RETURN TO 1998 ROD AR INDEX

1653

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean Resources Conservation and Assessment
Hazardous Materials Response and Assessment Division
Coastal Resources Coordination Branch
c/o USEPA
JFK Federal Bldg.
HEE Can-6
Boston, Ma. 02203

April 22, 1992

Ms. Gayle Garman
Remedial Project Manager
EPA, Region I
Waste Mangement Division
Massachusetts Waste Management Branch
JFK Federal Building
Boston, Massachusetts 02203-2211

Superfund Records Center
SITE: New Bedford
BREAK: 16.05
OTHER
SDMS DocID 000200893

Dear Ms. Garman:

NOAA is happy to at last submit its assessment on the issue of whether additonal remediation in the Outer New Bedford Harbor area has a basis for justification. This issue, as you are aware from our numerous meetings and discussions, is indeed technically difficult considering the paucity of excellent scientific data. Regardless, the information provided by EPA, its consultants, the Commonwealth of Massachusetts, the U.S. Department of the Interior, and numerous individuals within various segments of NOAA, especially Mr. L. Jay Field, provided us with a perspective which we believe jusitifies a more enhanced level of cleanup than the Minimal No-Action Alternative will offer. We make no assertions as to its implementability or costs for this is best left to those with the authority on which to make such decisions. However, the New Bedford Harbor Superfund Site is viewed as an environmental tragedy. The widespread contamination in all likelihood will result in continuing long term harm to the enviroment causing individuals who could benefit from a clean Buzzards Bay to be denied its full potential value. But our assessment indicates that localized environmental benefits, and potentially, individual user benefits could result from additional remediation.

NOAA, and I think I can state that the Commonwealth of Massachusetts as a natural resource trustee, appreciate the extended opportunity that EPA has provided the natural resource trustees to address the issue. NOAA looks forward to a continued constructive working relationship with EPA on this very difficult matter.

Sincerely,

John A. Lindsay
Coastal Resource Coordinator

enclosure:

cc: A. Giedt (NOAA GCNE)
J. Pederson (Ma. CZM)
T. Bigford (NMFS)
W. Patterson (DOI)

Evaluation of Effectiveness: Relative Exposure Model

Introduction

The New Bedford Harbor Feasibility Study (FS) modeling results indicate that achieving a 50 ppm target cleanup level (TCL) for the estuary and the lower harbor would significantly reduce PCB concentrations in water, sediment, and biota inside the Hurricane Barrier. However, these effects were projected to be highly localized. PCB concentrations in water, sediment, and biota in Upper Buzzards Bay were predicted to be comparable to results from the No Action Alternative, even though PCB flux to the Outer Harbor through the Hurricane Barrier was expected to be reduced considerably (Ebasco 1990b). Thus, over the 10-year simulation period for Upper Buzzards Bay, PCB concentrations in the water column were projected to remain above 12 ng/l (the Ambient Water Quality Criteria value calculated using the current FDA limit of 2 ppm) (Ebasco 1990a). PCB concentrations in lobster edible tissue were projected to remain above the FDA action level. PCB concentrations in winter flounder edible tissue and other species were projected to remain well above the 0.02 ppm health-based residual tissue levels (RTLs) determined in the human health risk assessment.

Monitoring of PCB concentrations in lobster and winter flounder from New Bedford Harbor and Upper Buzzards Bay demonstrates little change over the last 10 years (Kolek and Ceurvels, 1981; J. Schwartz, unpublished data; Ebasco 1990b). Only when sediment PCB concentrations in the Outer Harbor were projected by computer model to be reduced under the 1-ppm remedial action scenario were significant improvements indicated in PCB concentrations in the water column, sediment and biota (Battelle 1990)

The results of the Battelle model emphasize the importance of residual PCB sediment contamination in maintaining elevated concentrations in biota in Upper Buzzards Bay, regardless of exposure pathway. Thus, whether an organism is expected to obtain the majority of its PCB exposure from the water column or food sources, residual PCB concentrations in sediment play a major role in determining concentrations in biota.

The current Proposed Remedial Action Plan (PRAP) recommends remediating Upper Buzzards Bay to a 50 ppm TCL. The primary objective of this document is to evaluate the potential benefits of implementing further remediation of Upper Buzzards Bay to a 10 ppm TCL. A reduction in sediment PCB concentrations is important for several reasons:

(1) A reduction in PCB concentrations in biota should reduce body burdens in lower trophic levels, thereby contributing to improved overall ecological health. Further, lower trophic level biota are the primary pathway for PCB transfer between sediments and many organisms coveted by humans.

(2) PCB body burdens should be reduced in lobster and winter flounder that recruit to the fisheries in Buzzards Bay. While the average concentration of PCBs in edible tissue in Buzzards Bay may be below the current FDA action level, individual lobsters and other species with higher PCB concentrations present an increased risk to individual consumers and could also negatively affect the marketing of fisheries products from this region.

(3) If body burdens can be reduced, than commercial and recreational fisheries may be able to reopen sooner.

Two target areas in Upper Buzzards Bay just outside the Hurricane Barrier near the Cornell Dublier (CD) facility were defined in the FS that exhibit sediment concentrations greater than 50 ppm. A 10 ppm TCL is consistent with the remedial alternatives considered in the FS; a 1 ppm TCL was considered not practically attainable. Using data from the FS, three areas were identified that exhibit sediment PCB concentrations greater than 10 ppm, including the two CD outfall areas and

an area near the New Bedford Wastewater Treatment Plant outfall. Other areas with PCB concentrations exceeding 10 ppm have been identified by other studies (for example, Apponagansett Bay, Clarks Cove) but were not included in this analysis due to uncertainty about data quality.

