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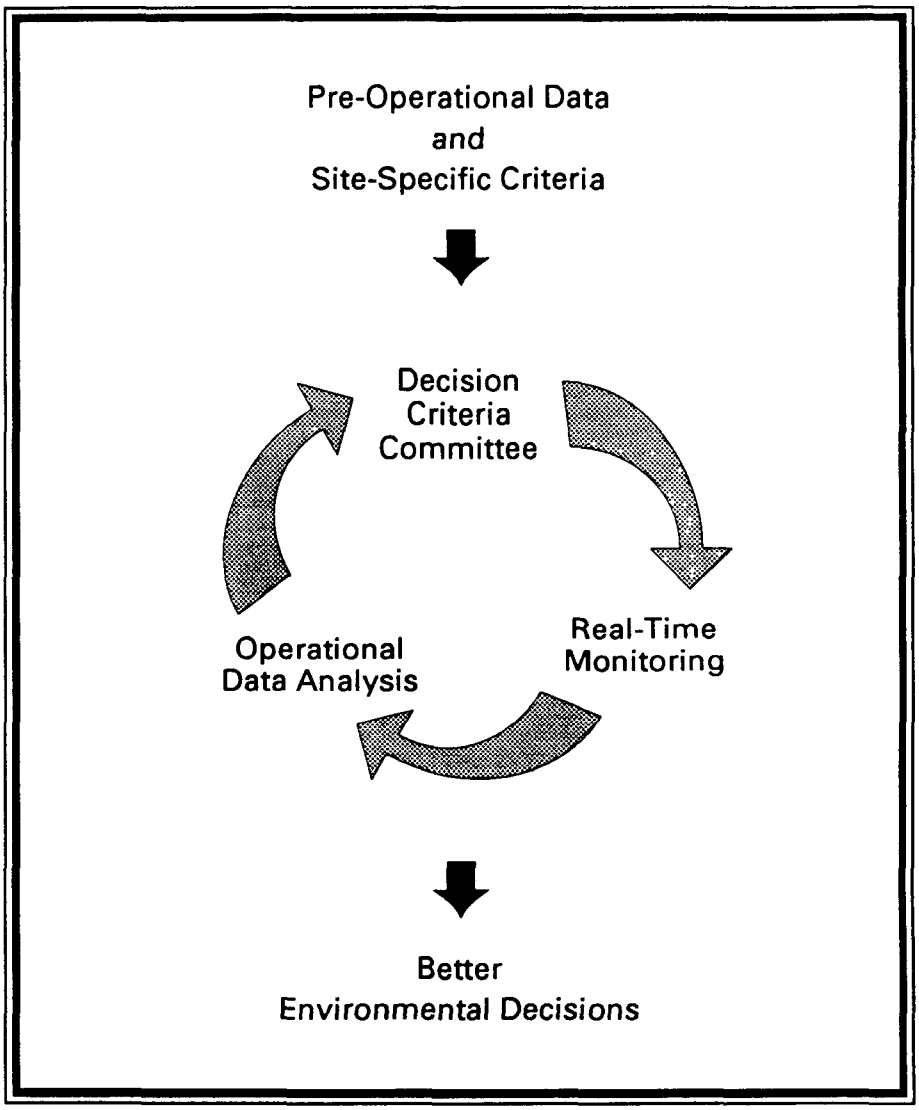
A Framework for Real-Time Decision-Making

New Bedford Harbor Pilot Dredging Study



PREFACE

Numerical water quality criteria have been employed by EPA in the protection of the environment for decades. Biological tests and analytical chemical procedures have been developed to assess the state of environmental quality based on these criteria. Numerous monitoring programs have been implemented to collect those data necessary to make decisions based on criteria values.

This technology transfer document provides an overview of a unique project that incorporates each component listed above into a "real-time" decision making framework. It was successfully used in a pilot study to determine whether dredging posed an "unacceptable" hazard as a remediation option at the New Bedford Harbor Superfund Site in Massachusetts. It represents a framework that can be employed at other locations to provide environmental protection during clean-up operations.

The successful completion of this project is the result of a team effort of over 80 individuals from the Federal and contract staff at our laboratory, as well as EPA Region I, the U.S. Army Corps of Engineers, and the State of Massachusetts' Department of Environmental Protection. This effort was part of a pilot study, therefore, any comments, suggestions, or other input are welcome.

