New Bedford Harbor Superfund
Meeting
January 24, 1996
6:00 p.m.
Greater New Bedford
Vocational High School

AGENDA

- Status of Superfund; prospects for continuing funding for EPA in the on-going budget confrontation: discussion of impact, if any, of funding crisis on this site.
- Report from the navigational/remedial dredging coordination subcommittee
- Report of subcommittee on CDF 1; plans for public meeting
- ~~Citizens groups~~/HARC/ACE presentation on issues related to cove siting of CDF 1
- Status of Treatability studies:
  - Solidification
  - Selection of pilot scale vendors
- Next meeting

Summary of Meeting Held January 24, 1996
of the New Bedford Harbor Superfund

In attendance at the session were:

<u>NOAA</u>
Jack Terrill

<u>MC&M</u>
David Janik

<u>Downwind Coalition</u>
Neal Balboni
Carol Sanz

<u>Town of Fairhaven</u>
John T. Haaland

<u>H.A.R.C.</u>
Jim Simmons
Barry Starr

<u>EPA-NE</u>
Larry Brill
Cynthia Catri
Frank Ciavattieri
Dave Dickerson
Harley Laing

<u>Town of Acushnet</u>
Roland R. Pepin

<u>Alternative for City & Env't</u>
Charlie Lord

<u>New Bedford City Council</u>
Paul Koczera
George Rogers

<u>Concerned Parents of Fairhaven</u>
Claudia Kirk

<u>New Bedford Mayor's Office</u>
Molly Fontaine

<u>DEP</u>
Paul Craffey
Andrea Papadopoulos
Helen Waldorf

<u>State Elected Official</u>
Rep. Bill Straus

EPA current budget runs out Friday, EPA is expecting a continuing resolution to go to March 1 or March 15. Budget will be reduced, but with respect to forum, the process should continue as normal. Superfund tax has expired and could have long term impact for New Bedford if additional funding is needed. New reauthorization bill is being proposed. Interim budgets are more stringent and may impact EPA's contracting ability. Overall interim budget should have no impact on New Bedford site.

The citizen meeting will be held at Club Recordacoes at 253 Coggeshall St. in New Bedford on February 11th at 2:00 p.m. This is the confirmed time for the meeting.

Solidification samples sent to laboratory for testing but testing delayed due to furlough. Three vendors were chosen for hot spot remediation. Federal regulations are very restrictive about disclosure of information regarding vendor selection. Ebasco recommended 3 vendors, however, one vendor Rust withdrew The other two are Geosafe-vitrification technology and Ionic-teamed with Commodore for solvent extraction to separate PCB. Ebasco used specific criteria to choose vendors. EPA proposed 2nd RFP for selecting a new 3rd vendor for pilot scale tests. This should allow schedule to be maintained. All vendors were asked if they wanted a debriefing. Forum supported seeking a third vendor.

Bill Strauss reported for the subcommittee for dredging. Subcommittee has not met but needs to set a meeting date for February. Discussion on CDFs and whether dredge material or Superfund clean up should go into which CDFs. Navigational dredging would require additional CDFs.

Charlie Lord gave presentation on CDF1. His issue paper was circulated and may be a topic for further discussion.

Proposed meeting on the 11th should focus on openness for learning public concern and education. Should clarify interests of neighborhood group.

Next Forum Meeting is scheduled for February 28, 1996 at 6:00 p.m. in the auditorium of the Greater New Bedford Vocational And Technical School.

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NBH FORUM

J. Great Lakes Res. 19(1):158–174
Internat. Assoc. Great Lakes Res., 1993

Investigation of Contaminant Transport from the Saginaw Confined Disposal Facility

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ABSTRACT. Pilot biomonitoring and modeling studies were conducted at the Saginaw Confined Disposal Facility (CDF), Saginaw Bay, Lake Huron, during 1987 to develop methods to assess the potential for or magnitude of 1) contaminant transport from the dike interior to the outside environment, 2) impacts of CDF disposal on the water column and sediments, and 3) impacts of CDF disposal on aquatic biota living in the outdike zone. Polychlorinated biphenyls (PCBs) were selected for study due to their presence in the sediments of the Saginaw River/Bay ecosystem. A mathematical model of near-field contaminant transport through the dike walls was constructed. Model predictions indicate that the rate of contaminant transport through the dike is expected to be small, amounting to less than 0.25 kg of PCBs after 5,000 days of simulation. A mathematical model of the far-field impacts of CDF transport was also constructed. Model predictions indicate that the incremental increase in steady-state, water column PCB concentrations in Saginaw Bay is expected to be approximately 0.05 ng/L per kg of PCB transported from the CDF. A biomonitoring program was developed to assess contaminant transport through dike walls and its impact on contaminant concentrations in biological tissues. Distinct transport of contaminants through the dike walls was not demonstrated using the biomonitoring approach.

0.00005 kg/d or 0.0001 kg/d

INDEX WORDS: Mathematical models, biomonitoring, contaminated sediments, polychlorinated biphenyls, PCBs.

INTRODUCTION

Sediment contamination is a problem common to most International Joint Commission Great Lakes Areas of Concern (Hileman 1988). Throughout the Great Lakes, the sediments of many harbors and tributaries are routinely dredged to maintain commercial shipping lanes and, due to contamination, often do not meet criteria for open-water disposal (IJC 1982). To meet the need for improved disposal alternatives, a major program was developed in the early 1970s for the disposal of contaminated sediments in confined disposal facilities (CDFs) (IJC 1986). CDF disposal involves the containment of dredged materials within a diked impoundment, usually located in or adjacent to a waterbody near the dredging site. Although CDFs were designed to confine contaminated sediments after dredging, the materials comprising the walls of CDFs are, in general, porous and may allow the transport of water and associated contaminants back into the surrounding environment. Contaminants transported back into waters surrounding CDF sites may have deleterious impacts on water quality, aquatic organisms and, ultimately, human health.

PROJECT SCOPE

An overview of three pilot studies with results and discussion is presented to describe general modeling and biomonitoring techniques that can be used to assess and evaluate CDF performance. These techniques were applied to the Saginaw CDF to preliminarily examine the observed and theoretical impacts of contaminant transport from the dike interior to the outside environment, the impacts of CDF disposal on the water column and sediments, and the impacts of CDF disposal on aquatic biota living in the surrounding area. Comprehensive evaluations of CDF contaminant retention, transport, and potential impacts on outdike biota have not been previously conducted (IJC 1986). It should be noted that while these results are specific to PCB transport from the Saginaw CDF, the modeling and biomonitoring techniques developed and described in this report are applicable to a variety of CDF configurations and wide range of organochlorine contaminants.

STUDY SITE LOCATION AND DESCRIPTION

The Saginaw CDF is located in Saginaw Bay, Lake Huron, east of the Saginaw River navigation channel entrance, less than 2 kilometers from the mouth of the Saginaw River, near Bay City, Michigan (Fig. 1). the CDF is kidney-shaped with an area of approximately 283 hectares (700 acres), and a

