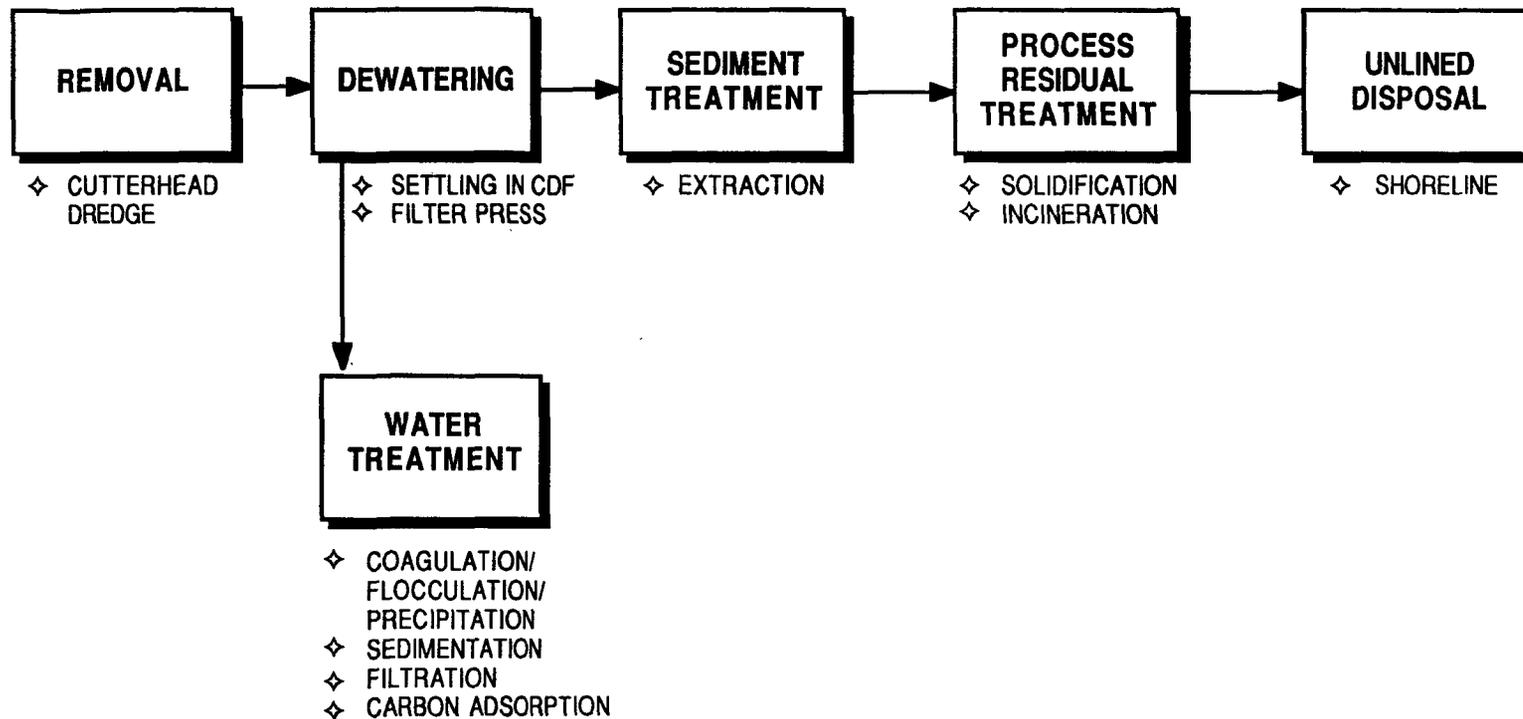
Comments received from the New Bedford Harbor Citizens Advisory Group indicate the community does not favor this alternative. The reasons for nonacceptance were the same as those of the state (see Subsection 7.3.9).

7.5 ALTERNATIVE HS-4: SOLVENT EXTRACTION

7.5.1 General Description

Alternative HS-4 will consist of dredging the Hot Spot area sediment, dewatering the sediment and treating all process wastewater produced during dewatering, and on-site solvent extraction of the dewatered sediment to remove PCBs. The processed sediment will be subjected to leaching tests to determine whether heavy metals remaining in the sediment following solvent extraction will exceed maximum allowable leachate concentrations. If it fails the leaching test, the processed sediment will be solidified to immobilize the heavy metals. The processed sediment will be disposed in an unlined shoreline facility. Figure 7-9 is a block diagram of Alternative HS-4. Figure 7-10 is a process flow diagram of Alternative HS-4.

The volume of Hot Spot area sediment (with PCB concentrations greater than 4,000 ppm) was estimated to be 10,000 cy (in-



**FIGURE 7-9
 ALTERNATIVE HS-4
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR**

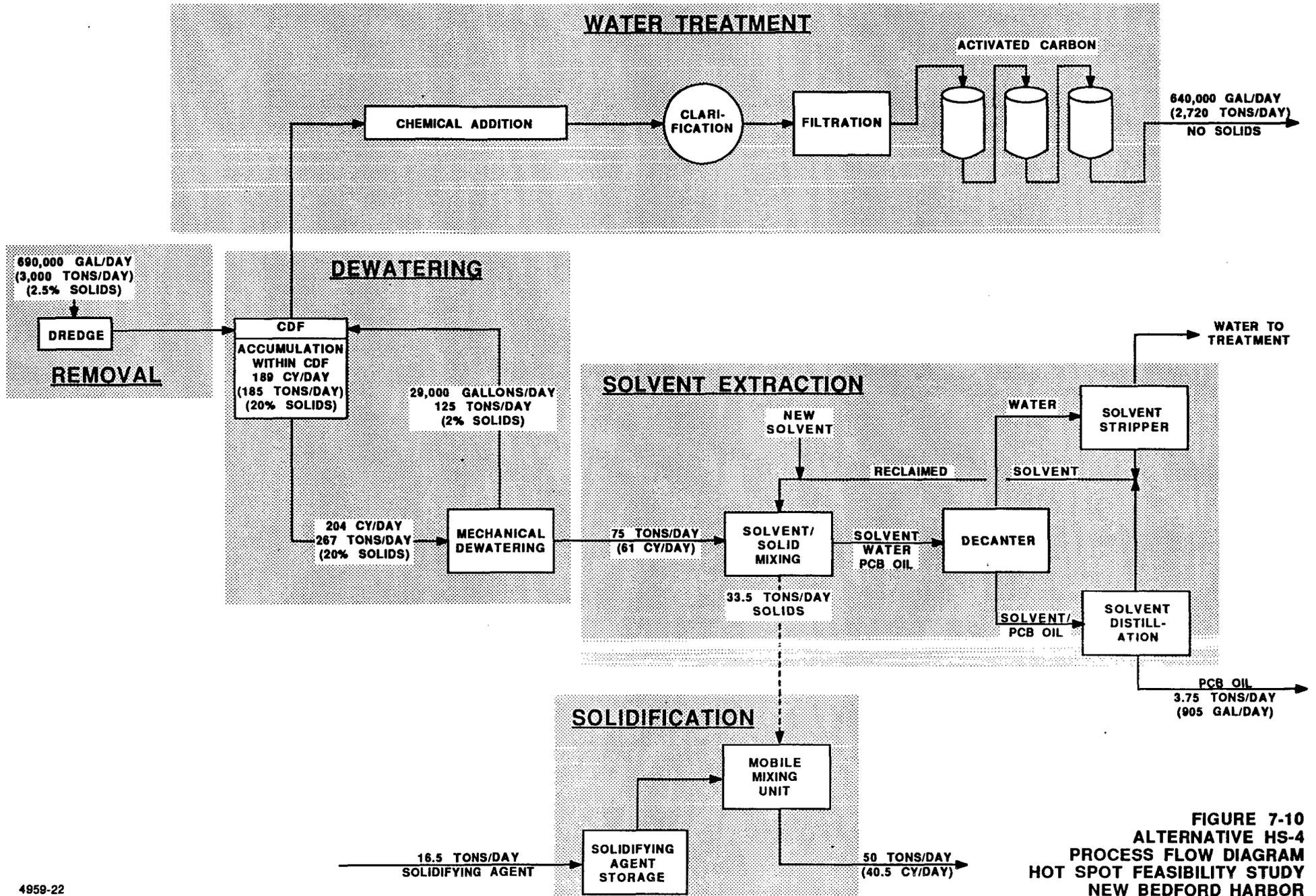


FIGURE 7-10
 ALTERNATIVE HS-4
 PROCESS FLOW DIAGRAM
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR

situ). Results of the USACE Pilot Dredging and Disposal Study indicate that overdredging will not be necessary to ensure removal of contaminated sediment (Otis, 1989). Therefore, 10,000 cy (in-situ) of sediment removed from the Hot Spot area will require treatment.

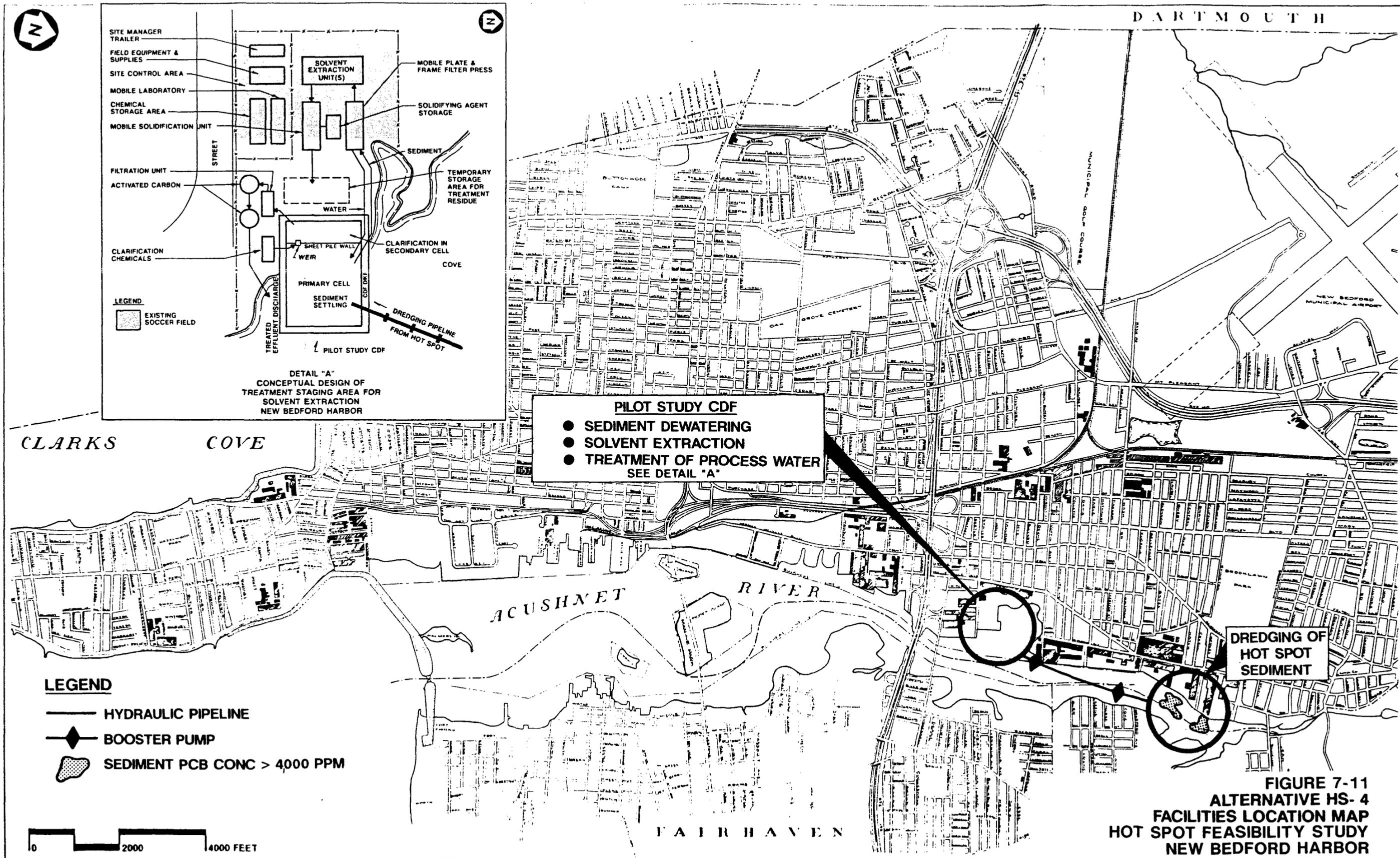
Treatment and disposal of the Hot Spot area sediment will take place in the pilot study area (Figure 7-11) for the reasons discussed in Alternative HS-2.