Relative Exposure Model

A simple model is proposed to evaluate the potential additional benefit of remedial action to a 10 ppm PCB TCL in the Outer Harbor beyond the preferred 50 ppm TCL offered in the PRAP. The model estimates the relative change in PCB exposure to resident biota following remediation to a 10 ppm TCL. This relative exposure model first defines study areas, and then uses area-weighted average PCB concentrations found in sediments to estimate the relative overall exposure to organisms residing in various contaminated areas. The change in average concentration of PCBs in the sediment that would result from remedial action provides an estimate of the relative change in exposure to biota in the area and an approximation of the magnitude of residual risk.

Assumptions

The model relies on three basic assumptions: 1) PCB concentrations in biota are directly related to surficial sediment PCB concentrations; 2) the sediments of the Outer Harbor are the predominant source of PCBs to the species of concern in the Outer Harbor ; and 3) the sediment PCB data provide a reasonable characterization of the present distribution pattern of PCBs in the Outer Harbor. These assumptions are discussed below.

(1) PCB concentrations in biota are directly related to sediment PCB concentrations.

Exposure can be estimated using dry weight sediment concentrations.

Equilibrium partitioning theory suggests that sediment total organic carbon (TOC) concentrations are a major factor in determining the availability of PCBs in the sediment to benthic infauna. Investigators find that equilibrium partitioning models using TOC-normalized sediment concentrations for organic contaminants are better than dry weight concentrations in estimating accumulated PCB body burdens in infaunal organisms such as bivalves and polychaetes in both laboratory and field studies. However, these models may not be appropriate for predicting accumulation of PCBs in higher trophic level organisms, such as lobster and winter flounder, that receive much of their PCB body burden from food sources (Lake et al., 1990). Disturbances of the sediment, due to strong tidal currents, storms, or bioturbation, may also result in greater availability of PCBs in the sediment than would be predicted by simple equilibrium partitioning.

Data from a number of areas, including New Bedford Harbor and Buzzards Bay, indicate that tissue PCB concentrations in a variety of aquatic organisms from different trophic levels reflect dry weight sediment PCB concentrations in their habitat.

Exposure is related to the time spent in an area and the concentration of PCBs in that area. No assumptions are made about the exposure pathway.

For mobile organisms, the time spent in an area is proportional to the size of the area and the range of the organism. This also assumes that they do not avoid or favor areas of contamination. Thus, contaminated areas would have as equal a probability of providing exposures as non-contaminated areas. Since PCB concentrations in mobile species integrate exposure over an area, they would be expected to reflect area-to-area differences in average PCB concentration (Connolly, 1991).

(2) The sediments of the Outer Harbor are the predominant source of PCBs to resident biota in the Outer Harbor (Upper Buzzards Bay).

After implementation of the preferred remedial action (50 ppm TCL) in the estuary and lower harbor, PCB flux to the Outer Harbor from inside the Hurricane Barrier is predicted to be significantly reduced, according to the hydrodynamic and sediment/contaminant transport model used in the FS (Ebasco 1990b, V.III p. 2-10). Average PCB concentrations in the water column, sediment, and biota in the Outer Harbor, however, are not expected to show a significant decline relative to the No Action Alternative. This suggests that the effects of the cleanup will be localized and that residual sediment contamination in the Outer Harbor will continue to provide a major source for elevated PCB concentrations in the water column and biota in the Outer Harbor.

Since sediment PCB concentrations inside the Hurricane Barrier (Fishing Area I) following the preferred remedial action are expected to remain elevated at about 10 ppm, species of concern and their prey that spend significant amounts of time inside the Hurricane Barrier would be exposed to elevated PCB concentrations in the water column and sediment. It is known that both winter flounder, and, to a lesser extent, lobster may be found inside the Hurricane Barrier. However, the model assumes that for the adult populations of both species in Fishing Areas II and III, the use of the Inner Harbor is limited (i.e., only a small percentage of the population uses that habitat or that the time of exposure is limited). This assumption is supported by the observation that PCB concentrations in the tissue of winter flounder and lobster in Fishing Areas I-III and Buzzards Bay are consistent with the PCB concentrations in water and sediment from the same area (Connolly, 1991).

(3) The sediment PCB data accurately reflect the present distribution pattern of PCBs in the Outer Harbor.

Only sediment data from the FS are used in this evaluation. Data from other studies conducted between 1973 and 1986 indicate that other areas of sediment PCB contamination greater than 10 ppm, or even 50 ppm, exist in Upper Buzzards Bay. Although some of these data are relatively old and of unknown quality, the areas defined are consistent with data collected during the FS and with probable sources. The effects of storm activity on the distribution of PCBs in the Outer Harbor are difficult to judge, but the fact that tissue concentrations in lobster and winter flounder have remained consistently elevated over nearly a decade of study indicates that contamination at unacceptable concentrations is still present.

[Note: Any remedial action, including the No Action Alternative should require the collection of additional sediment data to determine present extent of sediment contamination.]

Selection of Target Species

Lobster and winter flounder were chosen as the target species for this analysis. The sole intent of target species selection is to simply demonstrate *via* pragmatic examples a rationale for undertaking further consideration of additional remedial action in the Outer New Bedford Harbor area.

These two species are important in commercial and recreational fisheries; they are susceptible as higher trophic level organisms to accumulating elevated PCB body burdens; and they utilize Upper Buzzards Bay habitat for much of their life history. Further, Buzzards Bay is recognized as the most productive lobster inshore nursery area in Massachusetts (Collings et al. 1981), and winter flounder production is also extremely high. Therefore, any negative impact on these valuable fisheries is considered significant by the Commonwealth of Massachusetts and NOAA.