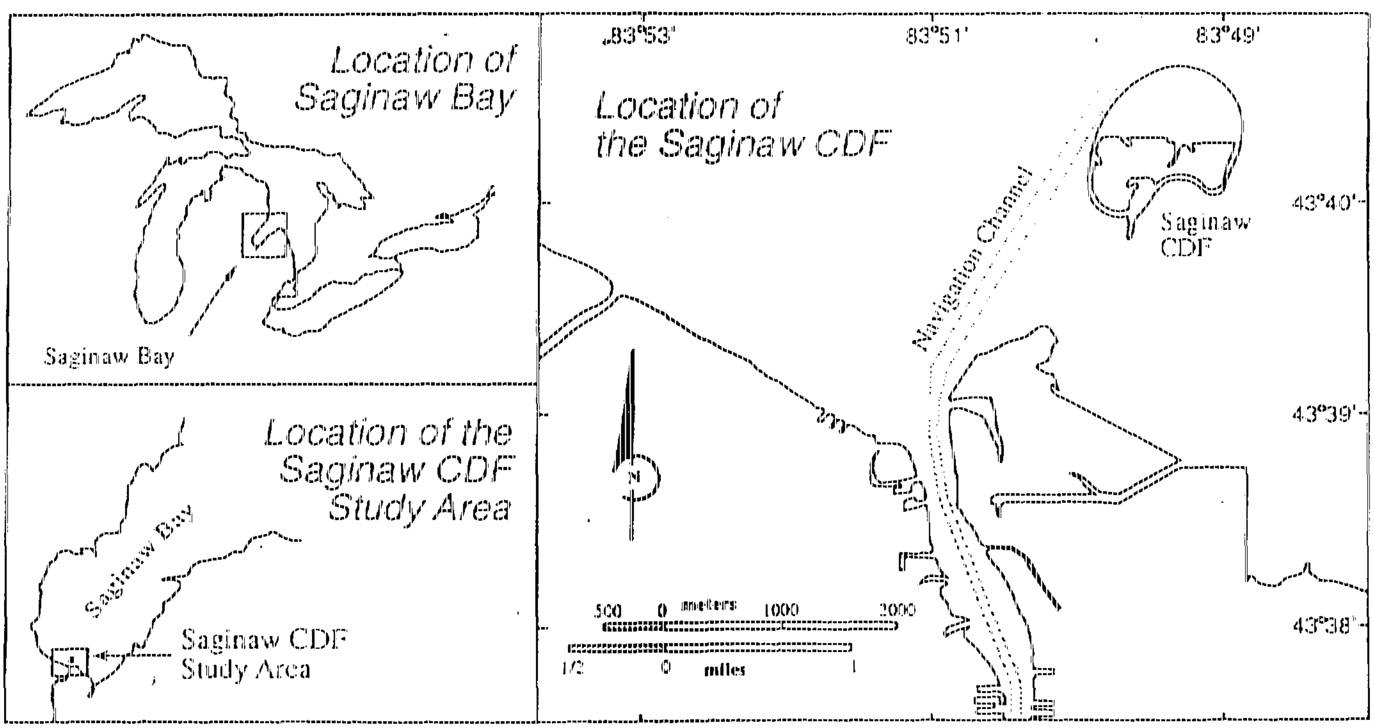

FIG. 1. Location of Saginaw Bay, the Saginaw CDF Study Area and the Saginaw CDF.

capacity of approximately 7,645,000 cubic meters (IJC 1986). Construction of the dike wall was completed in 1978. The CDF was constructed to contain Shelter and Channel islands, which existed prior to construction of the dike wall (Fig. 2).

The dike wall is 7.7 meters high and trapezoidal in cross-section with a thickness of 3.1 meters at the top and 36 meters at its base (Fig. 2). The dike wall is composed of a prepared limestone core (individual stones from 1 to 16 cm in diameter) covered by a fine, plastic filter cloth. Underlayer stone (14 to 113 kg) with cover stone (113 to 950 kg) and/or riprap stone (14 to 113 kg), dependent on placement, furnish protection for the core (USAE 1976). An interior cross-dike wall separates the CDF into two disposal cells, north and south (Fig. 2). As a result of its construction, the CDF is porous and permits the bulk movement of water through the dike wall both into and out of the CDF dependent on temporal variations in hydraulic conditions.

This facility regularly receives materials dredged from the Saginaw River and its associated navigation channel. The first disposal operation was carried out in 1979 and eight disposal operations were completed at the time of the 1987 biomonitoring study. A ninth disposal operation was in progress at the time that the pilot biomonitoring study was conducted. As a result of earlier disposal operations, the north disposal cell of the dike and the northwest section of the south disposal cell were completely filled with dredged materials.

BIOMONITORING STUDY OVERVIEW

Biomonitoring involves the introduction or collection of organisms (biota) at a specific location to determine the occurrence, distribution, and/or availability of contaminants. This approach was applied to the Saginaw CDF to develop the field techniques and data interpretation methods needed to preliminarily determine whether contaminants are transported through CDF dike walls in quantities sufficient to be accumulated by organisms in the outdike environment (Rathbun *et al.* 1988). The biomonitoring approach was utilized because, unlike water, biota accumulate contaminants, integrating their exposure to any intermittent transport over time. This factor is particularly important because of temporal variations in hydraulic conditions both inside and outside of the dike and the influence these variations have on outward transport. Whereas a conventional water sampling approach would require an intensive sampling strategy staged during an event, and can only reflect the presence of contaminants at the time of sampling, the biomonitoring approach requires a relatively small number of samples and can reflect the presence and distribution of

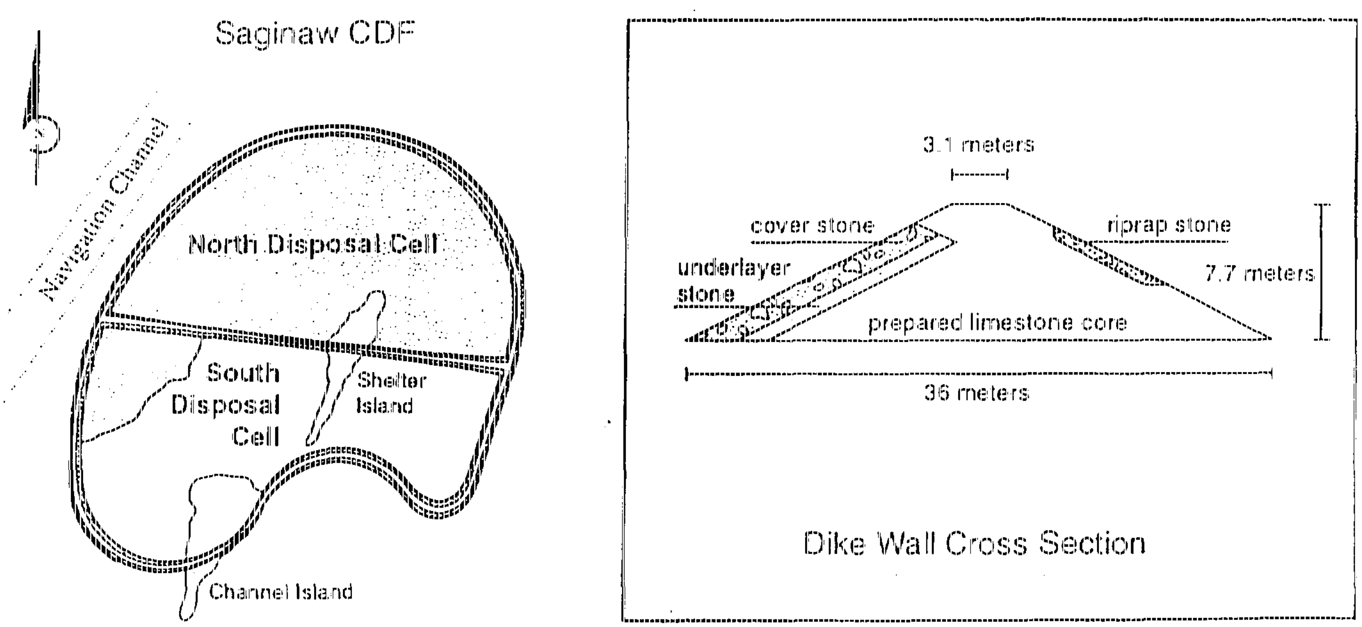

FIG. 2. Saginaw CDF and dike wall cross section.

contaminants as integrated in biological tissues over the entire period of exposure during any series of events. Additionally, biota bioconcentrate/bioaccumulate contaminants to concentrations much higher than present in the surrounding water. This facilitates the detection and measurement of contaminants.