The following paragraphs are detailed descriptions of the response actions comprising Alternative HS-4. (See descriptions of those response actions which do not change in Alternative HS-4.) Descriptions of the response actions are presented in the order shown in Figure 7-9.

Dredging. Dredging of the Hot Spot sediment and transport to the CDF will be conducted as described in Alternative HS-2.

Dewatering. Primary and secondary dewatering of the Hot Spot area sediment will be conducted as described in Alternative HS-2.

Water Treatment. Treatment of CDF effluent and dewatering filtrate will be conducted as described in Alternative HS-2.



**FIGURE 7-11
ALTERNATIVE HS-4
FACILITIES LOCATION MAP
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

Solvent Extraction. Solvent extraction is the process of leaching a soluble substance from a solid with a liquid solvent. Although PCBs characteristically have relatively low solubilities in water, they are readily soluble in certain organic solvents under appropriate conditions of temperature and/or pressure.

The removal efficiency of solvent extraction depends on the number of extraction steps. The amount of PCBs that can be removed from the sediment during any one extraction step is limited by the following (E.C. Jordan Co./Ebasco, 1987c):

- the contaminant's solubility in the solvent
- the solvent and sediment mixing efficiency
- mass transfer coefficients governing the rate at which the contaminant dissolves
- the time the solvent and sediment are in contact
- the ability to separate solvent from the sediment
- the presence of interfering substances in the sediment

Treatment tests were conducted on New Bedford Harbor sediment using two solvent-extraction technologies: the TEA-based BEST process developed by RCC; and the liquified (gas) propane process developed by CF Systems. Treatment tests using the RCC process were conducted on a bench-scale, while the CF Systems process was tested on a pilot-scale as part of the EPA SITE program. Descriptions of these technologies and a brief summary of the test results are in Subsection 5.4.2.

Test results of both solvent-extraction technologies indicated that PCB removal efficiencies of 96 percent (CF Systems) to 99 percent (RCC) are achievable for treating the Hot Spot area sediment. Neither process is capable of removing metals from the sediment. However, results of the RCC bench test revealed that the treated sediment from the BEST process passed the leaching test. This finding is significant because it indicates that secondary treatment of the processed sediment, such as solidification, may not be necessary to immobilize residual metals prior to final disposal of the processed sediment.

In the following paragraphs, the BEST process has been selected for detailed evaluation of sediment treatment using solvent extraction. Solvent extraction of PCBs (and the associated oil fraction) from Hot Spot area sediment would begin with mixing the dewatered Hot Spot area sediment with an appropriate solvent. After mixing, the solvent containing PCBs and the

sediment containing little or no residual PCBs would be separated by conventional methods (e.g., centrifugation or gravity settling). The PCB/oil fraction is separated from the solvent, by either changing the temperature and/or pressure of the solvent which changes the solubility of the PCBs, or by distillation methods. The solvent is subsequently recycled and the PCB/oil fraction can be disposed of via incineration.

The solvent extraction process depicted in Figure 7-6 is a simplified representation of the BEST process. Throughput rate for a solvent extraction unit is assumed to be 75 tons (i.e., 61 cy) of dewatered sediment per day. Therefore, approximately 160 consecutive days will be required to treat 10,000 cy of Hot Spot area sediment. The dewatered sediment will be separated into three distinct effluent streams: sediment solids, water, and an extract containing PCBs and oil. The 35.5 tons per day of sediment solids containing residual PCBs and metals may require additional treatment prior to ultimate disposal. Leaching tests would be used to determine the need for secondary treatment, such as solidification. Laboratory-scale work currently being conducted by RCC indicates that the addition of 10 percent (by weight) of solidifying agent to the processed sediment is effective in immobilizing residual PCBs and metals (RCC, 1989b).

The 29,000 gallons per day (gpd) of water removed from the sediment will be recycled back to the primary cell of the CDF

for eventual water treatment (Subsection 7.3.1).

Approximately 905 gallons per day (gpd) of PCB/oil extract will be generated. The total volume of PCB/oil extract produced during the solvent extraction operation will be approximately 144,800 gallons. The PCB/oil fraction would be incinerated at an off-site facility. Thirty truckloads, each with a capacity of 5,000 gallons, will be required to transport the PCB extract to an off-site incinerator. Several incinerators are capable of treating this extract: the SCA facility in Chicago, Illinois; the Aptas facility in Coffeerville, Kansas; the ENSCO incinerator in ElDorado, Arkansas; and the Rollins facility in Deer Park, Texas. Selection of the final incineration facility will be made just prior to implementation of remedial action, and will depend on the available capacity and regulatory status of the receiving facility.

Disposal. The process sediment will be disposed of as described in Alternative HS-2.

7.5.2 Reduction in Mobility, Toxicity, and Volume

Solvent extraction of Hot Spot area sediment will provide a reduction in both the mobility and volume of PCBs by physically removing them from the sediment. A reduction in PCB toxicity will be achieved by incineration of the PCB/oil extract.

Solidification of processed sediment may be required as a secondary treatment to immobilize residual PCBs and metals. Solidification would achieve a reduction in mobility of the residual PCBs and metals, but would increase the volume of processed sediment by 20 to 40 percent.

7.5.3 Short-term Effectiveness

Risk to the community (i.e., local residents) is expected to be minimal during implementation of Alternative HS-4 for the same reasons discussed in Alternative HS-2 (see Subsection 7.3.3).

Workers on-site during remedial activities could be exposed to contaminants by dermal contact and inhalation of airborne particulates or volatilized contaminants. Dermal and inhalation exposure to contaminants could arise as a result of dredging operations (e.g., clearing debris from or unclogging the dredgehead), dewatering the sediment, and solvent extraction operations (e.g., contact with the TEA solvent and PCB/oil fraction). To minimize or prevent such exposure, personal protection equipment (i.e., respirators, overalls, and gloves) would be used. In addition, air monitoring would be conducted to ensure worker safety within immediate areas of remedial activity.

No adverse environmental impacts are expected as a result of dredging of Hot Spot area sediment for the reasons discussed in Alternative HS-2 (see Subsection 7.3.3).

Based on a throughput rate of 75 tons per day for the solvent extraction unit, approximately 150 to 170 days will be required to complete the remedial activities described in Alternative HS-4 to meet the remedial response objectives.

7.5.4 Long-term Effectiveness and Permanence

The long-term effectiveness of dredging Hot Spot area sediment to remove PCBs was discussed in Alternative HS-2 (see Subsection 7.3.4).

Bench tests conducted on New Bedford Harbor sediment indicate that solvent extraction can effectively remove more than 99 percent of the sediment PCBs. However, the processed sediment may require secondary treatment to immobilize metals that would not be extracted. Limited data are available to assess full-scale operation of solvent-extraction technologies. While bench- and pilot-scale tests of the BEST and liquefied propane technologies indicated that these technologies can be effective in removing PCBs from sediment, the tests also indicated potential material-handling problems (e.g., solvent recovery and

feed input to the extraction unit), which would need to be resolved prior to full-scale implementation.

Disposal of processed sediment in the unlined CDF is not expected to present long-term risks to public health or the environment. Processed sediment containing residual PCBs and metals would constitute the only source of contamination that would be reintroduced into the environment. However, the concentration of PCBs and metals in any leachate generated is expected to be minimal. Solidification of the processed sediment (as a secondary treatment step to immobilize metals) would further reduce the leaching potential of the PCBs and metals. Placement of a cap on the CDF would reduce the potential for leachate generation due to infiltration of precipitation and surface runoff. Furthermore, attenuation of leachate contaminant concentrations would be expected as the leachate migrated through the earthen dikes of the CDF. Long-term monitoring and maintenance of the CDF cover and monitoring of the CDF dike will be necessary to assess leachate migration and contaminant concentration.

7.5.5 Implementation

7.5.5.1 Technical Feasibility

Constructability. Dredging operations that will occur at the Hot Spot area were proven effective in the USACE dredging pilot study.

The dewatering and water treatment technologies are well-developed for their intended application. Prior to final design, bench-scale studies will be required to determine equipment size, chemical dosage, and activated carbon requirements.

Results of the RCC BEST process indicate that solvent extraction using TEA is technically feasible for treating Hot Spot area sediment. CF Systems liquified gas extraction process was also shown to be effective for New Bedford Harbor sediment, based on results of the EPA SITE program pilot demonstration. Actual selection of a specific solvent-extraction system will be performed during remedial design.

Incineration of the PCB/oil extract is currently the most appropriate available technology for the destruction of PCB materials. The treatment will occur at a facility permitted to treat such waste.

Solidification of the solid process residuals is a common method for reduction of the mobility of metals in solid matrices. The process will result in a material that can be easily handled and stable for disposal.

Reliability. Hydraulic dredging with a cutterhead dredge has been demonstrated to be a reliable technology for use in New Bedford. Downtime during operational periods should be limited to clearing debris from or unclogging the cutterhead.

A 100-ton-per-day BEST unit was used to treat oily sludge at a site near Savannah, Georgia. The sludge was contaminated with approximately 10 ppm of PCBs. The process was able to provide about 99-percent removal of PCBs from the sludge. However, some problems were encountered with the materials-processing equipment during the operation. Changes in process design were incorporated, and it is anticipated that performance of the equipment will be improved.

RCC is currently developing a new hardware system consisting of LittlefordTM rotary washer-dryer units. This system will allow more efficient mixing of solvent and solids, thereby increasing the extraction efficiency per stage. In addition, the sediment is not moved from one reaction stage to the next, as in the original 100-ton-per-day unit, which simplifies material handling.

CF Systems liquified gas extraction was only demonstrated for treatment of oily sludge on a bench-scale level. Reliability of the process on a full-scale level is unknown. A pilot-scale test of the CF Systems process on New Bedford Harbor sediment was conducted under the EPA SITE program. Results from this test indicate additional development is required to resolve numerous problems (see Subsection 5.4.2).

Ease of Undertaking Additional Remedial Action. No additional remedial actions are anticipated if the solvent extraction process proves successful. However, if the solvent-extraction process is proven unsuccessful, a mobile incinerator could readily be brought on-site to treat the dredged material. In addition, future remedial actions may be required for sediment in the estuary outside the Hot Spot area. Hot Spot remedial action should not affect implementation of any of these future actions. Instead, experience gained during Hot Spot remediation will provide a valuable source of knowledge pertaining to the dredging, treatment, and disposal of contaminated sediment.

Monitoring Considerations. Environmental monitoring of the dredging operation will include sampling of the water column in the dredging area, frequent inspection of the hydraulic pipeline will also be necessary to monitor pipeline integrity.

Air monitoring would be conducted at predetermined locations near the dredging area and the treatment area throughout the remedial action period.

Monitoring stations will also be established at predetermined locations within the estuary to assess the degree of sediment/contaminant migration associated with dredging operations. Baseline conditions (i.e., TSS, PCBs, and dissolved metals concentrations) developed during the pilot study will be used as a starting point for Hot Spot dredging activities.

Monitoring of the hydraulic pipeline will include one crew of workmen in small, shallow-draft boats. The crew will be in radio contact with the dredge operator so that appropriate action can be taken in the event of a leak or break in the line. Additional workmen will be required to monitor the operation of the booster pumps.

Appropriate monitoring of dewatering and solidification operations will be necessary to provide protection to workers and the public. Periodic sampling of the water discharged from the water treatment facility will be necessary to ensure system performance standards are met.

7.5.5.2 Administrative Feasibility

Coordination between the lead agency (USACE or EPA), the City of New Bedford, and the Commonwealth of Massachusetts will be important. Coordination would involve active communication, including formal and informal meetings, among these agencies at critical points in the remedial action process. Because there will be no off-site activities, permits need not be obtained for this alternative.

7.5.5.3 Availability of Services and Materials

Cutterhead dredges are readily available and a maximum of 90 days is anticipated for delivery and setup once ordered. Personnel are also available to operate the machinery.