Lobster

Lobster from shallow water areas, such as Upper Buzzards Bay, have different behavior patterns than lobster from more offshore, deeper-water areas, even though they are considered to be different parts of the same population. Lobster from deeper offshore areas tend to be larger and move greater distances, usually moving into shallower water to spawn. Shallow water, inshore lobster tend to mature at a smaller size and are more restricted in their movement. Larval lobsters that settle out in Upper Buzzards Bay are likely to stay within close proximity to the place of settlement for the first three years. Between the fourth and sixth years, these lobsters tend to remain in the general vicinity of settlement, but they begin to move about in order to forage over wider areas. Typically by the sixth year lobsters reach sexual maturity and some will migrate into deeper and cooler offshore waters of Buzzards Bay, or beyond. Part of the adult population, however, remains resident year-round in Upper Buzzards Bay, including Fishing Areas II and III. But various factors including, overcrowding, aggressive behavior and breeding ultimately drive each individual lobster from Fishing Areas II and III. When these lobsters move beyond the closure areas,they mingle with lobsters originating from other shallow water areas of Buzzards Bay, as well as with lobsters from deeper offshore waters. Consequently, the lobsters from the New Bedford Harbor area which have bioaccumulated elevated tissue concentrations of PCBs, now become available to the commercial and recreational fisheries located beyond the closure boundary of Fishing Area III. Catch statistics indicate that all lobsters within Buzzards Bay are harvested within one molt after breeding. Because the New Bedford Harbor area lobsters mingle with individuals from less contaminated areas, the probability of catching a contaminated lobster is lower than if fishing for these same lobsters solely within the closed areas of New Bedford Harbor.

Lobsters receive significant portions of their PCB body burdens from the benthic component of the food chain which in turn derive their PCB body burdens from both the sediment and the water column. Buzzards Bay lobsters are thought to feed extensively on benthic species such as bivalve molluscs and other crustaceans, especially crabs. Bivalve molluscs are filter feeders and consequently derive their PCB burdens predominantly from the water column. Studies by the Commonwealth of Massachusetts and EPA demonstrated the relationship between filter feeding bivalves and exposure to a contaminated water column. Caged mussels were deployed at three stations running in a line from upper Clarks Cove into Buzzards Bay (Duerring 1990). PCB concentrations in mussels was highest in the upper cove and decreased with distance along the transect. Similarly, caged mussel studies by EPA during pilot dredging work for remediation of the "hot spot" revealed storm induced turbulence, or the resuspension of contaminated sediments, resulted in the filter feeding mussels acquiring elevated PCB body burdens.

Crabs also feed extensively, although not exclusively, on bivalve molluscs and other organisms that derive their food from the water column. Crabs, therefore, indirectly receive a significant portion of their PCB burdens from the water column. Because the water column appears as an important route of exposure to some prey items any reduction in water column concentrations of PCBs should be ultimately followed by body burden reductions in those species feeding directly or indirectly through the water column. However, it is noteworthy that water column concentrations of PCBs in Fishing Areas II and III are derived from and directly linked to sediment concentrations.

Lobsters also consume prey items which derive their PCB body burdens from the sediment. Both crabs and lobsters feed on benthic infauna, such as polychaet worms and amphipods. Reducing benthic infaunal exposure to PCBs should ultimately result in reductions to lobsters.

PCB body burdens in lobsters have been highest in Fishing Areas I and II. Average PCB concentrations have been lower in Fishing Area III, and lower yet in samples taken throughout

Buzzards Bay. Regardless of the pathway, a relationship between sediment concentrations and body burden concentrations is apparent.

Winter Flounder

The biology of the winter flounder also lends itself to increased susceptibility to long-term PCB exposure in the New Bedford Harbor/Buzzards Bay area. The winter flounder is an omnivore, feeding primarily on benthic organisms such as polychaet worms, amphipod and isopod crustaceans, bivalve molluscs, and plant material. Polychaetes are considered the predominant prey. Winter flounder spawn in shallow bays and estuaries such as the inner and outer New Bedford Harbor. Young of the year and juveniles remain in these inshore nursery areas for a period which may last six years. Upon reaching sexual maturity, adult winter flounder migrate offshore to deeper, cooler water during the summer and inshore to the spawning areas in late fall. Tagging studies by Saila (1961) and Black et al. (1988) suggest that winter flounder tend to return to their original spawning grounds, although inter-population mixing does occur. Consequently, winter flounder from the New Bedford Harbor area are exposed to elevated concentrations of PCBs throughout most of their life cycle.

The effects of inherited PCBs on winter flounder eggs and larvae received attention by Black et al. (1988). Larvae hatched from eggs of New Bedford Harbor flounder had elevated concentrations of PCBs, and they were significantly smaller than larvae from a reference area. The authors suggest that these smaller larvae feed less efficiently, and are more vulnerable to predation, which could negatively affect recruitment potential.

PCB body burdens in winter flounder are high enough to pose potential human health concerns, although most studies fail to demonstrate that contamination in edible flesh exceeds the 2 ppm FDA action level. Sport fishing for winter flounder is closed in Area II, but similar to the pattern for lobster, flounder from within Area II may migrate offshore and become part of the commercial fishery.

Definition of study area

The study area is defined by the boundaries of Fishing Areas II and III (Figure 1). These areas are appropriate for both lobster and winter flounder movement patterns. Part of the lobster population remains resident within these areas throughout their life history, while others spend their early life history (5 years) in Upper Buzzards Bay and periodically return to these shallow water areas to spawn. Winter flounder are present in these areas for a substantial part of the year.

Definition of target areas in Outer Harbor between 10 and 50 ppm

The same data sets are used in this evaluation as in the FS. Thus, only data are included that meet rigid QA/QC standards. Although data from other studies conducted between 1973 and 1986 indicated that other areas exist with PCB concentrations in the sediment greater than 10 ppm in Upper Buzzards Bay, these data are not used to define target areas due to the uncertainty about the data quality and the relationship to current conditions in Upper Buzzards Bay.