The pattern of contaminants accumulated by an organism can reflect the relative distribution of available contaminants present in its surrounding environment (Willford *et al.* 1987, Mac *et al.* 1990, Mac and Schmitt 1992). The ability to recognize the patterns of accumulation, the so-called chemical fingerprint, for a given class of compounds is essential to this application of the biomonitoring approach.

PCBs were chosen as the target class of compounds for this study because of the demonstrated existence of PCB contamination in the Saginaw River/Bay system. PCBs are also a good choice as the physical-chemical properties of PCBs are representative of a wide range of organochlorine compounds and the analytical techniques for detecting and discriminating between the member compounds in this class (congeners) are well defined (Mullin *et al.* 1984). Further, PCBs were chosen because the 100 or so congeners which occur in the environment are apparently accumulated by certain biota in patterns that are indicative of their exposure. The capability to quantify PCB congeners and identify PCB homolog and congener patterns are paramount to the success of this approach.

BIOMONITORING STUDY FIELD OPERATIONS AND METHODS

A dye study was conducted to determine the most permeable region of the dike wall (Schroeder 1987). Based on information provided by the dye study, three sites were chosen for deployment of caged biota in the study area (Fig. 3). The outdike site was located along the exterior of the dike wall at the point of greatest permeability. The indike site was located along the interior of the dike wall, opposite the outdike station. The reference site was located at navigation buoy #28 a short distance from the CDF. The reference site location was chosen so that the biota at this station and at the outdike station would have a similar exposure to Saginaw River water.

The following organisms were successfully used as biomonitors during the course of this study: green algae (*Cladophora glomerata* (L.) Kuetzing), fat-

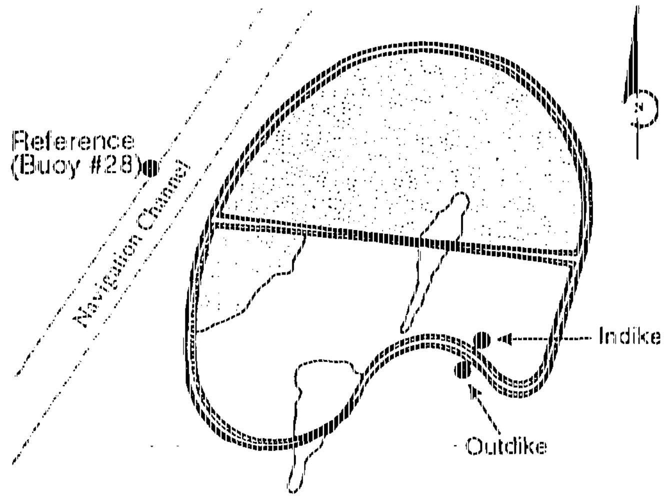

FIG. 3. Location of biomonitoring study sampling sites.

head minnows (*Pimephales promelas* Rafinesque), and mussels (*Lampsilis radiata siliquoidea* Barnes). *Cladophora* is a large genus of freshwater and marine algae, is widely distributed throughout the Great Lakes, and is typically a dominant component of attached algal assemblages. The presence of *Cladophora* at all stations (dike walls and buoy surface) was paramount to its selection as the representative, resident organism in this study. Therefore, the exposure period of Cladophora extended from its development in the spring until the time of collection and differed from the exposure period of fathead minnows and mussels. *Cladophora* has previously been used as an indicator of local organochlorine or heavy metal contamination (Anderson *et al.* 1982, Larsson 1987). At the time cages were recovered from each station, samples of the filamentous alga were obtained by scraping the hard substrates with a knife. Microscopic examination indicated that *Cladophora* was the primary biomass of these samples, although microscopic fauna and flora were associated with the filaments. The fathead minnow is a common and widely-distributed native fish in the Great Lakes and has been successfully used in other PCB bioaccumulation experiments (USEPA 1987, Willford *et al.* 1987, Mac *et al.* 1990). Adult fish were obtained from Kurtz's Fish Hatchery in Elverson, Pennsylvania and were received one day prior to cage deployment. *Lampsilis* is one of the most abundant native bivalves in the Great Lakes and has been successfully used in other PCB bioaccumulation experiments (USEPA 1987, Kauss and Hamdy 1985). Mussels were collected from northwest Lake St. Clair 1 day prior to cage deployment. Pre-exposure PCB concentrations in fathead minnow and mussel samples were determined. Pre-sediment disposal total PCB concentrations in *Cladophora* were not determined.

Caged biota were placed in the study area to simulate the exposure of colonizing, sedentary, and mobile organisms that have direct or proximate contact with the Saginaw CDF. Organism deployment and recovery coincided with dredging and confinement of the most heavily contaminated sediments removed from the Saginaw River during the 1987 dredging and disposal cycle. It was anticipated that this time period would yield the greatest potential for contaminant transport events due to variations in hydraulic conditions within the dike.

The cages used in this study were constructed of 2-cm, angled aluminum frames (3 mm in thickness), 100 x 52 x 32 cm in size, covered with Aquanet®7-mm mesh plastic netting. The tops of the cages were hinged to allow access. The interiors of the cages were divided into equal-volume compartments, separated by plastic netting (Mac *et al.* 1990). Five mussels and 15 fathead minnows were placed into each of three compartments of each cage.

The cages were deployed at each of the three stations on the morning of 2 September 1987, and recovered after 8 days of exposure. The target exposure period was for 10 days as described by the U.S. Fish and Wildlife Service short-term bioassay protocol (Willford *et al.* 1987, Mac *et al.* 1990, Mac and Schmitt 1992). Due to dredging schedule changes, the exposure period had to be shortened to 8 days to prevent contamination of the reference site samples.

At the indike and reference stations, the cages were deployed so that they floated (submerged) in the water column and did not rest upon, come into contact with, or otherwise disturb the bottom sediments. The indike cage was suspended in the ponded water of the CDF, 0.7 m below the water surface. The pond depth at the indike site was 1.5 m. The reference cage was suspended 2 m below the water surface to minimize wave disturbance. The water column depth at the reference site was 5 m. At the outdike station, the cage was deployed so that it was directly across the dike wall from the indike cage, horizontally but not vertically displaced from the CDF pond. To minimize effluent dilution due to waves and currents, the outdike cage was anchored to and rested on the dike wall approximately 1 m below the water surface. Resident *Cladophora* were collected from each station on the last day of the exposure period.

Grab samples of whole water were collected at each of the three stations on the first and last days of the exposure period. These samples were collected as close as possible to the cages. Six clean 4-L amber glass bottles were submerged and filled at each station. The bottles were returned to shore and each six-bottle set, containing a total of 24 L, was split into twelve bottles, each containing 2 L. Two hundred milliliters of dichloromethane (DCM) were added to each of the twelve bottles and their contents were shaken vigorously for 10 seconds to stabilize the samples.

LABORATORY AND ANALYTICAL METHODS

All biota samples were returned to the laboratory on ice and kept frozen until processed. Mussel soft tissue and whole fathead minnow samples were each homogenized in a blender. *Cladophora* samples were air-dried at room temperature for 64 hours and homogenized using a mortar and pestle. Twenty-gram aliquots of mussel and minnow tissue were mixed with anhydrous sodium sulfate (1:3, w:w) in a cellulose thimble and exhaustively Soxhlet extracted with n-hexane and DCM. Three-gram aliquots of dried *Cladophora* were prepared and mixed with anhydrous sodium sulfate (1:10, w:w) in a cellulose thimble and exhaustively Soxhlet extracted with n-hexane and acetone. All extracts were then cleansed of lipids and other interfering compounds by gel permeation chromatography (GPC) and sulfuric acid, sealed in glass ampules, and stored in the dark at a constant temperature of 4°C until analysis.