Contractors and equipment for construction of the dewatering and water treatment plant are available to respond to requests for proposals in a timely and responsive manner. "Turn-key" clean-up contractors capable of executing the entire alternative are also available, thereby increasing the likelihood of multiple responsive bids.

Only one full-scale unit is currently available for the BEST process. This unit is designed for a 100-ton-per-day operation. However, the new hardware processing system using the LittlefordTM rotary washer-dryer units should be available by the end of 1989.

No full-scale units using CF Systems supercritical extraction process are currently available; however, construction of a full-scale treatment unit is underway.

7.5.6 Cost

Costs for Alternative HS-4, solvent extraction, are summarized in Table 7-4. Dredging, dewatering, water treatment, and disposal costs include expenses relating to equipment mobilization, operation, and labor. A separate cost associated with mobilization of solvent-extraction equipment is also included. A solvent extraction unit cost of \$176 per ton was used for this cost analysis. Costs for disposal of the PCB extract were estimated at \$4.20 per gallon for disposal, with transportation estimated at \$4.50 per loaded mile (5,000-gallon tank truck) to the SCA incinerator in Chicago, Illinois.

Indirect costs associated with health and safety, administration, engineering, and services during construction are included along with a 20-percent contingency to cover any

TABLE 7-4
 COST ESTIMATE: ALTERNATIVE HS-4
 SOLVENT EXTRACTION

HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

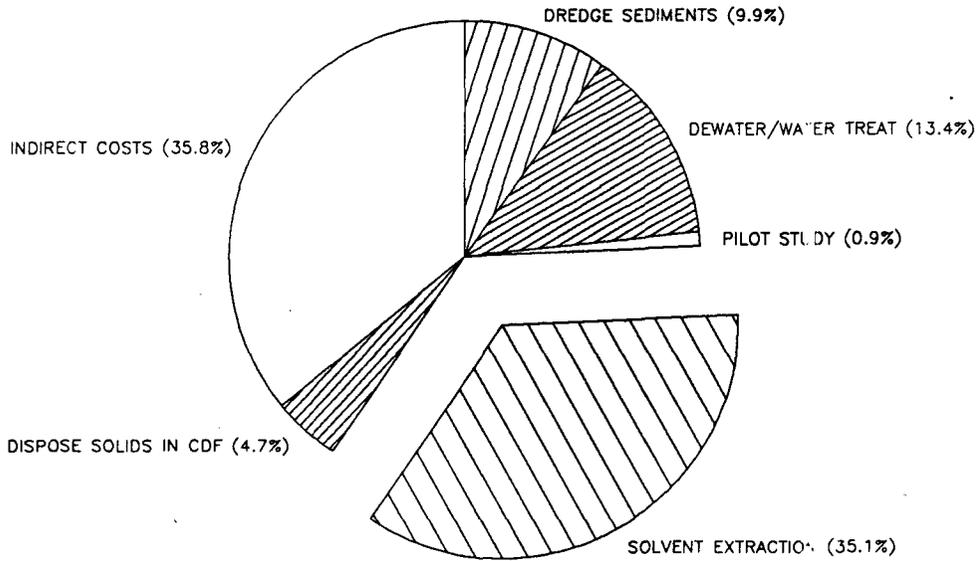
ACTIVITY	COST (\$)
I. CAPITAL COSTS	
A. SITE PREPARATION	\$ 345,000
B. DREDGE HOT SPOT SEDIMENTS (\$121/CY)	\$ 1,210,000
C. SECONDARY DEWATERING (\$52/CY)	\$ 575,000
D. WATER TREATMENT	\$ 1,059,000
E. SOLVENT EXTRACTOR PILOT STUDY	\$ 115,000
F. SOLVENT EXTRACTOR MOBILIZATION, DEMobilIZATION, AND DECONTAMINATION	\$ 575,000
G. SOLVENT EXTRACTION OF SEDIMENTS (\$200/TON)	\$ 2,484,000
H. OFF-SITE DISPOSAL OF PCB EXTRACT	\$ 870,600
I. SOLIDIFICATION OF SOLID RESIDUALS (OPTIONAL) (\$98/CY)	\$ 350,750
J. DISPOSAL OF SOLIDIFIED RESIDUAL IN SHORELINE CDF (UNLINED)	<u>\$ 222,000</u>
TOTAL DIRECT COSTS	\$ 7,806,350
K. HEALTH AND SAFETY (ACTIVITIES B, E, G) LEVEL C PROTECTION (@ 15%)	\$ 571,400
L. HEALTH AND SAFETY (ACTIVITIES A, C, D, F, H, I, J) LEVEL D PROTECTION (@ 5%)	\$ 200,000
M. LEGAL ADMINISTRATION, PERMITTING, SECURITY (@ 6%)	\$ 468,400
N. ENGINEERING (@ 10%)	\$ 780,600
O. SERVICES DURING CONSTRUCTION (@ 10%)	\$ 780,600
P. CONTINGENCY (@ 20%)	<u>\$ 1,561,300</u>
TOTAL INDIRECT COSTS	\$ 4,362,300
TOTAL COST	<u>\$12,168,650</u>

unexpected occurrences. Land acquisition costs were not considered when developing this cost estimate because the pilot study will be used for all treatment disposal activities. The total cost for the alternative is estimated to be \$12,168,650.

Since solvent extraction is an innovative technology and unproven in full scale applications, costs associated with this component were considered to be the most sensitive to change. Therefore, the sensitivity analysis performed for this alternative centered around this component. Three variations were analyzed: additional extraction steps, the accuracy of the vendor price quote to full scale operation, and the costs to incinerate the soil should the technology fail.

The \$200-per-ton cost estimate developed by RCC for the BEST process is based on treating the Hot Spot area sediment with a range of four to six extractions. Additional extractions may be required in a full-scale process to achieve TCL levels. Figure 7-12 contains a pie chart showing the breakdown of costs associated with this alternative. Costs for solvent extraction are the largest single cost associated with this alternative, accounting for approximately 35 percent of the overall cost. The bar chart in Figure 7-12 illustrates a sensitivity analysis performed to determine the variability of costs as a function of extraction steps. As illustrated in Figure 7-12, the alternative costs are not sensitive to the need for additional extraction stages.

ALTERNATIVE HS-4: ON-SITE SOLVENT EXTRACTION
 TOTAL COST: \$12,168,650



COST SENSITIVITY ANALYSIS

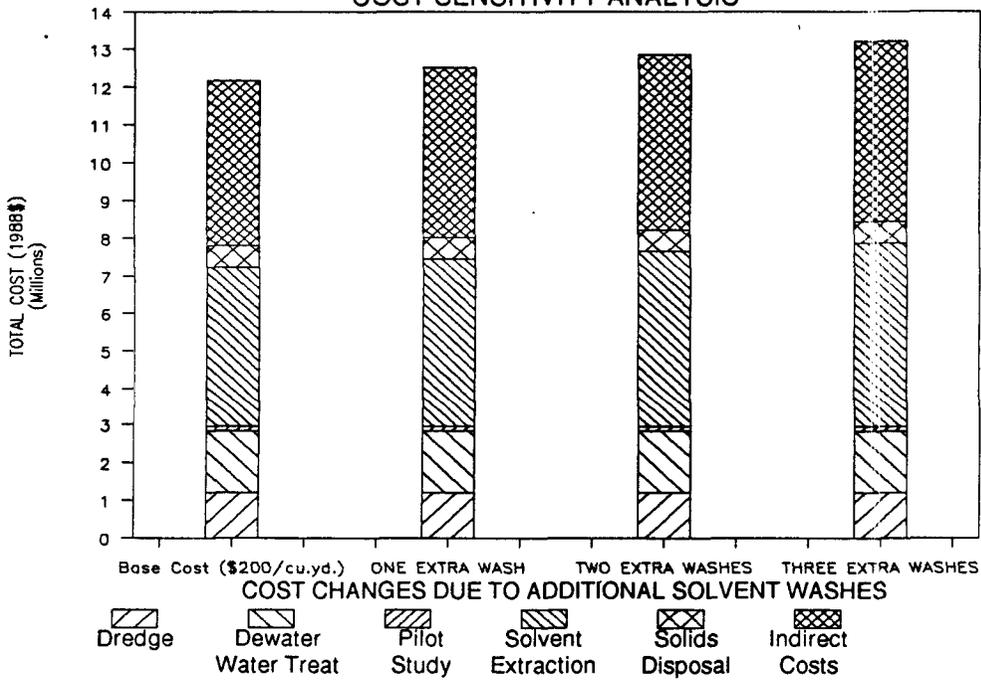


FIGURE 7-12
 COST ANALYSIS: ALTERNATIVE HS-4
 ON-SITE SOLVENT EXTRACTION
 HOT SPOT FEASIBILITY STUDY
 NEW BEDFORD HARBOR, MASSACHUSETTS

Unit costs from vendors are difficult to verify without actual field data. It is possible that unit costs could increase by as much as 50 percent due to unforeseen circumstances in scale-up from pilot test to actual field implementation. If this were to occur, then the total alternative costs could expand from \$12,168,650 to \$14,197,500.

Since solvent extraction is an innovative technology, the potential exists that solvent extraction followed by solidification will be incapable of achieving the target clean-up levels. If this were to occur, a mobile incinerator could be brought on-site to incinerate the extracted sediment. From Table 7-2, an additional \$690,000 would be required to mobilize an incinerator, plus \$4,577,000 to incinerate the extracted sediment. The total additional cost that could be expended is estimated to be \$5,267,000. It is unlikely that this would occur as a pilot-scale test would be performed prior to full-scale operations to verify compliance with target clean-up levels. This cost, therefore, represents the upper limit of the sensitivity analysis for this alternative. The total alternative cost under this scenario would be \$17.4 million. It is important to note, however, that this additional cost would likely be absorbed by the remediation contractor and not passed on to the lead agency.

As with Alternative HS-2, this alternative is sensitive to the total amount of sediment removed. If an additional 1,800 cy of sediment would require dredging for operational considerations, then the total cost of this alternative would increase from \$12.1 million to \$14.1 million.

To summarize the sensitivity analyses, the costs for solvent extraction were based on vendor price quotes and have not been verified during full-scale remediation. Because of this, the costs are expected to range from \$12.1 million to \$14.1 million. Under a worst-case scenario of the technology failing, the costs could approach \$17.4 million.

7.5.7 Compliance with ARARs

Potential chemical-specific ARARs for dredging and solvent extraction of Hot Spot area sediment can be divided into two media: surface water and air. Massachusetts Surface Water Quality Standards (310 CMR 4.00), federal AWQC criteria are the surface water ARARs for this alternative. In addition, the federal FDA level for PCBs in biota consumed by humans is a regulation "to be considered." Removal of the Hot Spot, which constitutes approximately 45 percent of the mass of PCBs in New Bedford Harbor, is not expected to result in reducing PCB water concentrations below these levels. This is an interim remedy

and, as such, need not comply with ARARs. Removal of PCBs in the Hot Spot is consistent with the overall objective of ultimately achieving these criteria.

Federal and state regulations pertaining to air emissions from remedial activities include the following:

- Federal National Air Quality Standards (40 CFR 40)
- State DEQE Air Quality Regulations (310 CMR 6.00 - 8.00)

These ARARs would be attained during site remediation by the application of BACT control technology for any emissions from the solvent-extraction unit and fugitive dust control for dust-related activities.

Potential location-specific ARARs for this alternative can be divided into three groups:

- federal and state wetlands regulations
- federal floodplain regulations
- federal and state coastal zone regulations

As outlined in Subsection 4.2.3, compliance with wetlands regulations would be attained by minimizing activities in these areas. The floodplain regulations would be attained by locating the treatment facility outside the 100-year floodplain. The

actual dredging of the sediment is expected to have minimal effect on the Acushnet River floodplain. The federal and state coastal zone management ARARs would be attained by submitting a consistency determination to the Commonwealth of Massachusetts at 90-percent completion of remedial design. This consistency determination would outline proposed activities, potential environmental impacts to the coastal zone, and mitigative measures to be used.