A total of three target areas with surficial sediment PCB concentrations exceeding 10 ppm were defined: Areas A, B, and C (Figure 1). Areas A and B lie just outside the Hurricane Barrier near the CD outfalls that were targeted for cleanup to the 50 ppm TCL in the PRAP. Area C is located near the New Bedford Wastewater Treatment Plant (WWTP) Outfall. All three target areas lie within Fishing Area II.

Target area boundaries were hand-drawn to include all data points with values greater than 10 ppm. No sediment PCB values between 10 and 50 ppm were available to define Target Area A;

consequently, Target Area A is defined relative to the estimated boundary defined in the FS for the 50 ppm TCL area, and data points in the surrounding vicinity with sediment concentrations less than 10 ppm.

Determination of average concentrations for background and target areas

TOC-normalized average concentrations were not used in this analysis three reasons. (1) No individual sample TOC data were available to match the individual dry weight sediment PCB concentrations. Using average TOC values with average PCB concentrations would only increase the uncertainty of the results. (2) A review of the available TOC data indicated that the range of values was small (1.4-2.5%) relative to the differences in PCB concentrations. This review suggest that the effect of TOC-normalization would have a minimal effect on the predicted change in exposure following remediation. (3) Although evidence indicates that the availability of PCBs to benthic infauna is determined largely by the TOC content of the sediment, such may not be the case for higher trophic level organisms. For example, lobster and winter flounder accumulate a large percentage of their total PCB body burdens from food sources.

Both arithmetic and geometric mean values were calculated to represent the average sediment PCB concentrations in the background and target areas (Table 1). For this data set, arithmetic mean values were always higher than the geometric means.

Background areas

Average background values were determined for three areas:

- Fishing Area II,
- Fishing Area III,
- 183-acre area along the easterly side of Clarks Point Peninsula

The Clarks Point Peninsula area is treated separately from the rest of Fishing Area II because it appeared to have higher residual PCB concentrations than the other background areas (Figure 2/Table 1). It includes most of the area sampled during the GCA study, which was directed toward locations of expected contamination (e.g., areas adjacent to sewer outfalls).

Target Areas A and B are within the 183 acre background area along the Clarks Point Peninsula. But the PCB concentration values for Target Areas A and B were excluded from the determination of the background mean concentrations, and areal values excluded from calculations of total background areal size.

The background mean concentration for the remainder of Fishing Area II (excluding Clarks Point Peninsula and Target Areas A and B) and Fishing Area III was based on Battelle stations. For Fishing Area II the stations numbers are 12, 13, 14, 15, and 17; for Fishing Area III, the station numbers are 18 and 19. The arithmetic means for each station from the different cruises were determined, and these values were used to determine an overall mean for each background area.

Target areas

Arithmetic and geometric mean sediment PCB concentrations were determined for Target Areas B and C (Table 1). Since no data points were available for Target Area A, the average PCB concentration was estimated to be 30 ppm, based on a simple average between the 10 and 50 ppm isopleth. The average concentration for Target Area C was based on three values collected from the same station during different sampling periods.

Post remedial PCB concentrations in each target area were assumed to equilibrate to the average background PCB concentration in Fishing Area II, whereas, the average PCB concentration of the 183-acre area along the Clarks Point Peninsula was assumed to remain unchanged. These average concentrations serve as the basis for estimates of relative change in exposure between pre - and post remediation.

Estimated relative change in exposure

The predicted percent reduction in PCB exposure following sediment remediation is similar whether using arithmetic or geometric mean values, although geometric mean values are lower (Table 2). The predicted reduction in relative exposure following cleanup of all 3 target areas in comparison to the calculated background concentrations in Fishing Area II was approximately 15% and 18% for geometric and arithmetic mean values, respectively. When Fishing Areas II and III background concentration estimates are considered together, the predicted reduction in relative exposure decreases to approximately 9% and 13% for geometric and arithmetic mean values, respectively.

Obviously, the size of the total area directly influences the magnitude of the predicted reduction in relative exposure. The total size of the three Target Areas, A, B, and C, is less than 60 acres (Table 1). Whereas, the background area for Fishing Area II is 4500 acres, which when added to the area encompassed by Fishing Area III increases the size to 17,000 acres (Table 1). Consideration must be given to the fact that the larger area (ie. Areas II and III in combination) likely includes a greater percentage of the populations of concern, and therefore, the overall significance of the effect may, in fact, be greater.

Uncertainty

The major source of uncertainty associated with this application of the relative exposure model is concern over the inadequacy of the database. The current conditions in Upper Buzzards Bay may not be reflected by the historical data and the spatial coverage provided by the available data has severe limitations.

Changes over time in the extent and magnitude of sediment PCB contamination may have occurred since sampling was conducted for the FS. Major storm activity (e.g., Hurricane Bob in 1991) along with other natural sediment processes may have considerably altered the distribution of contamination in the Outer Harbor. It is possible that former areas with high concentrations have spread out over a larger area, or have been buried by cleaner sediment, or higher concentrations found deeper in sediments may have been exposed by storm activity.

The small number of sediment PCB values used to define the target areas, particularly Target Areas A and C, results in considerable uncertainty about both the size and average concentration in the areas. For example, Target Area C near the New Bedford WWTP Outfall, was defined by three data points from a single station. In addition, data from other studies indicate that a number of other areas in Upper Buzzards Bay have sediment PCB concentrations of PCBs exceeding 10 ppm. The data used to determine the average background PCB concentrations also were limited in number of samples and spatial distribution. Most of the available data were collected from areas of known or suspected contamination, consequently, the data is likely biased towards elevated concentrations.

Another source of uncertainty pertains to the use of the entire harbor and bay by the species of concern. Both lobster and winter flounder are known to utilize habitat in the New Bedford Inner Harbor where they would be exposed to higher average sediment concentrations than in the Outer Harbor. The relative importance of the Inner Harbor area to populations in Fishing Areas II and III is not known, but from a quantitative perspective it may be offset by portions of the populations that spend more time in the outer, less-contaminated areas of Fishing Area III. Conversely, the

possibility exists that lobster and/or winter flounder show a pattern of disproportionate use of some of the more contaminated areas, such as the WWTP outfall as evidenced in a 301(H) waiver investigation, since increased production of some benthic prey organisms may be found in these organic rich areas.