All water samples were returned to the laboratory and stored at room temperature until processed. A three-stage liquid:liquid extraction was performed on each sample. The sample bottles were vigorously shaken at 150 rpm for 10 minutes on a model G10 Gyrotory Shaker®. The DCM layer was siphoned into a clean 4-L, amber glass solvent bottle and then replaced with an additional 200 mL fresh DCM. The shake and siphon steps were performed three times after which the water was discarded. The DCM layers extracted from each sample were then composited by station to provide a time-integrated sample for the entire period of biota exposure. Additionally, each sample bottle was rinsed with 50 mL of DCM. The rinse solutions were then also added to the composite samples. The volume of each composited extract was reduced over a steam bath to 10 mL and then to 0.5 mL under nitrogen gas. All composite extracts were cleansed of interfering compounds by GPC and sulfuric acid followed by cleanup with activated copper (to remove sulfur), sealed in glass ampules, and stored in the dark at a constant temperature of 4°C until analyzed.

All PCB analyses were performed on Varian® model 3700 capillary column gas chromatographs fitted with dual Ni^{63} electron capture detectors, autosamplers, and DB-5 fused silica columns. Congener 204 (2,2',3,4,4',5,6,6' - octachlorobiphenyl) was used as an internal standard to verity column retention times and concentrations. Individual congeners were identified with reference to a standard mixture of Aroclors 1232, 1248, and 1262 using a modified version of COMSTAR (Burkhard and Weininger 1987). Data output were expressed as the absolute concentration of each detected congener in a sample on a mass or volumetric basis (e.g., µg/kg, ng/L) and as total PCB. For statistical analysis, these absolute concentrations were additionally expressed as relative concentrations (congener fraction of the total mass of PCBs in the sample) by dividing the absolute congener concentration by the summed concentrations of all congeners detected in the sample.

After chemical analyses and quality assurance were completed, the absolute and relative concentrations of the PCBs were statistically examined. Student's t-tests were conducted on total PCB and congener concentrations to determine whether significant differences existed between sample sites for each biota type. Tests were performed using the MICROSTAT software package (Ecosoft, Inc. 1985). Principal component analysis (PCA), a multivariate method of statistical analysis, as well as other parametric and non-parametric techniques, were used to examine the patterns of PCB accumulation in each of the biota and water samples collected. PCA is a data transformation and reduction technique that facilitates the search for patterns within a data set. The relative concentrations of the PCB congeners were grouped into a set of derived data called principal components (PCs). Each of the PCs is a linear combination of the original data with the first PC accounting for the greatest and each successive PC accounting for a decreasing proportion of the total variance in the data. The sum of all the PCs accounts for all the variability in the original data. PCA was conducted using SAS as detailed in the users manual (SAS Institute, Inc. 1987).

BIOMONITORING STUDY RESULTS AND DISCUSSION

Total PCB concentrations in water and biota samples collected as part of the biomonitoring study are presented (Table 1). Total PCBs in the indike water sample were substantially higher than in the outdike and reference samples by a factor of 10 to 20. Total PCB concentrations in mussels and fathead minnows after 8 days of exposure were 3 to 18 times greater than pre-exposure samples, dependent on station. Total PCB concentrations in the indike samples of all three biota types were significantly higher ($p<0.05$) than in the outdike or reference station samples, while the total PCB concentrations in the outdike and reference station samples were not significantly different ($p>0.05$) within a biota type. Because the total PCB concentrations in the indike water and biota samples were significantly higher than the outdike and reference sample and the outdike and reference samples were not significantly different, the transport of PCBs through the CDF dike wall could not be inferred for the exposure period.

The overall PCB congener patterns of the outdike and reference whole water samples were very similar (Fig. 4). The congener patterns of these samples suggested that both sites were equally influenced by the Saginaw River. The pattern of the indike water sample, while similar, contained comparatively higher relative concentrations of several low molec-

TABLE 1. Concentrations of Total PCB in water and biota samples from the Saginaw Bay CDF Study, 1987.

Matrix	Units	Pre-Exposure	Reference	Outdike	Indike
Water	ng/L	-----	5.2	10.2	91.4
Lampsilis	µg/kg	9.5±3.0	32.3± 9.5	26.7±1.5	87.0±22.1
Fathead Minnows	µg/kg	35.7±4.5	113.3±20.8	86.3±24.0	643.3±55.1
Cladophora	µg/kg	-----	180.8±52.9	335.0±106.1	1,400±100

[n = 1 for water samples; n = 3 for biota samples; 8-day exposure; ±1 standard deviation of the mean is presented]

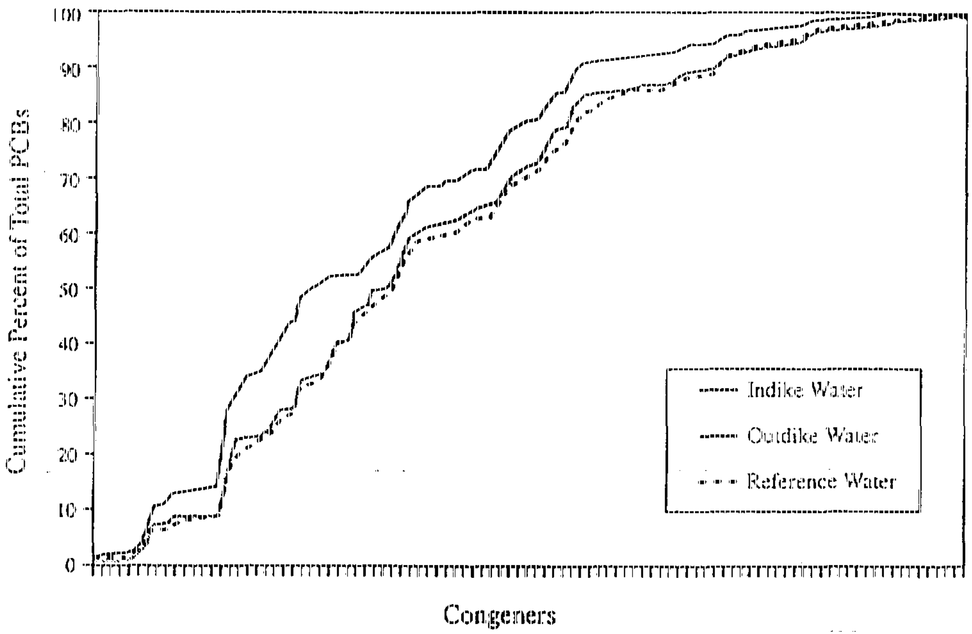

FIG. 4. Cumulative composition (% of total) of PCB congeners in CDF water samples. Congeners arranged by IUPAC number.

ular-weight congeners. These low molecular-weight congeners are most likely to be transported due to differential partitioning to materials comprising the dike wall. Differences in congener patterns between sites is a necessary condition for this application of the biomonitoring approach.

Once it was established that the relative concentrations of the congeners at the indike site were sufficiently different to apply the biomonitoring approach, the congener patterns in biota were examined. Cumulative percent diagrams of PCB congeners for each biota type indicated a difference between the indike site and the other two study sites, whereas the reference and outdike sites were very similar. The data of the outdike site more closely resemble those of the reference site than the indike site. This was true for each of the three biota types. Data for mussels are presented as an example (Fig. 5). Based on the cumulative percent results, no distinct evidence of PCB transport from the Saginaw CDF was observed during the 8-day period of biota exposure.