Potential action-specific ARARs pertinent to solvent extraction and disposal of sediment can be divided into four groups:

- ARARs associated with the construction and operation of a treatment facility (RCRA regulations, TSCA regulations, DEQE hazardous waste regulations)
- ARARs associated with dredging activities (CWA 40 CFR R5, 404; NEPA 40 CFR 6)
- ARARs associated with the treatment, transportation, and disposal of hazardous wastes (TSCA 40 CFR 761.70 - 761.79 RCRA 40 CFR 268, DOT 49 CFR 107, 171.1 - 172.6)
- ARARs associated with the regulation of hazardous waste activities or federal work standards (OSHA Federal Safety Standards, Massachusetts Right-to-Know Regulations)

The ARARs in each group are discussed in the following paragraphs.

The RCRA facility regulation and DEQE hazardous waste regulations would be attained because these regulations would serve as the basis for remedial design. ARARs pertaining to dredging activities (CWA, NEPA) would be attained during dredging activities by conducting these activities to minimize sediment resuspension and subsequent PCB mobilization. This was successfully performed during the USACE pilot test, and similar procedures will be implemented during full-scale dredging.

The TSCA storage and disposal regulation (40 CFR 761.6 - 761.79) are applicable and the RCRA land disposal regulations (40 CFR 268) are relevant and appropriate to the treatment and disposal of Hot Spot sediment. Under these regulations, solvent extraction would be considered an alternative treatment technology and would need to achieve a level of performance equivalent to incineration (i.e., 2 ppm) prior to disposal. Treatment with solvent extraction coupled with solidification of the treated sediment is expected to achieve these levels. The DOT Rules for Transportation of Hazardous Materials (49 CFR 171.1 - 172.558), which are applicable to the transport of PCB extract, would be attained by incorporating the requirements of this regulation into remedial design.

OSHA regulations and the Massachusetts Right-to-Know Regulations (DPW-105 CMR 67, DOI-441 CMR 21, DEQE-310 CMR 33) would be attained by incorporating the procedural requirements of these regulations into the remedial design phase.

Appendix B presents the potential chemical-, location-, and action-specific ARARs for this alternative in greater detail, and also outlines corresponding remedial actions required to attain each ARAR.

7.5.8 Overall Protection of Public Health and the Environment

The removal, solvent extraction, and on-site disposal of the Hot Spot area sediment will permanently reduce the toxicity and mobility of PCBs in the estuarine environment. Public health and environmental risks directly associated with the Hot Spot will be significantly reduced. The exact level of reduction, however, cannot be quantified at this time. Qualitatively, the removal of approximately half the PCBs in the aquatic environment is expected to have a significant long-term effect.

7.5.9 State Acceptance

Preliminary comments from the Commonwealth of Massachusetts indicate that it supports this alternative. This alternative is consistent with the MCP, in that it permanently treats

contaminated sediment. The state is concerned that treated sediment passes EP toxicity tests prior to disposal. EPA shares this concern, and the solidification step will be added if PCB-extracted sediment does not pass EP Toxicity tests.

Formal comments will be received from the state during review of the draft FS and incorporated into the ROD.

7.5.10 Community Acceptance

Comments received from the New Bedford Harbor Citizens Advisory Group indicate that the community reacted favorably to and supports this alternative, because it permanently removes and treats Hot Spot area sediment.

7.6 COMPARISON OF REMEDIAL ALTERNATIVES

A comparative analysis was performed to evaluate the relative performance of each alternative in relation to each of the evaluation criteria. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key trade-offs can be identified. The comparative analysis is presented for each criteria in the following subsections. This comparative analysis serves as a summary for the detailed evaluation of alternatives.

7.6.1 Reduction in Mobility, Toxicity, and Volume

Alternatives HS-2 and HS-4 provide the greatest reduction in mobility, toxicity, and volume because both permanently treat and destroy PCBs. Reduction in toxicity and mobility are also achieved if solidification is not required to prevent leaching of the metals.

Alternative HS-3 provides the next level of treatment in that the mobility of the Hot Spot area sediment is permanently reduced by solidification and off-site disposal in a TSCA/RCRA facility. The toxicity of the PCBs, however, is not reduced and there is a volume increase due to the solidification process.

Alternative HS-1, the no-action alternative, provides no reduction in mobility, toxicity, or volume because it employs no treatment.

7.6.2 Short-term Effectiveness

Each alternative would be equally effective at protecting the community during remedial actions. Alternative HS-2 would pose the greatest risk to workers due to the inherent risks associated with the high operating temperatures of incineration. Each alternative is also equally effective with respect to adverse environmental impacts. Each alternative removes the contaminated sediment by a cutterhead dredge using

procedures developed and tested by USACE to minimize PCB migration. Alternatives HS-2, HS-3, and HS-4 all have implementation times of approximately one year. HS-1, the no-action alternative, has no minimal short-term effectiveness because there are minimal construction activities.

7.6.3 Long-term Effectiveness and Permanence

Alternatives HS-2 and HS-4 provide the greatest long-term effectiveness and permanence because they permanently treat the PCB-contamination and reduce the mobility of the metal contamination where needed. Alternative HS-4 has an advantage with respect to the response objectives because it incorporates an innovative technology. Under Alternatives HS-2 and HS-4, there is minimal residual risk.

Alternative HS-3 utilizes solidification as the principal treatment element. Because the PCBs are only immobilized, a residual risk at the off-site disposal facility exists and will require adequate controls.

Alternative HS-1, the no-action alternative, has minimal long-term effectiveness because the Hot Spot sediment remains in-place, untreated.

7.6.4 Implementation

Alternative HS-1 would be the simplest alternative to implement because it would involve minimal construction with no treatment activities. Alternative HS-2 would be the next implemented alternative. The construction area and water treatment facilities are already constructed and mobile incinerators are readily available. Alternative HS-3 is easy to implement, provided suitable landfill space is available in a compliance TSCA/RCRA landfill. Solidification equipment, which is readily available, would need to be brought on-site.

Alternative HS-4 is expected to be the most difficult to implement. Specialized solvent extraction equipment would need to be mobilized to the site and tested prior to full-scale operation. Because this is an innovative technology and equipment is not readily available, the equipment may need to be scheduled or constructed prior to mobilization.

7.6.5 Cost

Costs for the four alternatives and sensitivity of these costs to various assumptions is discussed previously in this section. The present worth of each alternative is summarized in ascending

order of expense, as follows:

<u>ALTERNATIVE</u>	<u>DESCRIPTION</u>	<u>COST</u>
HS-1	No-Action	\$ 455,000
HS-4	Solvent Extraction	\$12,168,650
HS-3	Solidification	\$13,300,200
HS-2	Incineration	\$14,397,300

7.6.6 Compliance with ARARs

None of the four alternatives is expected to comply with the chemical-specific ARARs. Removal of PCBs in the Hot Spot area would not be sufficient to achieve AWQC and reduce PCB levels in biota to below the FDA action level. However, because this is an interim remedy that would be consistent with a final remedy for New Bedford Harbor, a waiver from ARAR compliance is justifiable.

Alternative HS-2 complies with all location- and action-specific ARARs. Alternative HS-3 and HS-4 use alternate treatment technologies and would comply with all location- and action-specific ARARs, if it can be demonstrated that these technologies achieve a level of performance equivalent to incineration.

Alternative HS-1, the no-action alternative, does not invoke location- or action-specific ARARs because of the minimal construction activity.

7.6.7 Overall Protection of Public Health and the Environment

Alternatives HS-2 and HS-4 provide the best protection of public health and the environment. Under both alternatives, PCBs are destroyed and the metals are immobilized. Alternative HS-3 is also protective of public health and the environment. However, in this alternative, the PCBs are not destroyed but rather solidified and disposed of in a TSCA/RCRA landfill.

Alternative HS-1 provides little protection of public health and no protection for the environment. PCB migration from the Hot Spot area into the estuary and harbor is expected to continue.

7.6.8 State Acceptance

Based on preliminary comments received from the Commonwealth of Massachusetts, Alternatives HS-2 and HS-4 are favored by the state because they employ permanent treatment of the waste.

Alternatives HS-1 and HS-3 are not favored because they incorporate off-site disposal or no-action, which is inconsistent with the goals of the MCP. Comments received from the state on this draft report will be incorporated into the final draft report.

7.6.9 Community Acceptance

Comments received from the public at meetings of the New Bedford Harbor Community Action Committee indicate that the public favors either of the permanent treatment Alternatives HS-2 and HS-3. The public did not favor off-site disposal due to the potential for excessive transportation costs. In addition, the public will not support Alternative HS-1, the no-action alternative. From their perspective, the worst area needs to be treated first.

Table 7-5 provides a summary of the comparative analysis of alternatives.

TABLE 7-5
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
• Reduction of Toxicity, Mobility, or Volume	No reduction in toxicity, mobility, or volume since no treatment is employed.	Reduction in toxicity and mobility of PCB-sediments. Volume also reduce unless ash is solidified to prevent metals leaching.	Reduction in mobility of the Hot Spot Sediments. No reduction in toxicity. Volume increased by solidification.	Reduction in toxicity and mobility of PCB sediments. Volume will increase if solidification is employed. to prevent metal leaching.
• Short-term Effectiveness				
- Time Until Protection is Achieved	Reduction in public health risk due to direct contact could be achieved in one month. No reduction in environmental risk.	Reduction in public health and environmental risk should occur within one year after remedial action is initiated.	Same as Alternative HS-2.	Same as Alternative HS-2.
- Protection of Community During Remedial Actions	No impact to community during remedial action.	Dredge controls and air quality controls will minimize community impacts.	Same as Alternative HS-2.	Same as Alternative HS-2.
- Protection of Workers During Remedial Actions	Minimal risk to workers during fence/sign installation.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered sediments and ash.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered sediments and solidification process.	Protection required against dermal contact with dredged sediments and fugitive dust from dewatered and treated sediments.
- Environmental Impacts	No significant adverse environmental impact from fence installation.	Minimal environmental impact expected from dredging or construction.	Same as Alternative HS-2.	Same as Alternative HS-2.
• Long-term Effectiveness				
- Magnitude Of Residual Risk	Significant risks remain for public health associated with direct contact of surface soils. Environmental risks would continue unmitigated.	After sediments have been incinerated and the ash solidified (if needed). There will be minimal risk associated with the treated sediments.	After sediments have been solidified and disposed off-site, there will be minimal residual risk.	After sediments have been treated and solidified (if needed), there will be minimal residual risk.
- Adequacy of Controls	No direct engineering controls; fence subject to vandalism; annual monitoring and repair required.	Incineration is a proven technology; no long-term management of treatment residuals required.	TSCA/RCRA landfill is a proven technology; annual monitoring and maintenance is required.	Treatment by solvent extraction is expected to produce a treated sediment that will not need long-term control.

TABLE 7-5
(continued)
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
- Reliability of Controls	Sole reliance on fence and institutional controls to prevent exposure; high level of residual risk.	Remedy will be highly reliable due to removal of sediment causing risk.	Likelihood of landfill failure is small as long as O&M is performed.	Same as Alternative HS-2.
Implementation				
- Technical Feasibility	Fence/signs are easily constructed; environmental monitoring well-proven.	Incineration would require special equipment and operators; treated residuals would require testing to verify treatment effectiveness; technology has been demonstrated at other sites.	TSCA/RCRA Landfill easy to implement; dewatering and solidification of sediments proven during bench- and pilot-scale tests.	Solvent extraction would require special equipment and operators; treated residuals would require testing to verify treatment effectiveness; technology has been pilot-tested on Hot Spot sediments.
- Administrative Feasibility	No off-site construction; therefore, no permits required.	Same as Alternative HS-1.	Same as Alternative HS-1.	Same as Alternative HS-1.
- Availability of Services and Materials	Services and materials locally available.	Dredge, dewatering, and mobile incinerator equipment and operators needed; available services in eastern United States.	Dredge, dewatering, and solidification services available in eastern United States. TSCA/RCRA disposal facility not locally available.	Solvent extraction equipment available from vendors but not readily. Equipment construction or pilot-scale tests may be required.
Cost				
- Capital Cost	\$ 48,000	\$14,397,300	\$13,300,200	\$12,168,650
- O&M Cost	407,000	--	--	--
- Present Worth Cost	455,000	14,397,300	13,300,200	12,168,650
Compliance with ARARs/TBCs				
- Compliance with ARARs	AWQCs will not be attained.	AWQCs will not be attained. All other ARARs will be met.	Same as Alternative HS-2.	AWQCs will not be attained. Solvent extraction will need to achieve equivalent performance standards.
- Appropriateness of Waivers	Not justifiable.	Justifiable based on interim remedy.	Same as Alternative HS-2.	Same as Alternative HS-2.