Table 1. The size and average PCB concentration (ppm) in the sediment of three target areas in Upper Buzzards Bay with sediment concentrations between 10 and 50 ppm PCBs and background areas.

Area	Size (Acres)	Mean PCB Concentration. Arithmetic	Geometric	Number of Values
Target Areas				
A	7	30.0	30.0	0[a]
B	35	11.4	4.4	8
C	17	56.6	28.7	3
Background Areas				
Peninsula	183	3.1	1.8	23
Fishing Area II	4500	1.4	1.0	6[b]
Fishing Area III	12500	0.3	0.3	5[c]

Table 2. Estimated additional percent reduction in average sediment PCB concentration in Upper Buzzards Bay Fishing Areas II and III following cleanup to a 10 ppm target cleanup level (assuming that the two areas identified in the Feasibility Study with concentrations greater than 50 ppm were already remediated).

Average Value Determination	PERCENT REDUCTION	
	AREA II	AREA II and III
Arithmetic means	18.4	12.6
Geometric means	14.6	8.6

[a] Estimated from 1 data point used to define the 50 ppm target area
[b] Data from 5 stations
[c] Data from 2 stations

Sensitivity

The sensitivity of the model results was evaluated relative to changes in initial conditions set for both the target and background area concentrations, and the areal size of the target areas used in the model. This evaluation provides a way to assess the potential implications of the uncertainty discussed above that is associated with the quality of the data. The sensitivity evaluation examines the effects of changing the values for each of the following three variables:

(1) average background concentration in Fishing Area II

(2) PCB concentrations in Target Area C only

(3) size of Target Area C.

In the sensitivity analysis, each of these variables was changed by factors of 2, 5, 0.5 and 0.2. These factors are meant to represent a possible margin of error attributable to the limited amount of data available for determining both the size and average concentration of the target areas as well as the possible changes in sediment PCB concentrations over time.

The results shown in Table 3 are based on arithmetic mean values only. Geometric mean values would yield the same pattern. Fishing Area II was used to evaluate the potential implications on the change in percent reduction of average PCB concentrations following remediation. Since all of the proposed remedial action in Upper Buzzards Bay is within Fishing Area II, including Fishing Area III in the evaluation has the same effect as increasing the size of the background area. As the size of the background area increases, the magnitude of the change in average PCB concentration following remediation decreases.

The results (Table 3) demonstrate the considerable effect that would occur if background mean values are found to be different than values used in the model. As discussed above, new and updated information based on new sampling may result is a finding of a more appropriate background mean. For example, reducing the average background value by a factor of 0.5 results in an increase in the estimated percent reduction in average PCB concentration following remediation from 18.4% to 29.1%. Therefore, a more representative sampling of the total area included in this evaluation might result in a lower average background value. However, other areas of contamination are known to exist, and, if these areas were not remediated, the average background value could be higher.

Target Area C was selected as an example target area for estimating the amount of change that might be expected with changes in either the areal extent or the sediment PCB concentration. Target Area C was the most important of the three areas considered in this evaluation in terms of its relative contribution to the change in overall average PCB concentration after remediation. The effect of changing either the areal size or the average PCB concentration for Target Area C shows that if either were underestimated, the predicted change in exposure would increase (Table 3). For example, if the area for Target C was found to be 85 acres instead of 17 (a factor of 5 increase), the magnitude of the predicted reduction in average PCB concentration in Fishing Area II following remediation to a 10 ppm TCL would increase from 18 to 44 %. Since the data for Target Area C are derived from a single station, the collection of additional data could be expected to significantly alter the results of this evaluation. This would also be true for the other two target areas, but Target Area C is of greater relative importance to the outcome predicted by the model than even the combination of the other two areas.

Table 3. Change in predicted percent reduction in average (arithmetic) PCB concentration in Fishing Area II following remediation to a 10 ppm TCL under different model scenarios: using different values for (1) PCB concentrations in Fishing Area II background; (2) PCB concentrations in Target Area C; and, (3) size of Target Area C.

	Fishing Area II Background PCB Concentration		Target Area C PCB Concentration		Target Area C Size of Area	
Factor	ppm	%	ppm	%	Acres	%
1X (initial conditions)	1.4	18.4	56.6	18.4	17	18.4
2X	2.8	10.6	113.2	27.0	34	26.8
5X	7.0	4.7	283	44.7	85	43.9
0.5X	0.7	29.1	28.3	13.2	9	13.4
0.2X	0.3	44.7	11.3	9.8	3	10.1

Conclusions

The model provides a framework to evaluate the potential benefits of remedial action. Three potential target areas totalling less than 60 acres were defined with sediment PCB concentrations between 10 and 50 ppm, based on the available data. Remediation is currently planned for two areas with concentrations exceeding 50 ppm. Establishing a TCL of 10 ppm is estimated by the relative exposure model to result in a reduction in average exposure to organisms in Fishing Area II alone on the order of 15-18%, and 10% for Areas II and III combined. This reduction would be in addition to the reduction expected from remediating Target Areas A and B to a 50 ppm TCL as proposed in the PRAP. While these estimated changes in relative exposure are less than 20%, the high degree of uncertainty associated with the values for the areal size and average PCB concentration of the target areas suggests that the potential exists for a more substantial reduction.

These estimates for reduction in exposure represent an initial reduction following cleanup. Since these areas of elevated concentrations also act as a source of contamination for adjacent areas, average residual concentrations in the sediment, and exposure to biota, would be expected to decline more quickly.