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INTRODUCTION

New Bedford Harbor (NBH) is located along Buzzards Bay between the cities of New Bedford and Fairhaven, Massachusetts (Fig. 1). Since the 1940's, electronics and manufacturing companies in the area have discharged effluents containing polychlorinated biphenyls (PCBs) into the Acushnet River and the harbor. High PCB concentrations in river and harbor sediments were first documented in 1974 (Connelly and St. John, 1988). Over the past 15 years, nearly 18,000 acres of PCB- and heavy metals-contaminated sediment have been identified, with PCB concentrations as high as 100,000 parts per million (ppm) in some areas of the upper harbor. In 1982, the site was added to the Environmental Protection Agency's (EPA) National Priorities List of hazardous waste sites slated for cleanup under the Superfund Act.

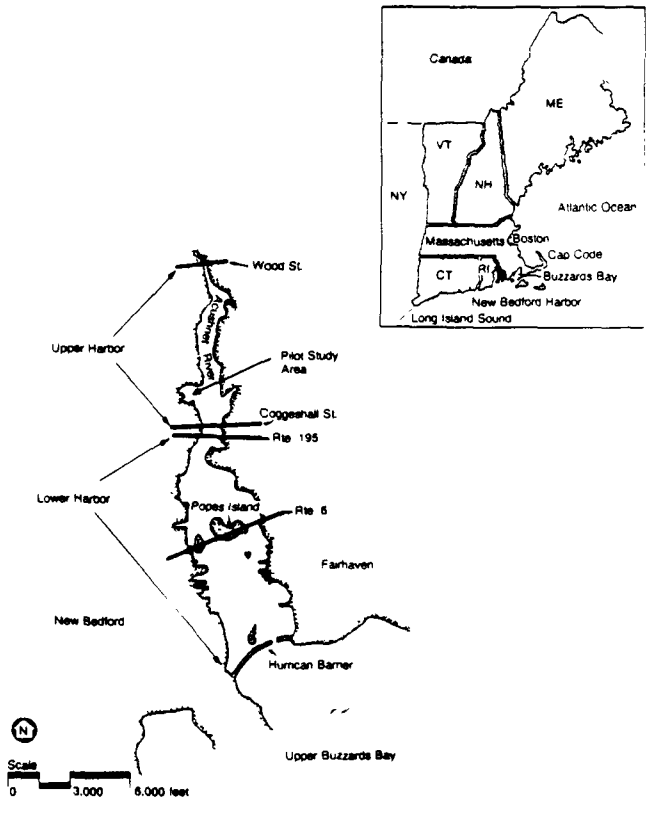


FIGURE 1.

A feasibility study conducted by EPA in 1984 proposed several alternatives for the remediation of NBH. One option common to most

remediation alternatives included dredging contaminated sediments out of the harbor. Federal, State, and local officials, as well as the public, expressed concern over dredging. Many believed that sediments resuspended during dredging would cause the release of contaminants that would affect biota inhabiting both the harbor and Buzzards Bay. Others cited potential pollution problems from contaminated water (leachate) leaking from the proposed disposal site (Averett and Francigues, 1988).

In order to address these concerns, the EPA decided to pre-test dredging and possible disposal options. Working with the U.S. Army Corps of Engineers (COE), EPA Region I designed a pilot study to examine dredging as a remediation option for the Superfund Site. A monitoring plan (including biological, chemical, and physical measurements) for all aspects of the Pilot Project was designed and implemented by EPA's Environmental Research Laboratory, Narragansett, R.I. (ERL-N). This technical transfer document summarizes the decision-making process and the "real-time" monitoring data used by project managers to assess the environmental "acceptability" of the dredging operation on a day-to-day basis. Subsequent publications will provide greater detail of the monitoring program with respect to evaluation of dredging and disposal options.

PILOT DREDGING PROJECT DESCRIPTION

The NBH Pilot Project was designed to examine and compare the efficiency and effects of three hydraulic dredges and two disposal methods for use in a possible large scale remediation with more highly contaminated sediment at the NBH Superfund Site. The COE selected dredges capable of removing sediment with

minimal resuspension as well as their ability to operate in the shallow water at the Pilot Study site. The two disposal methods investigated included: 1) a confined disposal facility (CDF), which required construction of a containment dike partially in-water and partially on land; and 2) a confined aquatic disposal cell (CAD), an in situ underwater disposal method (Otis, 1987).