Transport of PCBs through the dike wall was not suggested by PCA, as the indike and outdike biota were typically at the extreme opposite ends of the first PCA axis and the reference biota were generally associated with the outdike biota (Fig. 6). This relationship was observed for the composite ordination of all biota types and for each of the individual biota types. Data for mussels are again presented as an example (Fig. 7). Based on PCA results, no distinct evidence of PCB transport from the Saginaw CDF was observed during the 8-day period of biota exposure. Because noticeable hydraulic head was produced inside the dike due to disposal operations, thus providing the greatest potential for contaminant transport, and the PCB congener pattern of the indike water differed from the water at the outdike and reference sites, it was assumed that outdike biota would reflect indike PCB congener patterns, pattern remnants, or individual congeners if transport occurred. Multivariate and parametric statistical tests were sufficiently robust to delineate differences in sample PCB congener patterns even if differential transport due to partitioning occurred. Further, if contaminant transport occurred, it was expected that PCA ordination of the PCB congeners would yield a greater association between the outdike and indike biota in comparison to the reference biota, thus confirming both the occurrence of contaminant transport and the indike zone as the source. However, this association between outdike and indike samples was not observed and therefore did not suggest contaminant transport. The U.S. Army Corps of Engineers obtained a similar finding using clams as biomonitors in a study at the Buffalo CDF (Marquenie *et al.* 1990).

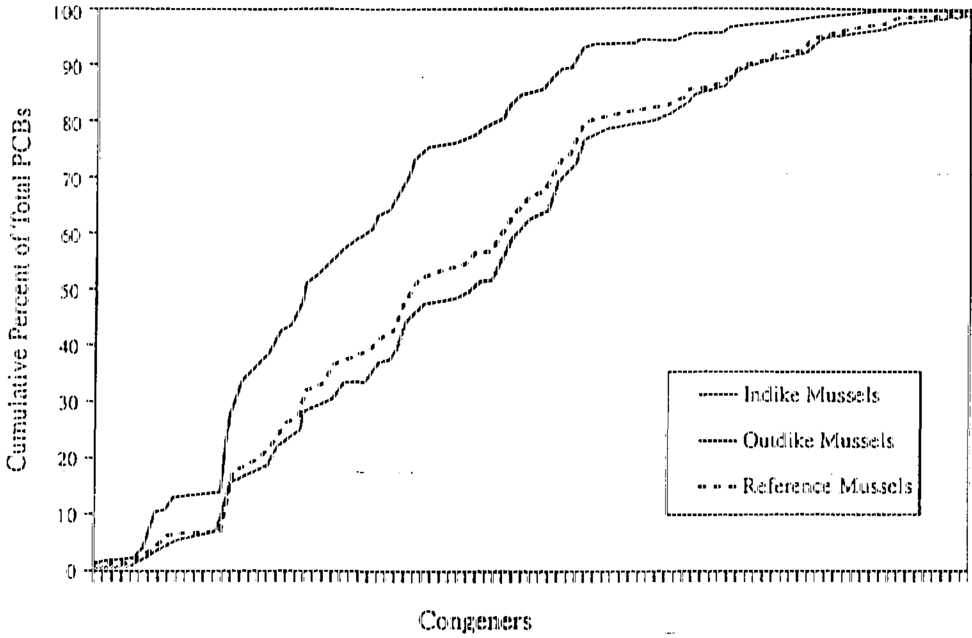

FIG. 5. Cumulative composition (% of total) of PCB congeners in CDF mussel samples. Congeners arranged by IUPAC number.

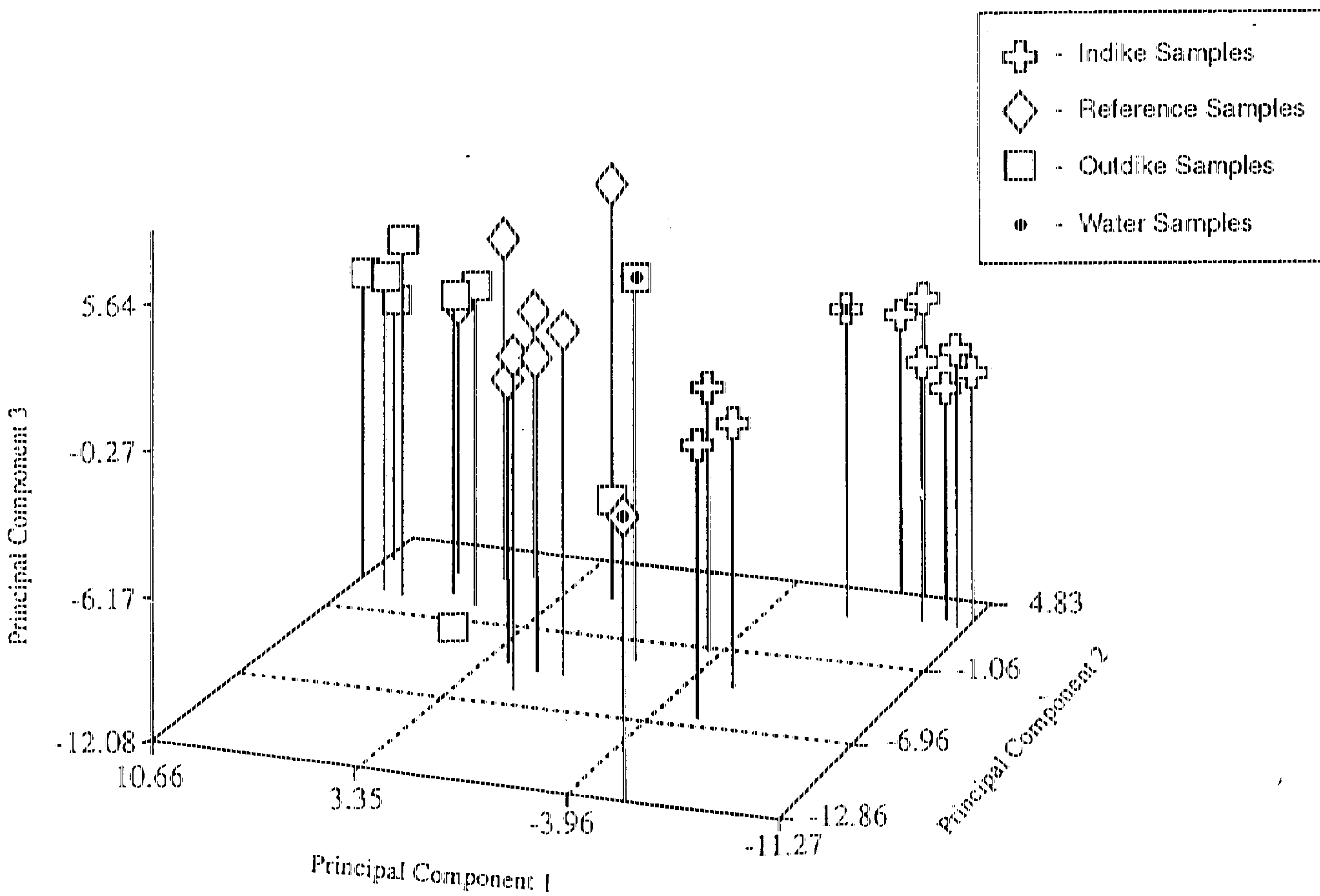

FIG. 6. Principal Component Analysis of algae, minnow, mussel, and water samples.