Selection of a 10 ppm TCL for the Outer Harbor would reduce the available PCBs to the biota in Fishing Areas II and III. However, additional investigations into the magnitude and extent of PCB sediment contamination in the Outer Harbor could significantly alter the findings of the relative exposure model, and either reduce the effectiveness of a 10 ppm TCL, or enhance it.

Other factors, such as the possible disproportionate use of contaminated areas, need to be taken into consideration in making the decision whether to remediate. The area in the vicinity of the New Bedford Wastewater Treatment Plant outfall may be an important feeding area. The increased abundance of some fish species in the vicinity of outfall areas that have abundant benthic/epibenthic prey organisms, as has been observed in a southern California flatfish species (Young et al. 1991), may increase the relative importance of these areas to species of concern.

The large amount of uncertainty resulting from the limited amount of information available on the present spatial distribution and magnitude of sediment PCB contamination in Upper Buzzards Bay makes any conclusions speculative. The extent of redistribution of PCBs in the sediment due to storms and other coastal processes is unknown. For example, it is possible that the sediment contamination in the two areas defined for cleanup under the 50 ppm TCL have been spread over a larger area, resulting in higher average concentrations within the 10 ppm isopleth. Under such a scenario, the value of remediating the areas above 10 ppm would likely increase. On the other hand, additional data may show that concentrations of PCB contamination in the sediment have declined since the completion of the FS sampling. Without additional data to adequately define the areas of elevated concentrations and the residual contamination in background areas, any technical evaluation of the effectiveness of remediation in reducing PCB concentrations in biota is uncertain.

The potential reopening of Fishing Areas II and III to commercial fishing depends on other factors beyond the scope of this paper. However, any remedial action that leads to a reduction in sediment PCB concentrations enhances the prospects of reducing body burdens in lower trophic level biota, and ultimately to species coveted by humans, exemplified by lobster and winter flounder. Most lobsters from Fishing Areas II and III eventually migrate beyond the closure boundary where they are subject to harvest by the recreational and commercial fisheries. Thus, any removal of PCBs from the sediment of Upper Buzzards Bay would reduce the current level of PCB contamination in lobsters entering the fisheries from within the closure areas.

References:

Battelle 1990. Final Report for Modeling of the Transport, Distribution, and Fate of PCBs and Heavy Metals in the Acushnet River/New Bedford Harbor/Buzzards Bay System.

Black, D.E., D.K. Phelps, and R.L. Lapan. 1988. The effect of inherited contamination on egg and larval winter flounder, *Pseudopleuronectes americanus*. Mar. Environ. Res. 25:45-62.

Collings, W. Stephen, C.C. Cooper-Sheean, S.C Hughes and J.L. Buckley. 1981. The Effects of Power Generation on some of the Living Marine Resources of the Cape Cod Canal and Approaches. Ma. Department of Fisheries, Wildlife and Recreational Vehicles, Division of Marine Fisheries. 212 pp. plus app.

Connolly, J.P. 1991. Application of a food chain model to polychlorinated biphenyl contamination of the lobster and winter flounder food chains in New Bedford Harbor. Environ. Sci. Technol. 25: 760-770. Duerring, C. 1990. Buzzards Bay Caged Mussel Pilot Biomonitoring Study 1987-1988. Massachusetts Dept. of Environmental Protection. 103 pp.

Duerring, C. 1990. Buzzards Bay Caged Mussel Pilot Biomonitoring Study 1987-1988. Massachusetts Dept. of Environmental Protection. 103 pp.

Ebasco. 1990a. Ecological Risk Assessment for New Bedford Harbor.

Ebasco. 1990b. Feasibility Study for New Bedford Harbor.

Kolek, A. and R. Ceurvels. 1981. Polychlorinated biphenyl analyses of marine organisms in the New Bedford area, 1976-1980. Ma. Div. Marine Fish., Publ. No. 12265-36-100-1-81-CR. January 1981.

Lake, J.L., N.I. Rubinstein, H.Lee II, C.A. Lake, J. Heltshe, and S. Pavignano. 1991. Equilibrium partitioning and bioaccumulation of sediment-associated contaminants by infaunal organisms. Environ. Toxicol. Chem. 9: 1095-1106.

Saila, S.B. 1968. A study of winter flounder movements. Limn. Oceanogr. 6: 292-298.

Schwartz, J.P. 1988. Distribution and concentration of polychlorinated biphenyls in lobster, winter flounder, and quahogs from Buzzards Bay, Massachusetts. Draft Report. Div. of Marine Fisheries, Cat Cove Marine Lab for US EPA. September 1988.

Young, D.R., A.J. Mearns, and R.W. Gossett. 1991. Bioaccumulation of p,p'-DDE and PCB 1254 by a flatfish bioindicator from highly contaminated marine sediments of southern California. In: R. Baker (ed.), Organic Substances and Sediments in Water: Volume 3, Biological. pp 159-169.