MONITORING STRATEGY/DECISION-MAKING FRAMEWORK

Evaluations of possible unacceptable contamination due to dredging during the Pilot Study was complicated by the fact that Federal and State water quality standards for PCBs and certain heavy metals were exceeded in NBH under preoperational baseline conditions. In addition, the U.S. Food and Drug Administration (FDA) action level for PCBs in seafood was exceeded and sediments were known to be toxic.

Because of these special conditions, typical monitoring program and management strategies were inappropriate. Therefore, it was necessary to develop a unique site-specific monitoring/management strategy for NBH (Fig 2). This framework included several unique aspects: 1) the development of a set of site-specific numerical decision values, the Decision Criteria, 2) the establishment of a panel of environmental managers, the Decision Criteria Committee (DCC), to use those data in a timely manner,

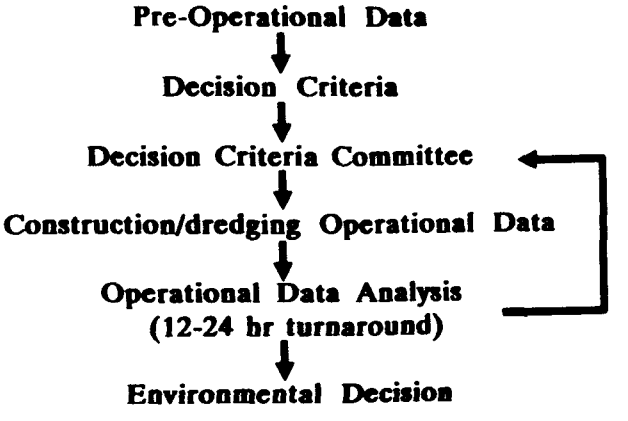


FIGURE 2.

provide the necessary environmental data to the DCC in a rapid time-frame (12-24 hours). This approach provided an effective feedback loop to evaluate, modify or terminate the dredging operation if environmental risks were unacceptable.

Each aspect of this strategy was successfully implemented. The site-specific Decision Criteria were established for a number of physical, chemical, and biological parameters based on data collected prior to the initiation of dredging. The DCC was formed with representatives from each of the principal parties involved in the study: EPA Region I, COE, Massachusetts Department of Environmental Protection, and ERL-N. A monitoring plan was developed to collect samples during the dredging and disposal operations, complete sample analysis within 24 hours, and compare those results to the Decision Criteria values. If the Decision Criteria values were exceeded, the DCC could require engineering corrections to the dredging operation before work was resumed, or termination of the project if environmental effects were judged excessive. The Pilot Project was completed successfully and environmental risks minimized by modification of dredging activities whenever transitory increases above Decision Criteria values were detected.

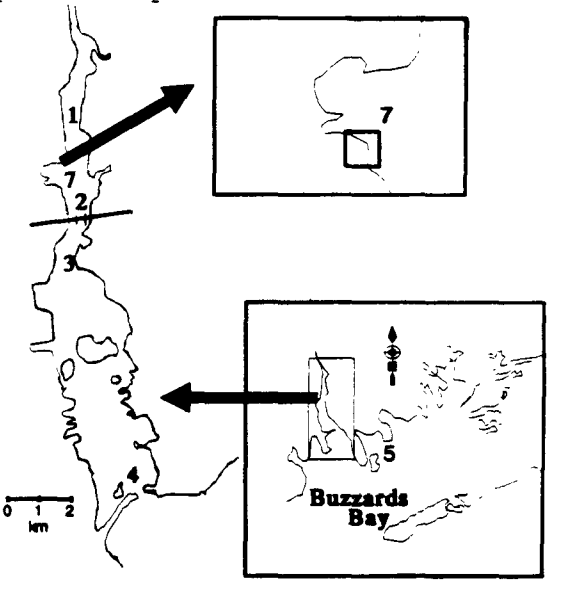
MONITORING PLAN

The philosophy adopted by the DCC during this project was that some "short-term environmental impact was worth long-term improvement in water quality." Station locations for the Decision Criteria were selected to reflect this principle. Some short-term minor increases in water chemical concentrations and chronic biological impacts in the immediate vicinity of the dredging

and chronic biological impacts in the immediate vicinity of the dredging operation, at Station NBH-2, were considered acceptable. However, any far-field impacts affecting Buzzards Bay were deemed not acceptable. This was accomplished by including a second strategic station at the Hurricane Barrier, Station NBH-4, representing the transition between NBH and Buzzards Bay.