TABLE 7-5
(continued)
COMPARATIVE ANALYSIS SUMMARY TABLE

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS

ASSESSMENT FACTORS	ALTERNATIVE HS-1 NO-ACTION	ALTERNATIVE HS-2 INCINERATION	SOLIDIFICATION/DISPOSAL	SOLVENT EXTRACTION
- Compliance with Criteria, Advisories, and Guidance	Does not meet FDA level for PCBs in fish and shellfish.	Is not expected to achieve FDA level for PCBs in fish and shellfish.	Same as Alternative HS-2.	Same as Alternative HS-2.
• Overall Protection of Human Health and the Environment				
- How Risks are Reduced, Eliminated, or Controlled	Risks to public health are reduced by restricting site access; environmental risks are not mitigated.	Risks to public health and the environment are significantly reduced by the removal and treatment of the Hot Spot.	Same as Alternative HS-2.	Same as Alternative HS-2.
• State Acceptance	Preliminary comments indicate non-acceptance.	Preliminary comments indicate acceptance.	Same as Alternative HS-1.	Same as Alternative HS-2.
• Community Acceptance	Preliminary comments from the New Bedford community action group indicates non-acceptance.	Preliminary comments from the New Bedford community action group indicates acceptance.	Same as Alternative HS-1.	Same as Alternative HS-2.

GLOSSARY OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BACT	Best Available Control Technology
CAD	confined aquatic disposal
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
cy	cubic yards
DEQE	Department of Environmental Quality Engineering (Massachusetts)
DOT	Department of Transportation (U.S.)
EFS	Engineering Feasibility Study
EPA	U.S. Environmental Protection Agency
ERL	U.S. Environmental Research Laboratory (EPA)
FDA	U.S. Food and Drug Administration
FS	Feasibility Study
gpd	gallons per day
gpm	gallons per minute
kg/yr	kilograms per year
KPEG	potassium hydroxide/polyethylene glycol
MCP	Massachusetts Contingency Plan
mg/l	milligrams per liter
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
NUS	NUS Corporation
OHM	OH Materials Corporation
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response (EPA)
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
ppb	parts per billion
ppm	parts per million
ppt	parts per thousands
psi	pounds per square inch

GLOSSARY OF ACRONYMS
(Continued)

RAMP	Remedial Action Master Plan
RCC	Resource Conservation Company
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SITE	Superfund Innovative Technology Evaluation
s/s	solidification/stabilization
STC	Silicate Technology Corporation
TCL	target clean-up level
TCLP	Toxicity Characteristic Leaching Procedure
TEA	triethylamine
TOC	total organic compound
TSCA	Toxic Substances Control Act
TSS	total suspended solids
UCS	unconfined compressive strength
USACE	U.S. Army Corps of Engineers
UV	ultraviolet
WES	Waterways Experiment Station

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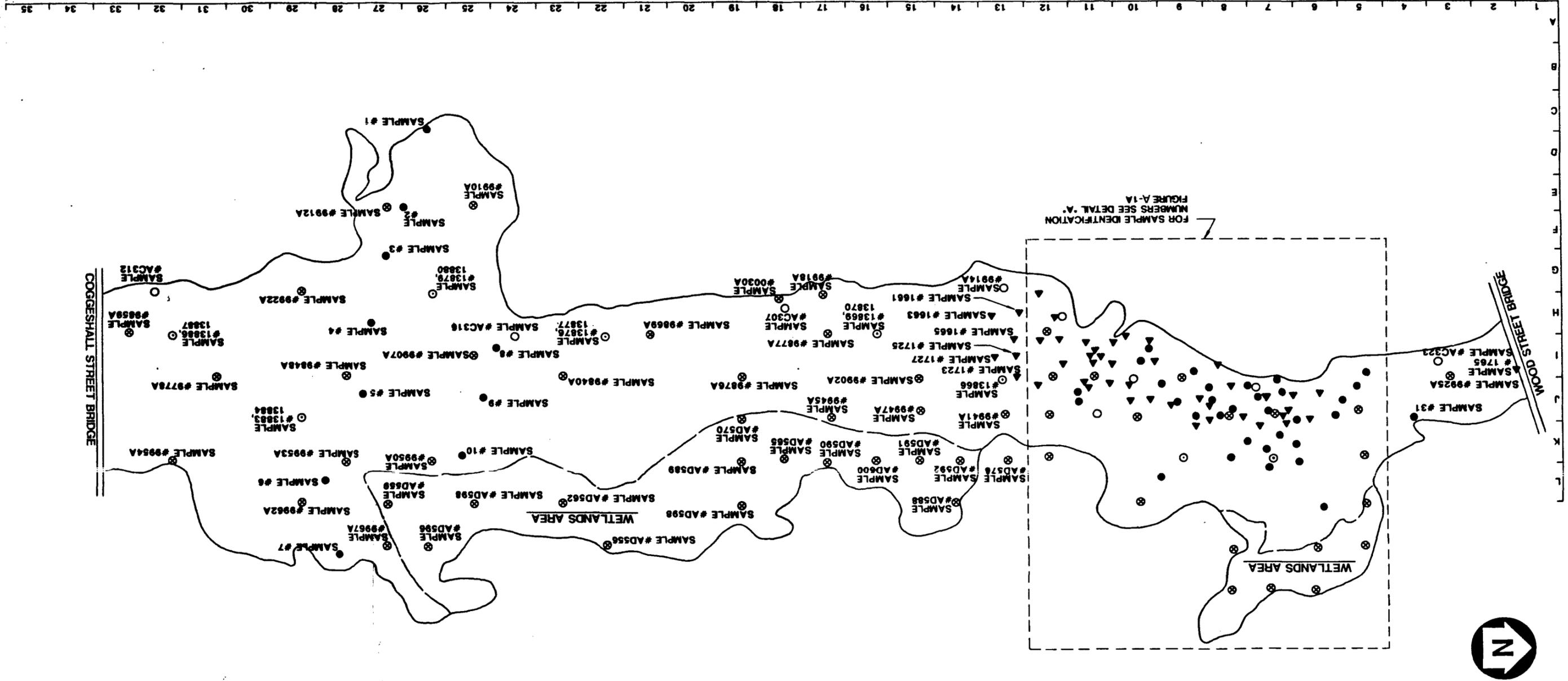
APPENDIX A
SEDIMENT ANALYTICAL DATA

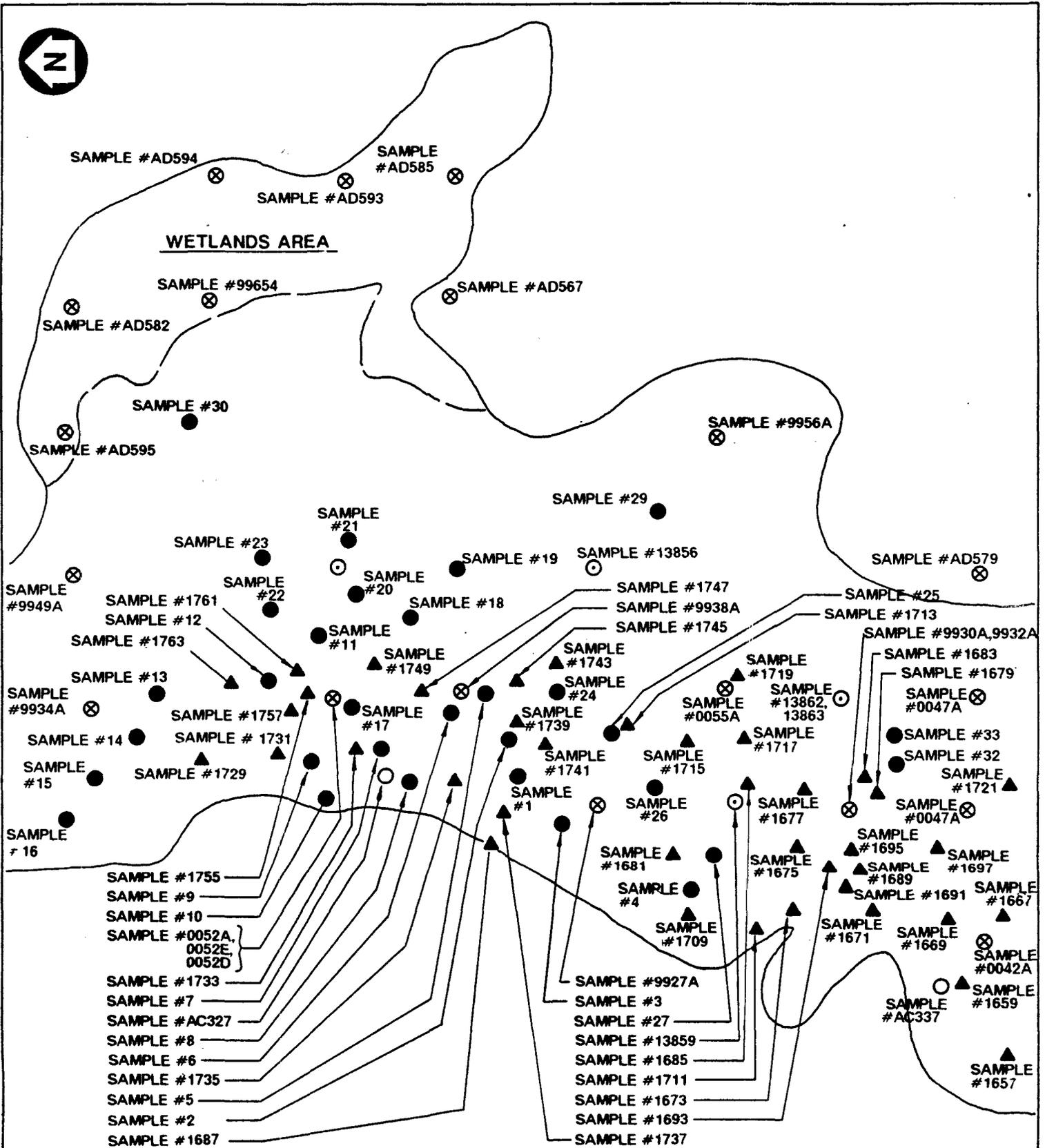
NOTE: Corresponding tables to this section will be provided by Battelle Northwest at a later date.

**FIGURE A-1
PCB SEDIMENT SAMPLING LOCATIONS
DEPTH: ZERO TO 12 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**



- LEGEND**
- BATTLETT HOT SPOT SAMPLING - GROUP 1
 - USACE SAMPLES - GROUP 2
 - ⊙ USACE SAMPLES - GROUP 3
 - ▼ USACE HOT SPOT SAMPLES