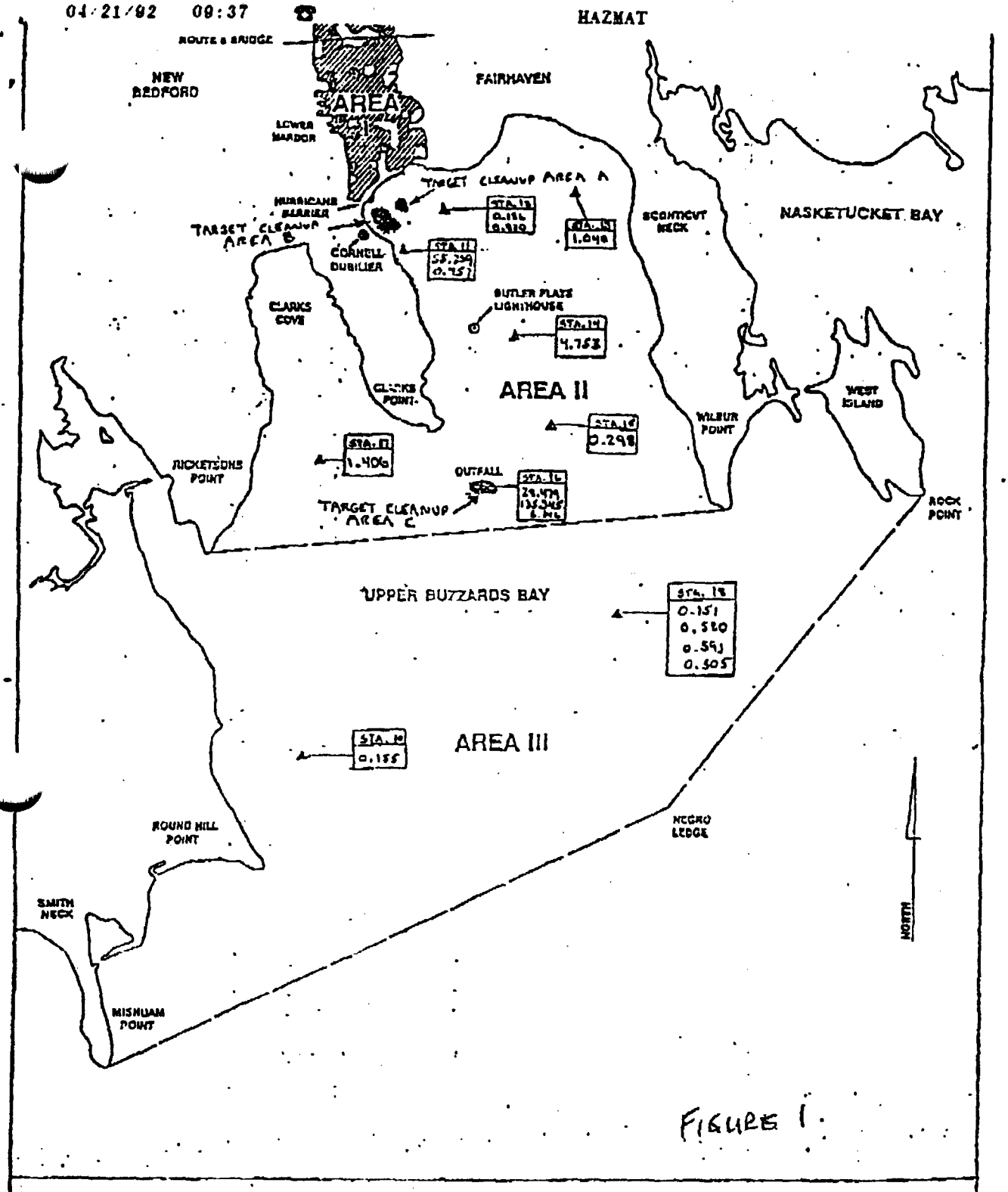


FIGURE 1.

NOTES

1. PCB values displayed are from the Battelle sampling program. ▲ = Battelle sampling station
2. *Fishing Closure Areas*
   - Area I - Waters closed to all fishing.
   - Area II - Waters closed to the taking of lobsters, eels, flounder, scup and tautog.
   - Area III - Waters closed to lobstering only.
3. Sediment PCB concentrations in ppm.

KEY

Target Cleanup Areas (Not to Scale)

APPROXIMATE SCALE 0 1 2 MILES

FIGURE 1

EBASCO SERVICES INCORPORATED

TARGET CLEANUP AREAS FOR UPPER BUZZARDS BAY AND THE RESULTS FROM THE BATTELLE SAMPLING PROGRAM FOR FISHING CLOSURE AREAS II & III