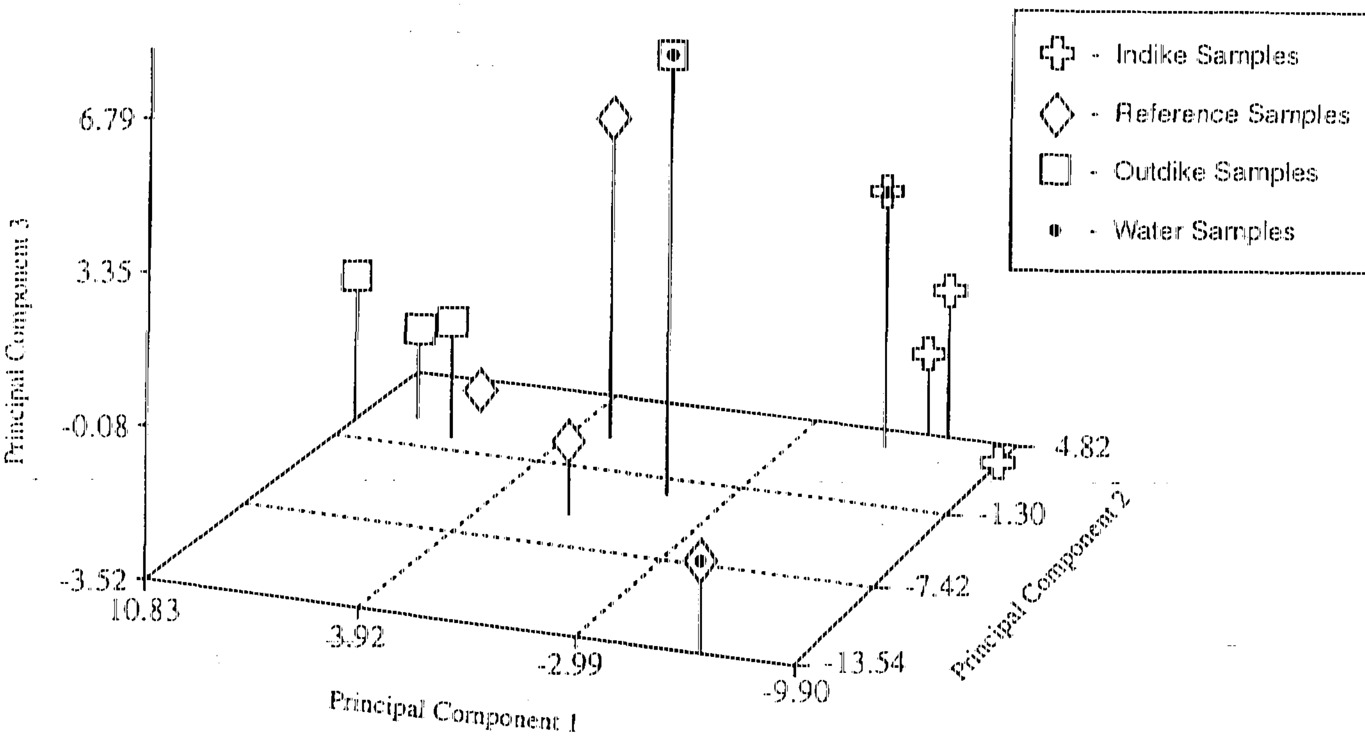

FIG. 7. Principal Component Analysis of mussel and water samples.

NEAR-FIELD/FAR-FIELD MODEL OVERVIEW

Screening-level modeling studies of the Saginaw CDF were also conducted. The primary purpose of these studies was to 1) develop the frameworks necessary to assess the magnitude and rate of contaminant transport from a CDF and its impacts on water column and sediment contaminant concentrations in the receiving waterbody, and 2) demonstrate the utility of this approach through a screening-level application to the Saginaw CDF.

NEAR-FIELD MODEL DESCRIPTION

The Saginaw Bay near-field model was developed to provide a theoretical, screening-level estimate of the magnitude and rate of contaminant transport from a CDF (Martin *et al.* 1988). This model is based upon the generalized contaminant mass balance modeling framework TOXI4, one of the WASP (Water Analysis Simulation Program) family of frameworks (Ambrose *et al.* 1988). TOXI4 was used to construct a contaminant transport and fate framework specifically for evaluating the effectiveness of a variety of CDF designs. TOXI4 uses a finite segment implementation of the generalized contaminant mass balance (partial differential) equation and Euler's method to numerically integrate the resultant series of ordinary differential equations (Ambrose *et al.* 1988). The model time step for numerical integration in this framework is limited by the magnitude of the contaminant mass relative to the contaminant mass rate of change (the derivative).

The framework performs dynamic mass balances for each solids type and contaminant, accounting for all material that enters, accumulates within, or leaves a CDF through loading, transport, and physicochemical and biological transformations. The exact transformation processes that should be included in the framework depend on the contaminant simulated. The framework also calculates the dissolved and particulate contaminant concentrations within the CDF as well as two types of loadings to the receiving waterbody: 1) direct discharges (over the dike wall), and 2) transport through the dike wall. This modeling approach was applied to the Saginaw CDF to estimate the magnitude and rate at which contaminants associated with materials confined in the CDF are transported to the outside environment.

NEAR-FIELD MODEL APPLICATION TO THE SAGINAW CDF

The Saginaw CDF was conceptualized as a semicircular dike with an inner radius of 605 meters and homogeneous limestone walls. The CDF interior was modeled as three horizontal segments (from top to bottom): ponded water, surficial sediment, and deep sediment (Fig. 8). The dike wall was modeled as 20 vertical segments (from dike interior to exterior), each 1 meter thick in cross-section (Fig. 8).

The Saginaw CDF as Conceptualized in the Near-Field Model

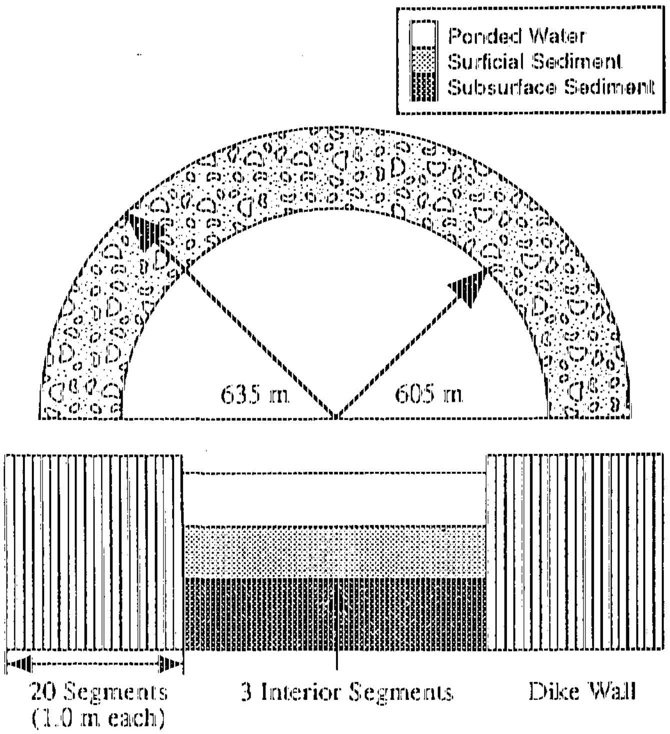

FIG. 8. Near-field model segmentation.

Parallel to the biomonitoring study, PCBs were chosen as the target contaminant for simulation and modeled as a single, homogeneous compound; individual PCB congeners were not modeled. Constants characterizing the dredged materials and the CDF dike wall are presented (Table 2). The water to sediment ratio chosen is typical of hydraulic dredging. The initial concentration of PCBs in the dike wall and the ponded water of the CDF was assumed to be zero. There is one source of PCBs in the model, sediment disposal, and two loss mechanisms, volatilization and transport through the dike (Fig. 9).

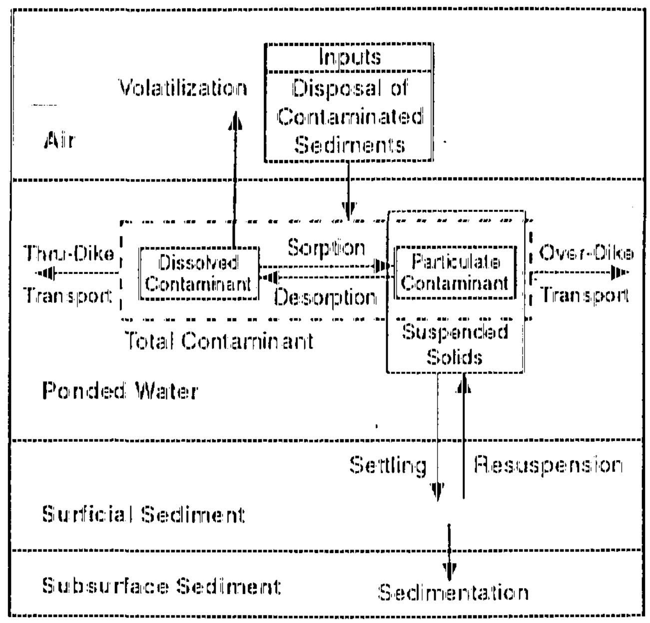

FIG. 9. Mass balance framework of the near-field model.