The Pilot Project employed a suite of biological, chemical, and physical monitoring techniques used at ERL-N. The biological procedures ranged from the short-term acute and chronic methods used in the Complex Effluent Toxicity Testing Program (CETTP) (US EPA, 1988) to in situ mussel deployments (Nelson, et al., 1987). Before any operations were begun by the COE, baseline physical, chemical, and biological measurements were completed. The biological measurements were used to assess the effects of existing water quality on plant and animal survival, growth, and reproduction. These tests served as a benchmark against which increased contamination and/or toxicity associated with the operational phases of the study were compared.

Five stations were selected for water quality monitoring, four in NBH, and a reference station in Buzzards Bay (Fig 3). Station NBH-1 was located north of the dredge site; Station NBH-7 was adjacent to the cove where dredging occurred; Station NBH-2 was at the Coggeshall St. Bridge, the transition point between the more severely polluted upper harbor and



NEW BEDFORD HARBOR

FIGURE 3.

point between NBH proper and Buzzards Bay.

The reference station for all water quality toxicity tests was NBH-5, located at West Island in Buzzards Bay. Mussels were deployed at stations NBH-2, NBH-3, NBH-4, and NBH-5. Only two of these stations, NBH-2 and NBH-4, were used in the Decision Criteria because of their strategic locations.

Seawater samples were collected separately for the ebb and flood tide at each NBH station. Flow proportional collections at NBH-2 allowed estimation of net transport. Each water sample was analyzed for total suspended solids, PCBs, copper, cadmium, and lead. In addition, biological measurements were completed including acute toxicity tests (survival of fish, mysids, mussels, a red alga, and the sea urchin sperm cell fertilization test) and chronic toxicity tests (fish growth, mysid growth and reproduction, mussel scope for growth, and algal reproduction).

Once the operational phases of the Pilot Project began, water samples were collected identical to those of the preoperational phase, however, the ebb tide samples were returned to ERL-N immediately, and chemical analyses and acute biological tests were completed overnight. These results were transmitted to the Decision Criteria Committee prior to the start of that days' dredging to assess any adverse environmental impacts and make any necessary adjustments to the operation. This "real-time" monitoring allowed the managers of this project to make timely decisions based on actual data, thus ensuring the best degree of environmental protection possible.

SUMMARY OF RESULTS

Physical. Total suspended sediment (TSS) measurements at the sampling stations indicated that the dredging operation resulted in little or no increase in TSS concentrations over background levels. On one occasion an increase in TSS concentration occurred at NBH-2 due to an accidental opening of the silt screen around the operation site. This resulted in the release of a plume from the construction site. The problem was quickly rectified and never reoccurred.

Water Chemistry. During the operational phases of the project, PCB concentrations at NBH-2 exceeded the Decision Criteria values on four occasions (Fig 4). Three of these instances were attributed to specific causative operational events (Fig 5). In all cases, modification of the operation resulted in lowered PCB water concentrations the following day. The only other exceedence was due to a meterological event; 50 mph winds at low tide caused resuspension of contaminated sediment in the upper harbor. The Decision Criteria value for lead was

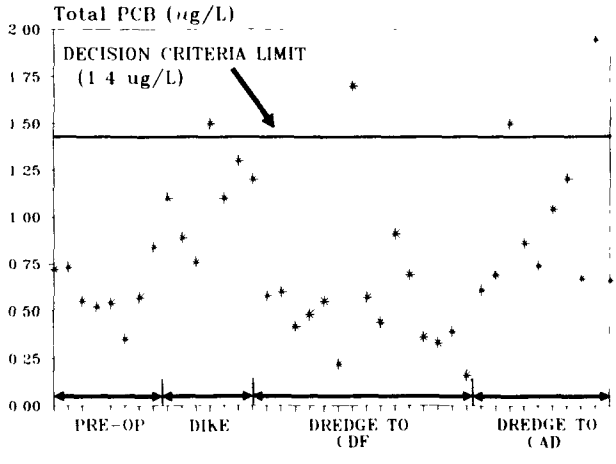


FIGURE 4.