SAMPLE #AD594

SAMPLE #AD585

SAMPLE #AD593

SAMPLE #99654

SAMPLE #AD567

SAMPLE #AD582

SAMPLE #30

SAMPLE #9956A

SAMPLE #AD595

SAMPLE #29

SAMPLE #21

SAMPLE #19

SAMPLE #13856

SAMPLE #AD579

SAMPLE #23

SAMPLE #22

SAMPLE #20

SAMPLE #18

SAMPLE #1747

SAMPLE #25

SAMPLE #9949A

SAMPLE #1761

SAMPLE #12

SAMPLE #11

SAMPLE #1749

SAMPLE #9938A

SAMPLE #1745

SAMPLE #1713

SAMPLE #9930A,9932A

SAMPLE #1763

SAMPLE #13

SAMPLE #1757

SAMPLE #17

SAMPLE #1743

SAMPLE #24

SAMPLE #1719

SAMPLE #13862, 13863

SAMPLE #1683

SAMPLE #1679

SAMPLE #0047A

SAMPLE #9934A

SAMPLE #14

SAMPLE #1731

SAMPLE #1739

SAMPLE #1741

SAMPLE #1715

SAMPLE #1717

SAMPLE #33

SAMPLE #32

SAMPLE #1721

SAMPLE #15

SAMPLE #1729

SAMPLE #16

SAMPLE #1755

SAMPLE #9

SAMPLE #10

SAMPLE #0052A, 0052E, 0052D

SAMPLE #1733

SAMPLE #7

SAMPLE #AC327

SAMPLE #8

SAMPLE #6

SAMPLE #1735

SAMPLE #5

SAMPLE #2

SAMPLE #1687

SAMPLE #1681

SAMPLE #4

SAMPLE #1709

SAMPLE #9927A

SAMPLE #3

SAMPLE #27

SAMPLE #13859

SAMPLE #1685

SAMPLE #1711

SAMPLE #1673

SAMPLE #1693

SAMPLE #1737

SAMPLE #1677

SAMPLE #1675

SAMPLE #1675

SAMPLE #1689

SAMPLE #1691

SAMPLE #1669

SAMPLE #1671

SAMPLE #1669

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SAMPLE #1689

SAMPLE #1691

SAMPLE #1669

SAMPLE #1671

SAMPLE #1669

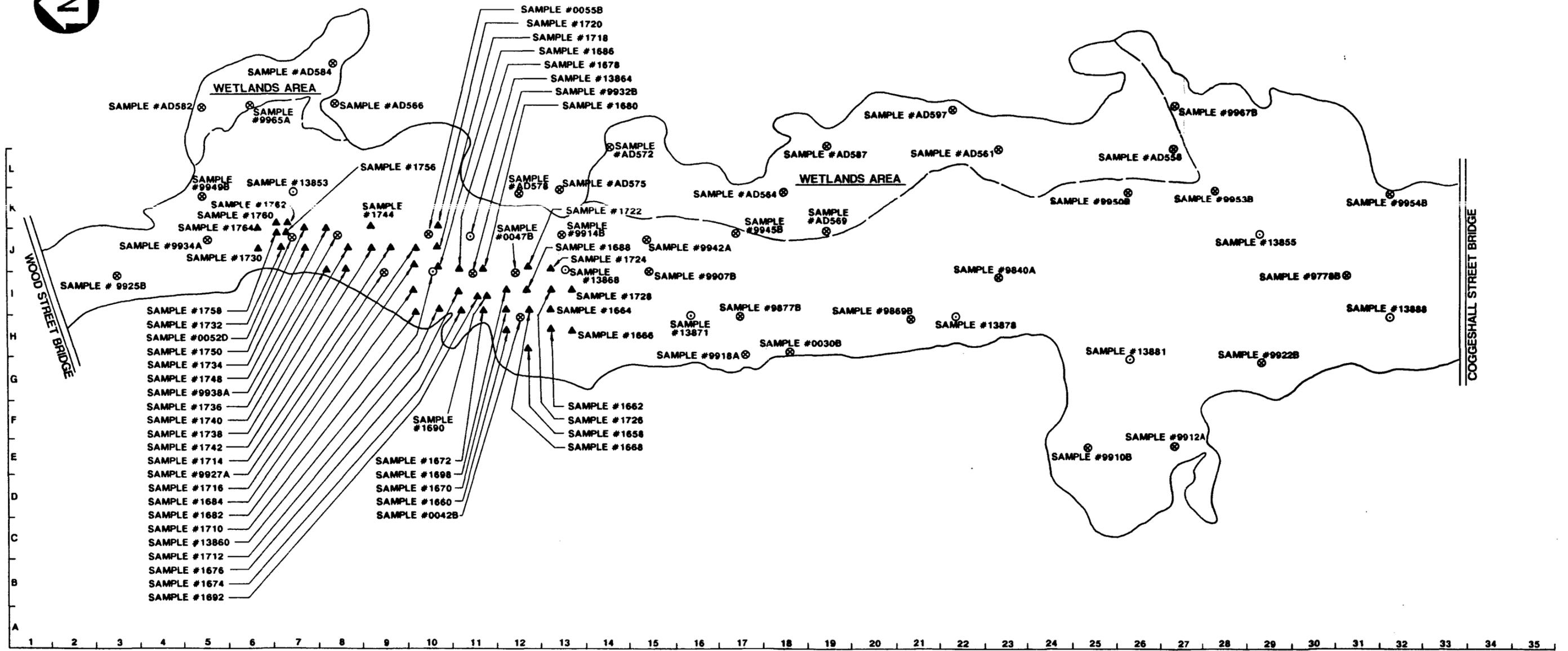
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SAMPLE #0042A

SAMPLE #1659

SAMPLE #AC337

SAMPLE #1659



LEGEND

- ⊙ USACE SAMPLES - GROUP 2
- ⊖ USACE SAMPLES - GROUP 3
- ▲ USACE HOT SPOT SAMPLES



**FIGURE A-2
PCB SEDIMENT SAMPLING LOCATIONS
DEPTH: 12 TO 24 INCHES
HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR**

APPENDIX B
ARARS SUMMARY TABLES

TABLE B-1

ALTERNATIVE HS-1 ARAR EVALUATION
NO ACTION

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS
CHEMICAL-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Surface Water</u>				
State Regulatory Requirement	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE surface water quality standards incorporate the federal AWQC as standards for the surface water of the state.	The no-action alternative would not meet the following water quality criteria: PCBs - 10 ppb (acute effects on aquatic life) - .03 ppb (chronic effects on aquatic life) Cadmium - 43 ppb (acute effects) 9.9 ppb (chronic effects) Copper - 2.9 ppb (acute effects) 2.9 ppb (chronic effects) Lead - 140 ppb (acute effects) 5.6 ppb (chronic effects)
Federal Criteria Advisories and Guidance (FCAG)	Federal Ambient Water Quality Criteria	Applicable	Federal AWQC are health-based criteria that have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQC are incorporated into mass DEQE standards as discussed above.
FCAG	Federal Food, Drug, and Cosmetic Act	To be Considered	This act sets forth FDA limits of 2 ppm for PCB concentrations in commercial fish and shellfish.	The no-action alternative would not contribute to the reduction of PCB concentrations in fish and shellfish to below the 2 ppm FDA limit.

LOCATION-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Wetlands/Floodplains</u>				

-NONE-

TABLE B-1 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
Federal Regulatory Requirements (FRR)	OSHA - General Industry Standards (29 CFR 1910)	Applicable	This regulation specifies the 8-hour, time-weighted average concentration for various organic compounds.	Proper respiratory equipment will be worn by site workers during fence installation if it is not possible to maintain the work atmosphere below these concentrations.
FRR	OSHA - Safety and Health Standards (29 CFR 1926)	Applicable	This regulation specifies the type of safety equipment and procedures to be followed during fence installation.	All appropriate safety equipment will be on-site and procedures will be followed during any site activities.
FRR	OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These regulations are applicable to the company contracted to install the site fence.
State Regulatory Requirements (SRR)	DEQE - Massachusetts Contingency Plan (310 CMR 40.000)	Applicable	These regulations provide the framework for the Commonwealth of Massachusetts to regulate hazardous waste activities in the state.	During remedial design, these regulations will be compared to the corresponding federal CERCLA regulations, and the more stringent requirements will be applicable.
SRR	DPW - Hazardous Substance Right-to-Know (105 CMR 67)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Public Works.	The requirements of this regulation will be attained during institutional control implementation.
SRR	DOL - Hazardous Substance Right-to-Know (441 CMR 21)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Labor.	The requirements of this regulation will be attained during institutional control implementation.
SRR	DEQE - Hazardous Substance Right-to-Know (310 CMR 33)	Applicable	These regulations outline the informational requirements for hazardous substances that may affect workers associated with the Department of Environmental Quality Engineering.	The requirements of this regulation will be attained during long-term environmental monitoring.

TABLE B-2

ALTERNATIVE HS-2 ARAR EVALUATION
DREDGING AND ON-SITE INCINERATION OF PCB-CONTAMINATED SEDIMENT

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS
CHEMICAL-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Surface-Water</u>				
State Regulatory Requirements	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE Surface Water Quality Standards incorporate the federal AWQC as standards for the state surface water.	The dredging activities are not expected to meet the chronic AWQCs for PCBs because the current water column exceeds this value. Dredging will be implemented to minimize sediment resuspension and subsequent PCB mobility.
Federal Criteria, Advisories, and Guidance (FCAG)	Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC are health-based criteria that have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQCs are incorporated into mass DEQE standards as outlined above.
FCAG	Federal Food, Drug, and Cosmetic Act	To be Considered	This act sets forth FDA limits of 2 ppm for PCB concentrations in commercial fish and shell fish.	The removal and treatment of the Hot Spot is expected to contribute to the reduction of PCB concentrations in fish and shellfish to below the 2 ppm FDA limit. However, Hot Spot removal is not expected to achieve this level.
<u>Air</u>				
Federal Regulatory Requirements	CAA - National Air Quality Standards (NAQS) (40 CFR 40)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Incinerator emissions will be controlled by Best Available Control Technology such that the regulations are met. In addition, fugitive dust on haul roads and work area will be controlled by water sprays or other dust suppressants.
State Regulatory Requirements	DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Incinerator emissions will be controlled by Best Available Control Technology such that the regulations are met. In addition, fugitive dust on haul roads and work areas will be controlled by water sprays or other dust suppressants.
Federal Criteria, Advisories, and Guidance	Threshold Limit Value (TLVs)	To be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site evaluation risks for incineration activities.

TABLE B-2 (continued)

LOCATION-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Wetlands/Floodplains</u>				
Federal Regulatory Requirements	Clean Water Act (CWA) 40 CFR Part 230	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available.	Dredging and incineration of Hot Spot sediment is not expected to significantly affect any of the wetlands adjacent to the Hot Spot area.
	Fish and Wildlife Coordination Act (16 U.S.C 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Services. This requirement is addressed under CWA Section 404 requirements.	Dredging and incineration of Hot Spot sediment is not expected to significantly affect the wetland areas. U.S. Fish and Wildlife Service will be contacted prior to remedial action.
	RCRA Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	The incinerator and associated equipment will be located outside of the 100-year floodplain of Acushnet River Estuary.
	Coastal Zone Management Act (15 CFR 930, 923.45)	Applicable	Any federal agency proposing to do work in a state's coastal zone must submit to the state a consistency determination 90 days before approval is required.	A consistency determination will be submitted to the state at 90 percent completion of remedial design.
State Regulatory Requirements	DEQE - Wetlands Protection (310 CMR 10.00)	Applicable	These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated.	Dredging and incineration of Hot Spot sediment is not expected to occur within 100 feet of a wetland or to significantly affect the adjacent wetland area.
	Environmental Affairs - Coastal Zone Management Program (301 CMR 20-22)	Applicable	These regulations outline Massachusetts requirements for compliance with the Coastal Zone Management Act.	As discussed above, a consistency determination outlining the proposed activities and their potential environmental impacts and associated mitigative impacts will be submitted at 90 percent completion of remedial design.
Federal Nonregulatory Requirements to be Considered	Wetlands Executive Order (EO 11990)	Applicable	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	Dredging and incineration of Hot Spot sediment is expected to have a minimal effect on adjacent wetlands.
	Floodplains Executive Order (EO 11988)	Applicable	Federal agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	Dredging of sediment from the Hot Spot is expected to have minimal impact on the floodplain of the Acushnet River.

TABLE B-2 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
Federal Regulatory Requirements (FRR)	RCRA - General Facility Standards (40 CFR 264.10 - 264.18)	Relevant and Appropriate	General facility requirements outlining general waste analysis, security measures, inspections, training, and location standards.	Facility will be constructed, fenced, and operated in accordance with this requirement. All workers will be properly trained. A written waste analysis plan must be developed and maintained on-site. Site entry must be prevented by a 24-hour surveillance system and appropriate signs posted. A written inspection program must be developed, and all personnel must complete an on-the-job training program to ensure facility compliance.
FRR	RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.37)	Relevant and Appropriate	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed on-site; local authorities will be familiarized with the site.
FRR	RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	Relevant and Appropriate	Every hazardous waste facility must have a contingency plan that is implemented immediately upon fire, explosion, or release of harmful hazardous waste constituents.	Plans will be developed during remedial design. Copies of the plans will be kept on-site.
FRR	RCRA - Releases from Hazardous Waste Management Units (40 CFR 264.90 - 264.109)	Relevant and Appropriate	This regulation details the requirements for a groundwater monitoring program to be installed on-site.	A groundwater monitoring program will be designed, installed, and operated to assess groundwater contamination.
FRR	RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	Relevant and Appropriate	This regulation details the specific requirements for closure and post-closure of hazardous waste facilities.	Incinerated sediment, if deemed hazardous, will be solidified prior to on-site disposal. A 30-year post-closure program must include groundwater monitoring. A notation on the deed to the property must be recorded that will notify any potential purchaser that the land has been used to manage hazardous waste. An impermeable cap will be constructed on top of the CDF disposal area.
FRR	RCRA - Incinerators (40 CFR 264.340 - 264.599)	Applicable	This regulation specifies the performance standards, operating requirements, monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	At closure, all wastes, residues, ash, and effluents will be placed in an on-site disposal area.
FRR	RCRA Regulations on Land Disposal Restrictions (40 CFR 268)	Relevant and Appropriate	This regulation outlines land disposal requirements and restrictions for hazardous waste.	Contaminated sediment would be treated to the Best Demonstrated Available Technology levels before being placed or replaced on the land. Hazardous waste cannot be stored except for accumulation for recovery, treatment, or disposal.