TABLE 2. Constants characterizing the CDF, dredged materials, and PCBs in the near-field model.

Parameter	Units	Value	Source
Sediment Density	kg/L	2.71	USAE 1987 (Estimated)
Sediment Porosity	-----	0.50	Mills *et al.* 1985 (Estimated)
Sediment Partition Coefficient	L/kg	4.0×10^5	USAE 1987 (Estimated)
PCB Concentration on Sediments	mg/kg	5.26	USAE 1987
Water/Sediment Ratio	-----	9:1	USAE 1987
Dike Wall Porosity	-----	0.6	Mills *et al.* 1985 (Estimated)
Dike Wall Hydraulic Conductivity	cm/s	1.7	Mills *et al.* 1985 (Estimated)
Dike Wall Partition Coefficient	L/kg	100	Estimate

Transport through the dike is influenced by short-term wave action, long-term waves such as seiches, and sediment disposal operations, as well as a variety of other conditions, that can significantly affect water levels both outside and inside the CDF. As water levels fluctuate and hydraulic conditions across the dike wall vary, the rate of contaminant transport also varies and is retarded due to sorption to materials comprising the dike wall. This mechanism for transport is hydraulic pumping (in the direction of the hydraulic gradient) and was modeled as a regularly recurring rise and fall of water levels in the CDF due to sediment disposal and seiches. The outflow seepage through the dike wall due to the disposal operations and internal water surface fluctuations was modeled using Darcy's law. The transport was computed as a function of the hydraulic conductivity and porosity of the dike wall using the arithmetic average of the head between the interior pond, determined from a water balance, and mean exterior water surface. The effects of the fluctuating exterior water surface elevations was modeled using two approaches: as a diffusive transport process and by estimating transmission through the dike based on wave characteristics. The transport into the dike due to external water surface variations was computed based on theoretical methods for predicting transmission through breakwaters (Madsen and White 1976, Madsen *et al.* 1978). All transport through the dike was assumed to be in the dissolved phase. Screening-level calculations, based on particle breakthrough in granular media filters, suggested that particle transport through the dike wall was negligible.

Modeled sediment disposal operations consisted of placing 240,000 m^3 of dredged materials in the CDF over a 60-day period beginning 100 days after the start of the simulation and repeated every 400 days until seven disposal operations were completed. After the final sediment disposal operation, the model simulations were continued until the total time of simulation was 5,000 days (13.7 years). These model runs were used to assess the magnitude and rate of contaminant transport from the Saginaw CDF.

It is worth stressing that this model was developed to provide screening-level estimates of the magnitude of contaminant transport from the Saginaw CDF. As with all water quality models, the accuracy and validity of the model is directly limited by the quality of the data available to parameterize it. The model has not been adequately calibrated or evaluated using site-specific CDF data. Currently, few data are available to characterize the Saginaw CDF (or any CDF). The effect of the model assumptions could only be tested using a limited sensitivity analysis, such as in assessing the impact of partition coefficients on model predictions (Martin *et al.* 1988). However, there were a number of factors which were not considered in the model, such as the effects of catastrophic events, long-term deterioration of the dike wall, and wave overtopping. In addition, there are a number of areas where the methods used are in need of refinement and testing, such as in the computation of contaminant transport through dike walls. It should also be recognized that the model does not consider the effects of contaminant transport or dispersal due to currents in the receiving waterbody. Further development of this model will be limited until data that allow quantitative description of the dike wall environment become available. Despite this limitation, the model is still valuable as a screening-level tool for providing initial estimates of the long-term effects of containing contaminated sediments in the Saginaw CDF after dredging as well as demonstrating the need for additional data.

NEAR-FIELD MODEL RESULTS

Model results indicate that after 1 year, the magnitude of PCB transport through the dike wall of the Saginaw CDF is expected to be on the order of 5–6 milligrams. Volatilization losses, though they do not directly impact the environment immediately surrounding the CDF, are on the order of 20 grams after 1 year. Model results also indicate that after repeated disposal operations, the magnitude of PCBs transported and volatilized from the CDF is expected to increase. Cumulative PCB loss through the dike walls are predicted to be on the order of 220 grams over 5,000 days of simulation. Cumulative volatilization losses are also predicted to be on the order of 3.32 kilograms over the same period (Figs. 10–12).

FAR-FIELD MODEL DESCRIPTION

The Saginaw Bay far-field model was developed to provide a screening-level estimate or prediction of the water quality impacts of contaminant transport from any source on the receiving waterbody (Velleux *et al.* 1988). This model is based on the generalized contaminant mass balance modeling framework WASP (DiToro *et al.* 1983). WASP uses a finite segment implementation of the generalized contaminant mass balance (partial differential) equation and Euler's method to numerically integrate the resultant series of ordinary differential

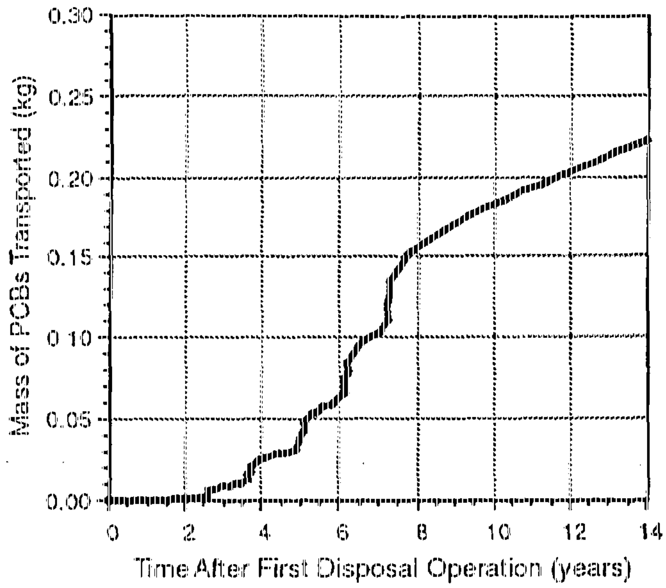

FIG. 10. Near-field model prediction of the cumulative mass of PCBs transported through the dike wall of the Saginaw CDF.

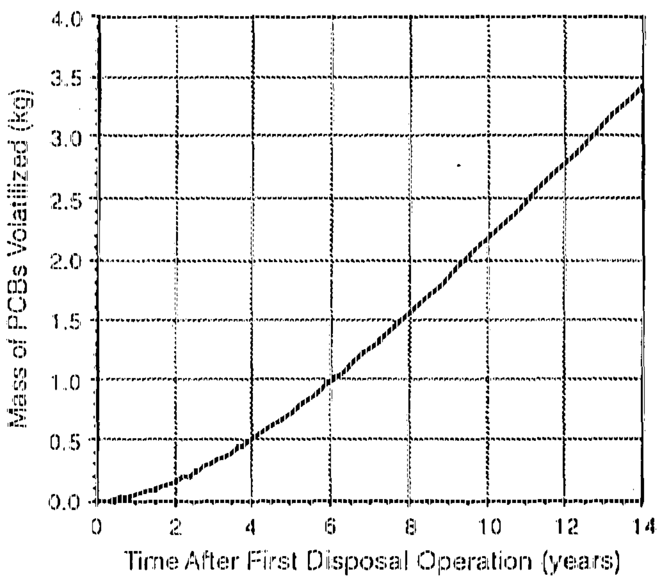

FIG. 11. Near-field model prediction of the cumulative mass of PCBs volatilized from the Saginaw CDF.

equations. The model time step for numerical integration in this framework is limited by the magnitude of the contaminant mass relative to the contaminant mass rate of change (the derivative).