INCIDENCE OF EXCEEDENCE OF DECISION CRITERIA VALUES

Operation Phase	Cause of Increase	Decision Criteria Committee Response
Dike	Mud Wave	Change Construction Procedure for Dike
CDF	Storm Event	Continue Operation
CAD	Dredging Depth	Alter Dredging Procedure
CAD	Diffuser Depth	Lower Diffuser

FIGURE 5.

exceeded at NBH-2, however, because this occurred during the same storm it was judged not to be related to the operation.

Mussel Chemistry. Mussels deployed in NBH showed a distinct spatial and temporal pattern with respect to PCB uptake. The PCB concentrations in mussel tissues from the preoperational deployments were highest in the upper harbor (NBH-2) and decreased moving down the harbor (NBH-4). PCB tissue concentrations also increased with length of exposure. Concentrations of PCBs in mussel tissues during the operational phases were not significantly elevated, indicating no increased bioavailability of PCBs due to the dredging operation.

Biological Tests. The short-term biological tests employed in this project demonstrated sporadic toxicity immediately adjacent to the dredging area (NBH-7). Reproduction in the red alga, Champia parvula, was consistently reduced and on one occasion fertilization was reduced in the sea urchin (Arbacia punctulata) sperm cell test. No effects were detected on growth or survival in the sheepshead minnow, Cyprinodon variegatus, or on growth or reproduction of the mysid, Mysidopsis bahia. The SFG of mussels never exceeded the Decision Criteria values. The acute and chronic toxicity tests indicated no unacceptable biological impacts from this project.

CONCLUSIONS

The New Bedford Harbor Pilot Dredging Project demonstrated the utility of biological, chemical, and physical monitoring techniques to evaluate, on a "real-time" basis, the environmental risks of a dredging operation. A set of site-specific criteria were developed and utilized by environmental managers to assess, on a day-to-day basis, the impacts of this dredging operation on water quality in NBH.

Monitoring data indicated that the dredging operation had a minimal effect on existing water quality. On those occasions when elevated PCB concentrations were detected, they were attributed to a specific causative operational procedure or meteorological event. Operational modifications were implemented effectively, thus limiting any environmental damage.

It would be unrealistic to expect to complete a Superfund remediation at an aquatic site with absolutely zero short-term impact. However, this program successfully established a set of limits (Decision Criteria) beyond which the impact was considered unacceptable, and a mechanism (real-time monitoring program) which provided the information necessary for environmental managers (Decision Criteria Committee) to effectively oversee this project to completion.

References

Averett, D.E. and N.R. Francingues, Jr. 1988. A case study: dredging as a remedial action alternative for New Bedford Harbor, Massachusetts. Superfund '88. Proceedings of the 9th National Conference. The Hazardous Materials Control Research Institue, pp 338-342.

Connelly, J.P. and J.P. St. John. 1988. Application of a mathematical food chain model to evaluate remedial alternatives for PCB-contaminated sediments in New Bedford Harbor, Massachusetts. Superfund '88. Proceedings of the 9th National Conference. The Hazardous Materials Control Research Institue, pp 359-362.

Nelson, W.G., D.K. Phelps, W.B. Galloway, R. Pruell, and P. Rogerson. 1987. Effects of Black Rock Harbor dredged material on the scope for growth of the blue mussel, Mytilus edulis, after laboratory and field exposures. Technical Report D-87-7. Prepared by the U.S. EPA Environmental Research Laboratory, Narragansett, R.I. for the U.S. Army Corps of Engineers Waterways Experimental Station, Vicksburg, MS.

Otis, M.J. 1987. Pilot study of dredging and dredged material disposal alternatives. Draft. U.S. Army Corps of Engineers, New England Division, Waltham, MA.

Otis, M.J. and D.E. Averett. 1988. Pilot study of dredging and dredged material disposal methods, New Bedford Harbor, Massachusetts Superfund Site. Superfund '88. Proceedings of the 9th National Conference. The Hazardous Materials Control Research Institue, pp 347-352.

U.S. Environmental Protection Agency. 1988. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. US EPA Environmental Research Laboratory, Cincinnati, OH. EPA 600/4-87/028