TABLE B-2 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	RCRA - Waste Piles (40 CFR 264.250 - 264.269)	Relevant and Appropriate	Details procedures, operating require- ments, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated soil is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste may comply with either the waste pile or landfill requirements. The solidification of the incinerator ash on-site, therefore, may need to comply with either subpart.
FRR	TSCA - Storage and Disposal (40 CFR 761.60 - 761.79)	Applicable	These regulations specify the disposal/ destruction requirements of PCB materials in excess of 50 ppm.	The requirements of this regulation will be attained during remedial action. Test burns will be required to maximize PCB destruction efficiencies.
FRR	OSHA - General Industry Standards (29 CFR Part 1910)	Applicable	These regulations specify the 8-hour, time-weighted average concentrations for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
FRR	OSHA - Safety and Health Standards for Federal Service Contracts (29 CFR 1926)	Applicable	This document contains instructions concerning worker safety at RCRA or Superfund hazardous waste facilities.	All appropriate safety equipment will be on-site, and appropriate procedures will be followed during remediation.
FRR	OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines OSHA recordkeep- ing and reporting regulations for an employer.	This regulation will be applicable to the con- struction company(s) contracted to set up the facility and perform the decontamination process on-site.
FRR	Protection of Archaeological Resources (32 CFR Part 229, 229.4)	Relevant and Appropriate	These regulations develop procedures for the protection of archaeological resources.	If archaeological resources are encountered during sediment dredging, work will stop until the area has been reviewed by federal and state archaeologists.
FRR	CWA - 40 CFR, R5	Applicable	This regulation specifies that a best management program (BMP) be developed to minimize pollutants release from the facility.	A BMP will be developed and will include sedimentation control around the excavation areas, and fugitive dust control.
FRR	CWA - Permits for Dredged and Fill Material (Section 404)	Applicable	This regulation states that no alternative that impacts a wetland shall be permitted if there is a practicable alternative that has less impact on the wetland. If there is no practicable alternative, impacts must be mitigated.	Dredging of Hot Spot sediment will be conducted to minimize impacts to the estuary and adjacent wetland areas.
FRR	National Environmental Policy Act (40 CFR 6)	Applicable	This act sets forth the policy for carrying out the provisions of the Floodplain Management and the Protection of Wetlands Executive Orders.	The policies for management of floodplains and protection of wetlands will be considered during remedial alternative implementation.

TABLE B-2 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1 - 172.558)	Applicable	This regulation outlines procedures for packaging, labelling, manifesting, and transporting hazardous materials.	PCB-contaminated sediment exists. If encountered during decontamination of heavy equipment and personal protective gear, these materials shall be packaged, manifested, and transported to a licensed off-site disposal facility. Waste must have registration number with the letters "DOT."
State Regulatory Requirements (SRR)	DEQE - Hazardous Waste Phases I and II (310 CMR 30.00)	Relevant and Appropriate	These regulations specify the Massachusetts requirements for closure and post-closure of hazardous waste facilities.	During remedial design, these regulations will be compared to the corresponding federal RCRA regulations, and the more stringent requirements will be relevant.
SRR	DEQE - Massachusetts Contingency Plan	Applicable	These regulations outline the Commonwealth of Massachusetts' procedures for regulating hazardous waste activities.	During remedial design, these regulations will be compared to the corresponding CERCLA regulations, and the more stringent requirements will be applicable.
SRR	DPW - Hazardous Substance Right-to-Know (105 CMR 67)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Public Works.	The requirements of this regulation will be attained during alternative implementation.
SRR	DOL - Hazardous Substance Right-to-Know (441 CMR 21)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Labor.	The requirements of this regulation will be attained during alternative implementation.
SRR	DEQE - Hazardous Substance Right-to-Know (310 CMR 33)	Applicable	These regulations outline the informational requirements for hazardous substances that may affect workers associated with the Department of Environmental Quality.	The requirements of this regulation will be attained during alternative implementation.

TABLE B-3

ALTERNATIVE HS-3 ARAR EVALUATION
DREDGING, SOLIDIFICATION, AND OFF-SITE DISPOSAL
PCB-CONTAMINATED SEDIMENT

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS
CHEMICAL-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Surface Water</u>				
State Regulatory Requirements	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE Surface Water Quality Standards incorporate the federal AWQC as standards for state surface water.	Dredging activities are not expected to meet the chronic AWQLs for PCBs because the current water column exceeds this value. Dredging will be implemented to minimize sediment resuspension and subsequent PCB mobility.
Federal Criteria, Advisories, and Guidance (FCAG)	Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC are health-based criteria that have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQCs are incorporated into Mass. DEQE standards as outlined above.
FCAG	Federal Food, Drug, and Cosmetic Act	To be Considered	This act sets forth FDA limits of 2 ppm for PCB concentrations in commercial fish and shellfish.	The removal and treatment of the Hot Spot is expected to contribute to the reduction of PCB concentrations in fish and shellfish to below the 2 ppm FDA limit. However, Hot Spot removal is not expected to achieve this level.
<u>Air</u>				
Federal Regulatory Requirements	CAA - National Air Quality Standards (NAQS) (40 CFR 40)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Fugitive dust from the solidification process, haul roads, work areas, and stockpiles will be controlled by water sprays or other dust suppressants.
State Regulatory Requirements	DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Fugitive dust from the solidification process, haul roads, work areas, and stockpiles will be controlled by water sprays or other dust suppressants.
FCAG	Threshold Limit Value (TLV)	To be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site evaluation, risks for the solidification activities.

TABLE B-3 (continued)

LOCATION-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Wetlands/Floodplains</u>				
Federal Regulatory Requirements	Clean Water Act (CWA) (40 CFR Part 230)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available.	Dredging and solidification of Hot Spot sediment is not expected to significantly affect any of the wetlands adjacent to the Hot Spot area.
	Fish and Wildlife Coordination Act (16 U.S.C 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Services. This requirement is addressed under CWA Section 404 requirements.	Dredging and solidification of Hot Spot sediment is not expected to significantly affect wetland areas. U.S. Fish and Wildlife Services will be contacted prior to remedial action.
	RCRA Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	Solidification and associated equipment will be located outside of the 100-year floodplain of Acushnet River Estuary.
	Coastal Zone Management Act (15 CFR 930, 923.45)	Applicable	Any Federal agency proposing to do work in a state's coastal zone must submit to the state a consistency determination 90 days before approval is required.	A consistency determination will be submitted to the state at 90 percent completion of remedial design.
State Regulatory Requirements	DEQE - Wetlands Protection (310 CMR 10.00)	Applicable	These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated.	Dredging and solidification of Hot Spot sediment is not expected to occur within 100 feet of a wetland or to significantly affect the adjacent wetland area.
	Environmental Affairs - Coastal Zone Management Program (301 CMR 20-22)	Applicable	These regulations outline Massachusetts requirements for compliance with the Coastal Zone Management Act.	As discussed above, a consistency determination outlining proposed activities and their potential environmental impacts and the associated mitigative impacts will be submitted at 90 percent completion of remedial design.
Federal Nonregulatory Requirements to be Considered	Wetlands Executive Order (EO 11990)	Applicable	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	Dredging and solidification of Hot Spot sediment is expected to have a minimal effect on adjacent wetlands.
	Floodplains Executive Order (EO 11988)	Applicable	Federal agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	Dredging of sediment from the Hot Spot is expected to have minimal impact on the floodplain of the Acushnet River.

TABLE B-3 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
Federal Regulatory Requirements (FRR)	RCRA - General Facility Standards (40 CFR 264.10 - 4.18)	Relevant and Appropriate	General facility requirements outlining general waste analysis, security measures, inspections, training, and location standards.	Facility will be constructed, fenced, and operated in accordance with this requirement. All workers will be properly trained. A written waste analysis plan must be developed and maintained on-site. Site entry must be prevented by a 24-hour surveillance system and appropriate signs posted. A written inspection program must be developed, and all personnel must complete an on-the-job training program to ensure facility compliance.
FRR	RCRA - Preparedness and Prevention (40 CFR 4.30 - 264.37)	Relevant and Appropriate	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed on-site; local authorities will be familiarized with the site.
FRR	RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	Relevant and Appropriate	Every hazardous waste facility must have a contingency plan that is implemented immediately upon fire, explosion, or release of harmful hazardous waste constituents.	Plans will be developed and implemented during remedial design. Copies of the plans will be kept on-site.
FRR	RCRA - Releases from Hazardous Waste Management Units (40 CFR 264.90 - 264.109)	Relevant and Appropriate	This regulation details the requirements for a groundwater monitoring program to be installed on-site.	A groundwater monitoring program will be designed, installed, and operated to assess groundwater contamination.
FRR	RCRA - Closure and Post-closure (40 CFR 264.110 -264.120)	Relevant and Appropriate	This regulation details the specific requirements for closure and post-closure of hazardous waste facilities.	The solidified sediments will be contained by placing a cap over the CDF. Sediment will be dewatered and wastes stabilized. A 30-year post-closure program must include groundwater monitoring. A notation on the deed to the property must be recorded that will notify any potential purchaser that the land has been used to manage hazardous waste.
FRR	RCRA Regulations on Land Disposal Restrictions (40 CFR 268)	Relevant and Appropriate	This regulation outlines land disposal requirements and restrictions for hazardous waste.	The Hot Spot sediment is a California Listed Waste because the total halogenated organic compounds exceed 1,000 ppm. Under this regulation, solidification would be considered an alternative treatment technology and would need to achieve a level of performance equivalent to incineration (i.e., 2 ppm) prior to disposal.

TABLE B-3 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	RCRA - Waste Piles (40 CFR 268)	Relevant and Appropriate	Details procedures, operating requirements, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated subsoils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste, may comply with either the waste pile or landfill requirements.
FRR	RCRA - Landfills (40 CFR 264.300 - 364.339)	Applicable	These regulations detail design, operating, monitoring, inspection survey, recordkeeping, and closure and post-closure requirements.	If an on-site landfill is constructed, two liners must be installed to prevent groundwater contamination. A leachate collection system must be placed above and between the liner systems. Monitoring inspections, surveying, and recordkeeping must be conducted in compliance with these requirements. This alternative will not comply with the RCRA landfill requirements.
FRR	TSCA - Storage and Disposal (40 CFR 761.60 - 761.79)	Applicable	These regulations specify the disposal/destruction requirements of PCB materials in excess of 50 ppm.	Solidification is considered an alternative method under TSCA. Bench-scale and treatability testing will be required to demonstrate that solidification achieves a level of performance adequate for off-site disposal. The solidified material will be disposed in a TSCA/RCRA landfill.
FRR	OSHA - General Industry Standards (29 CFR Part 1910)	Applicable	These regulations specify the 8-hour, time-weighted average concentrations for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
FRR	OSHA - Safety and Health Standards for Federal Service Contracts (29 CFR 1926)	Applicable	This document contains instructions concerning worker safety at RCRA or Superfund hazardous waste facilities.	All appropriate safety equipment will be on-site, and appropriate procedures will be followed during remediation.
FRR	OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines OSHA recordkeeping and reporting regulations for an employer.	This regulation will be applicable to the construction company(s) contracted to set up the facility and perform the solidification process on-site.
FRR	Protection of Archaeological Resources (32 CFR Part 229, 229.4)	Relevant and Appropriate	These regulations develop procedures for the protection of archaeological resources.	If archaeological resources are encountered during dredging, work will stop until the area has been reviewed by federal and state archaeologists.
FRR	CWA - 40 CFR, R5	Applicable	This regulation specifies that a best management program (BMP) be developed to minimize pollutant release from the facility.	A BMP will be developed and implemented during remedial action.