US EPA ARCS I PROGRAM

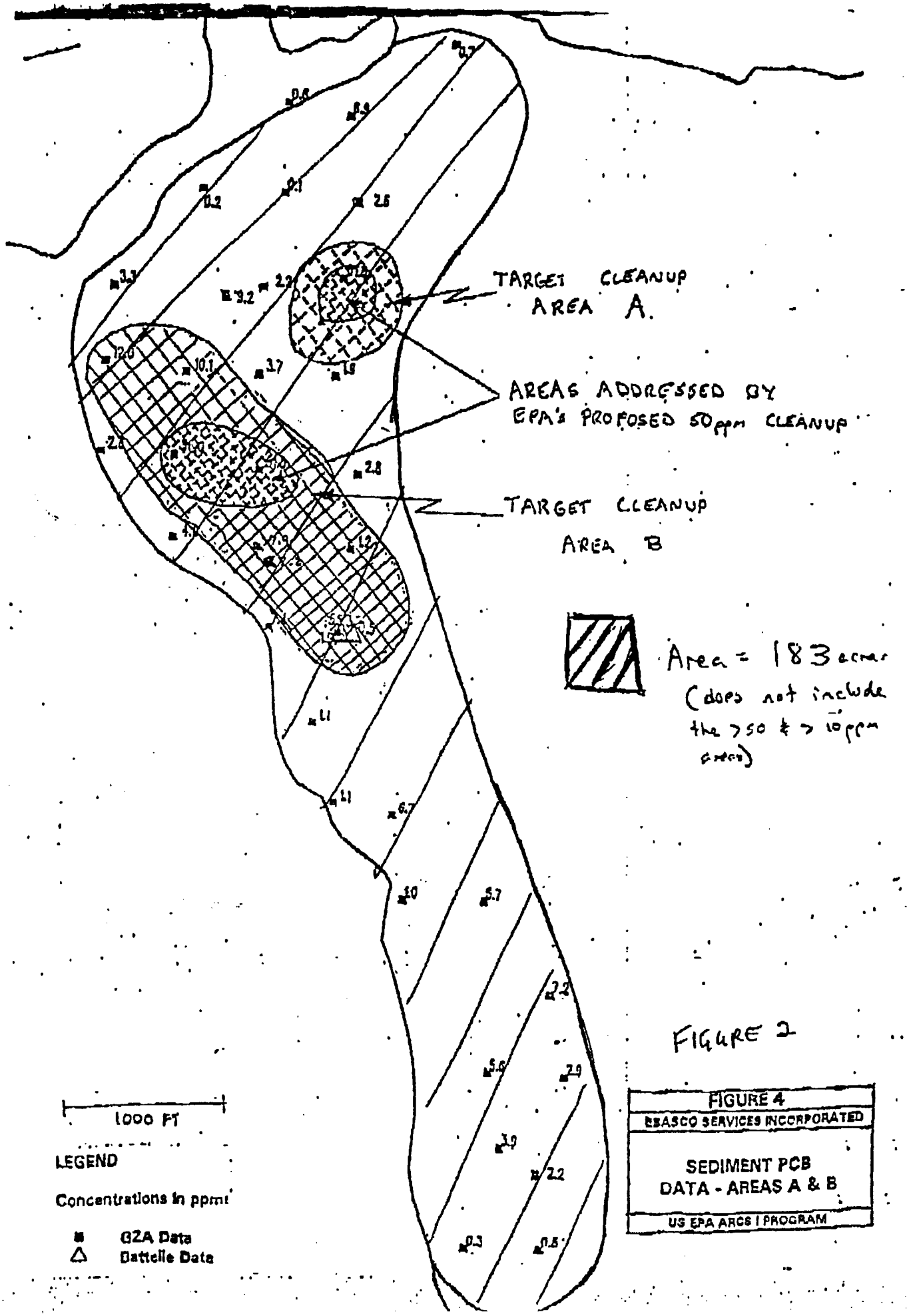
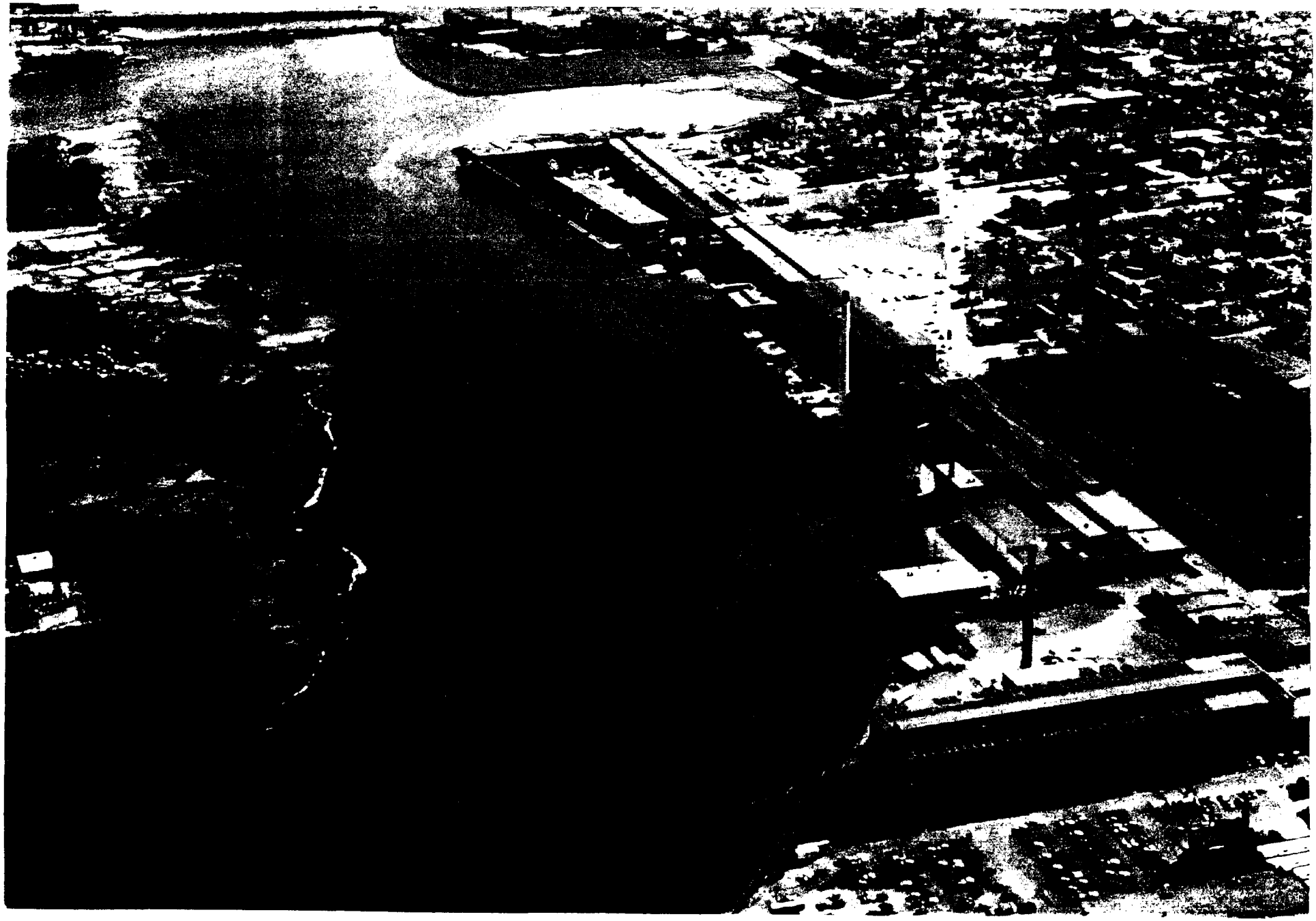


FIGURE 2

FIGURE 4
EBASCO SERVICES INCORPORATED
SEDIMENT PCB DATA - AREAS A & B
US EPA ARCS I PROGRAM

9198 AK