TABLE B-3 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	CWA - Permits for Dredged and Fill Material (Section 404)	Applicable	This regulation states that no alternative that impacts a wetland shall be permitted if there is a practicable alternative that has less impact on the wetland. If there is no practicable alternative, impacts must be mitigated.	Dredging of Hot Spot sediment will be conducted to minimize impacts to the estuary and adjacent wetland areas.
FRR	National Environmental Policy Act (40 CFR 6)	Applicable	This act sets for the policy for carrying out the provisions of the Floodplain Management and the Protection of Wetlands Executive Orders.	The policies for management of floodplains and protection of wetlands will be considered during remedial alternative implementation.
FRR	DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1 - 172.558)	Applicable	This regulation outlines procedures for the packaging, labelling, manifesting, and transporting of hazardous materials.	PCB-contaminated sediment will be solidified on-site. This material shall be packaged, manifested, and transported to a licensed off-site disposal facility. Waste must have registration number with the letters "DOT."
State Regulatory Requirements (SRR)	DEQE - Hazardous Waste Phases I and II (310 CMR 30.00)	Relevant and Appropriate	These regulations specify the Commonwealth of Massachusetts requirements for hazardous waste facilities.	During remedial design, these regulations will be compared to the corresponding federal RCRA regulations, and the more stringent requirements will be relevant.
SRR	DEQE - Massachusetts Contingency Plan	Applicable	These regulations outline the Commonwealth of Massachusetts procedures for regulating hazardous waste activities.	During remedial design, these regulations will be compared to the corresponding CERCLA regulations, and the more stringent requirements will be applicable.
SRR	DPW - Hazardous Substance Right-to-Know (105 CMR 67)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Public Works.	The requirements of this regulation will be attained during alternative implementation.
SRR	DOL - Hazardous Substance Right-to-Know (441 CMR 21)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Labor.	The requirements of this regulation will be attained during alternative implementation.
SRR	DEQE - Hazardous Substance Right-to-Know (310 CMR 33)	Applicable	These regulations outline the informational requirements for hazardous substances that may affect workers associated with the Department of Environmental Quality.	The requirements of this regulation will be attained during alternative implementation.

TABLE B-4

ALTERNATIVE HS-4 ARAR EVALUATION
DREDGING AND SOLVENT EXTRACTION OF PCB-CONTAMINATED SEDIEMNT

HOT SPOT FEASIBILITY STUDY
NEW BEDFORD HARBOR, MASSACHUSETTS
CHEMICAL-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Surface Water</u>				
State Regulatory Requirements	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE Surface Water Quality Standards incorporate the federal AWQC as standards for the state surface water.	Dredging activities are not expected to meet the chronic AWQLs for PCBs because the current water column exceeds this value. Dredging will be implemented to minimize sediment resuspension and subsequent PCB mobility.
Federal Criteria, Advisories, and Guidance (FCAG)	Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC are health-based criteria that have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQCs are incorporated into Mass. DEQE standards as outlined above.
FCAG	Federal Food, Drug, and Cosmetic Act	To be Considered	This act sets forth FDA limits of 2 ppm for PCB concentrations in commercial fish and shellfish.	The removal and treatment of the Hot Spot is expected to contribute to the reduction of PCB concentrations in fish and shellfish to below the 2 ppm FDA limit. However, Hot Spot removal is not expected to achieve this level.
<u>Air</u>				
Federal Regulatory Requirements	CAA - National Air Quality Standards (NAQS) (40 CFR 40)	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Emissions from the solvent extraction unit will be controlled by Best Available Control Technology such that the regulations are met. In addition, fugitive dust on haul roads and work areas will be controlled by water sprays or other dust suppressants.
State Regulatory Requirements	DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00).	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Emissions from the solvent extraction unit will be controlled by Best Available Control Technology such that the regulations are met. In addition, fugitive dust on haul roads and work areas will be controlled by water sprays or other dust suppressants.
FCAG	Threshold Limit Value (TLV)	To be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site evaluation risks for the solvent extraction activities.

TABLE B-4 (continued)

LOCATION-SPECIFIC ARARS

MEDIUM/AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
<u>Wetlands/Floodplains</u>				
Federal Regulatory Requirements	Clean Water Act (CWA) 40 CFR Part 230	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available.	Dredging and solvent extraction of Hot Spot sediment is not expected to significantly affect any of the wetlands adjacent to the Hot Spot area.
	Fish and Wildlife Coordination Act (16 U.S.C 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Services. This requirement is addressed under CWA Section 404 requirements.	Dredging and solvent extraction of Hot Spot sediment is not expected to significantly affect wetland areas. U.S. Fish and Wildlife Service will be contacted prior to remedial action.
	RCRA Location Standards (40 CFR 264.18)	Relevant Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	The solvent extraction unit and associated equipment will be located outside of the 100-year floodplain of Acushnet River Estuary.
	Coastal Zone Management Act (15 CFR 930, 923.45)	Applicable	Any federal agency proposing to do work in a state's coastal zone must submit to the state a consistency determination 90 days before approval is required.	A consistency determination will be submitted to the state at 90 percent completion of remedial design.
State Regulatory Requirements	DEQE - Wetlands Protection (310 CMR 10.00)	Applicable	These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated.	Dredging and solvent extraction of Hot Spot sediment is not expected to occur within 100 feet of a wetland or to significantly affect the adjacent wetland area.
	Environmental Affairs - Coastal Zone Management Program (301 CMR 20-22)	Applicable	These regulations outline Massachusetts requirements for compliance with the Coastal Zone Management Act.	As discussed above, a consistency determination outlining the proposed activities and their potential environmental impacts and the associated mitigative impacts will be submitted at 90 percent completion of remedial design.
Federal Nonregulatory Requirements to be Considered	Wetlands Executive Order (EO 11990)	Applicable	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	The dredging and solvent extraction of Hot Spot sediment is expected to have a minimal effect on adjacent wetlands.
	Floodplains Executive Order (EO 11988)	Applicable	Federal agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	Dredging of Hot Spot sediment is expected to have minimal impact on the floodplain of the Acushnet River.

TABLE B-4 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
Federal Regulatory Requirements (FRR)	RCRA - General Facility Standards (40 CFR 264.10 - 264.18)	Relevant and Appropriate	General facility requirements outlining general waste analysis, security measures, inspections, training, and location standards.	Facility will be constructed, fenced, and operated in accordance with this requirement. All workers will be properly trained. A written waste analysis plan must be developed and maintained on-site. Site entry must be prevented by a 24-hour surveillance system and appropriate signs posted. A written inspection program must be developed, and all personnel must complete an on-the-job training program to ensure facility compliance.
FRR	RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.37)	Relevant and Appropriate	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed on-site; local authorities will be familiarized with the site.
FRR	RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	Relevant and Appropriate	Every hazardous waste facility must have a contingency plan that is implemented immediately upon fire, explosion, or release of harmful hazardous waste constituents.	Plans will be developed during remedial design. Copies of the plans will be kept on-site.
FRR	RCRA - Releases from Hazardous Waste Management Units (40 CFR 264.90 - 264.109)	Relevant and Appropriate	This regulation details the requirements for a groundwater monitoring program to be installed on-site.	A groundwater monitoring program will be designed, installed, and operated to assess groundwater contamination.
FRR	RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	Relevant and Appropriate	This regulation details the specific requirements for closure and post-closure of hazardous waste facilities.	Treated sediment, if deemed hazardous, will be solidified prior to on-site disposal. A 30-year post-closure program must include groundwater monitoring. A notation on the deed to the property must be recorded that will notify any potential purchaser that the land has been used to manage hazardous waste.
FRR	RCRA - Incinerators (40 CFR 264.340 - 264.599)	Relevant	This regulation specifies the performance standards, operating requirements, monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	At closure, all wastes, residues, ash, and effluents will be placed in an on-site disposal area.
FRR	RCRA Regulations on Land Disposal Restrictions (40 CFR 268)	Relevant and Appropriate	This regulation outlines land disposal requirements and restrictions for hazardous waste.	The Hot Spot sediment is a California Listed Waste because the total halogenated organic compounds exceed 1,000 ppm. Under this regulation, solvent extraction would be considered an alternative treatment technology and would need to achieve a level of performance equivalent to incineration prior to disposal.

TABLE B-4 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	RCRA - Waste Piles (40 CFR 264.250 - 264.269)	Relevant and Appropriate	Details procedures, operating require- ments, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated soils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste, may comply with either the waste pile or landfill requirements. The covering of the incinerator ash on-site, therefore, must comply with either subpart.
FRR	TSCA - Storage and Disposal (40 CFR 761.60 - 761.79)	Applicable	These regulations specify the disposal/ destruction requirements of PCB materials in excess of 50 ppm.	Solvent extraction would be considered an alternative treatment technology and would need to achieve a level of performance equivalent to incineration prior to disposal. This regulation is also applicable to the off-site incineration of the PCB extract.
FRR	OSHA - General Industry Standards (29 CFR Part 1910)	Applicable	These regulations specify the 8-hour, time-weighted average concentrations for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
FRR	OSHA - Safety and Health Standards for Federal Service Contracts (29 CFR 1926)	Applicable	This document contains instructions concerning worker safety at RCRA or Superfund hazardous waste facilities.	All appropriate safety equipment will be on-site, and appropriate procedures will be followed during remediation.
FRR	OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines OSHA recordkeep- ing and reporting regulations for an employer.	This regulation will be applicable to the con- struction company(s) contracted to set up the facility and perform the decontamination process on-site.
FRR	Protection of Archaeological Resources (32 CFR Part 229, 229.4)	Relevant and Appropriate	These regulations develop procedures for the protection of archaeological resources.	If archaeological resources are encountered during dredging, work will stop until the area has been reviewed by federal and state archaeologists.
FRR	CWA - 40 CFR, R5	Applicable	This regulation specifies that a best management program (BMP) be developed to minimize pollutants release from the facility.	A BMP will be developed and followed during remedial activities.
FRR	CWA - Permits for Dredged and Fill Material (Section 404)	Applicable	This regulation states that no alternative that impacts a wetland shall be permitted if there is a practicable alternative that has less impact on the wetland. If there is no practicable alternative, impacts must be mitigated.	Potential impacts associated with erosion, sedimentation, and resuspension of sediment will be mitigated.
FRR	National Environmental Policy Act (40 CFR 6)	Applicable	This act sets for the policy for carrying out the provisions of the Floodplain Management and the Protection of Wetlands Executive Orders.	The policies for management of floodplains and protection of wetlands will be considered during remedial alternative implementation.

TABLE B-4 (continued)

ACTION-SPECIFIC ARARS

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CORRESPONDING REMEDIAL ACTION(S)
FRR	DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1 - 172.558)	Applicable	This regulation outlines procedures for packaging, labelling, manifesting, and transporting hazardous materials.	PCB-contaminated sediment exists. If encountered during decontamination of heavy equipment and personal protective gear, these materials shall be packaged, manifested, and transported to a licensed off-site disposal facility. Waste must have registration number with the letters "DOT."
State Regulatory Requirements (SRR)	DEQE - Hazardous Waste Phases I and II (310 CMR 30.00)	Relevant and Appropriate	These regulations specify the Massachusetts requirements for closure and post-closure of hazardous waste facilities.	During remedial design, these regulations will be compared to the corresponding federal RCRA regulations, and the more stringent requirements will be relevant.
SRR	DEQE - Massachusetts Contingency Plan	Applicable	These regulations outline the Commonwealth of Massachusetts procedures for regulating hazardous waste activities.	During remedial design, these regulations will be compared to the corresponding CERCLA regulations, and the more stringent requirements will be applicable.
SRR	DPW - Hazardous Substance Right-to-Know (105 CMR 67)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Public Works.	The requirements of this regulation will be attained during alternative implementation.
SRR	DOL - Hazardous Substance Right-to-Know (441 CMR 21)	Applicable	These regulations detail the informational requirements for hazardous substances used by the Massachusetts Dept. of Labor.	The requirements of this regulation will be attained during alternative implementation.
SRR	DEQE - Hazardous Substance Right-to-Know (310 CMR 33)	Applicable	These regulations outline the informational requirements for hazardous substances that may affect workers associated with the Department of Environmental Quality.	The requirements of this regulation will be attained during alternative implementation.