The framework performs dynamic mass balances

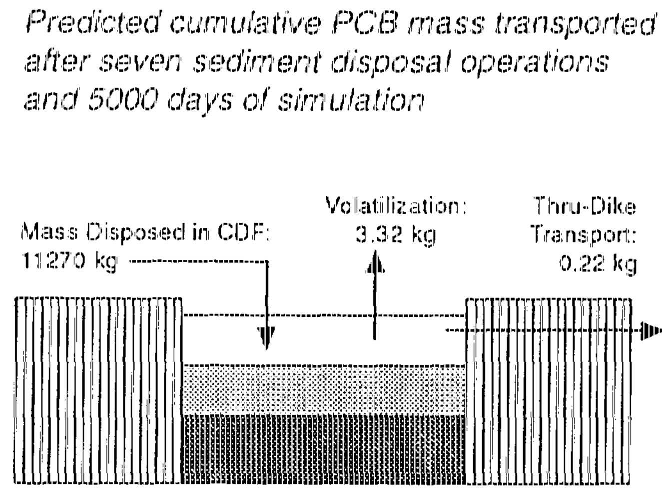

FIG. 12. Near-field model prediction of the cumulative mass of PCBs transported and volatilized from the Saginaw CDF.

for each solids type and contaminant, accounting for all material that enters, accumulates within, or leaves a waterbody through loading, transport, and physicochemical and biological transformations. The exact transformation processes that should be included in the framework depend on the contaminant simulated. The framework also calculates the dissolved and particulate contaminant concentrations in the water column and sediments throughout the waterbody. The WASP framework was previously used to construct and calibrate a PCB transport and fate model specifically for Saginaw Bay (Richardson *et al.* 1983). A modified version of this model was used to provide an estimate of the water column contaminant concentrations and relative risks that may arise from disposing contaminated sediments within the Saginaw CDF.

Model modifications were limited to removing all non-CDF PCB sources from the model (the Saginaw River, Lake Huron boundary condition, etc.) and adding PCB input from the Saginaw CDF. These modifications allowed the impact of contaminant transport from the CDF on PCB concentrations in Saginaw Bay to be easily assessed, independent of other PCB sources.

FAR-FIELD MODEL APPLICATION TO THE SAGINAW CDF

Saginaw Bay was modeled as 19 segments divided into three layers: five surface water, eight surficial sediment, and six deep sediment segments. The Saginaw CDF was conceptualized as a point source, located in segment 1 (Fig. 13).

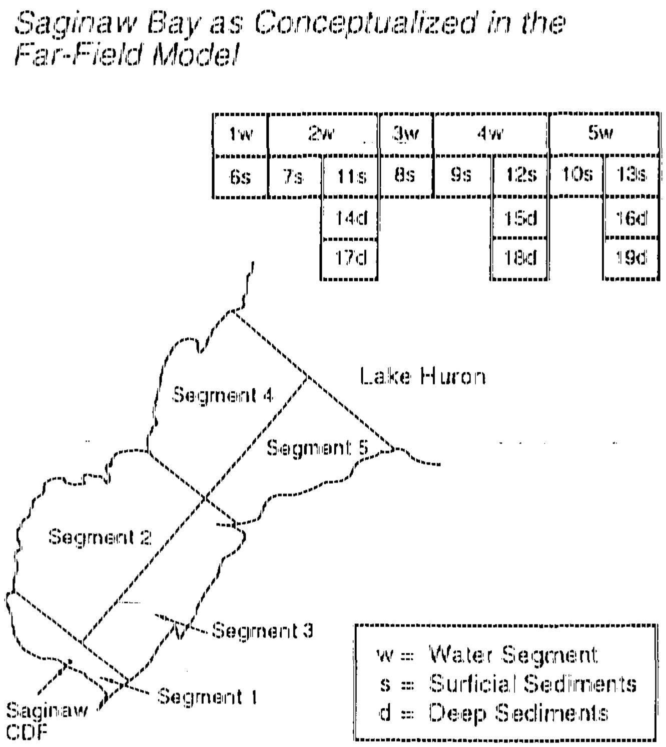

FIG. 13. Far-field model segmentation.

To allow comparisons between the far-field model and the data collected during the biomonitoring study, PCBs were chosen as the target contaminant for simulation and modeled as the composite of two industrial mixtures, Aroclors 1242 and 1260. Total PCBs were represented as the sum of these two Aroclors. The composition of the modeled load entering the bay from the CDF was assumed to be identical to the load entering the bay from the Saginaw River. Constants characterizing the behavior of solids and PCBs in Saginaw Bay have been previously described (Richardson *et al.* 1983) and are presented for convenience (Table 3). There is one source of PCBs in the model, transport from the Saginaw CDF, and three loss mechanisms, volatilization, transport out of the bay (to Lake Huron), and sedimentation (Fig. 14). Model runs were conducted to determine the relationship at steady-state between PCB transport from the Saginaw CDF and water column PCB concentrations in Saginaw Bay.

FAR-FIELD MODEL RESULTS

Model predictions indicate that steady-state water column PCB concentrations are expected to increase by about 0.05 ng/L per kilogram of PCB annually transported from the CDF. This estimate is based on the response of model segment 1, the area of the bay

TABLE 3. Constants characterizing the environmental behavior of solids and PCB Aroclors 1242 and 1260 in the far-field model (previously presented in Richardson et al. 1983).

Parameter	Units	Value	Source
Particle Settling Velocity:			Richardson *et al.* 1983
Organic Solids	m/day	0.10	(Calibration values)
Light Solids	m/day	0.20	
Heavy Solids	m/day	1.50	
Log Partition Coefficient:			Richardson *et al.* 1983
Aroclor 1242			(Calibration values)
Organic Solids	L/kg	4.78	
Light Solids	L/kg	4.30	
Heavy Solids	L/kg	3.30	
Aroclor 1260			
Organic Solids	L/kg	5.00	
Light Solids	L/kg	4.60	
Heavy Solids	L/kg	3.30	
Volatilization Rate:			Richardson *et al.* 1983
Aroclor 1242	m/day	0.20	(Calibration values)
Aroclor 1260	m/day	0.05	

immediately surrounding the CDF. Model results also indicate that PCB concentrations are predicted to be greatest near the CDF and decrease as distance from the CDF increases (Fig. 15).

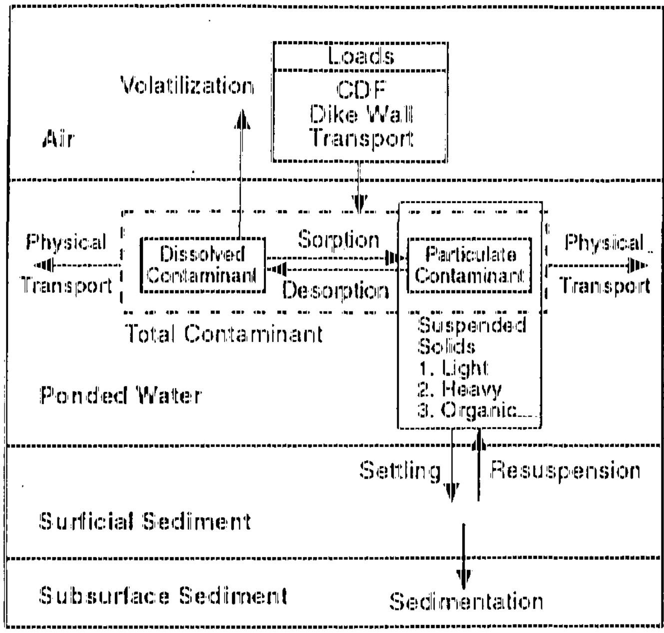

FIG. 14. Mass balance framework of the far-field model.

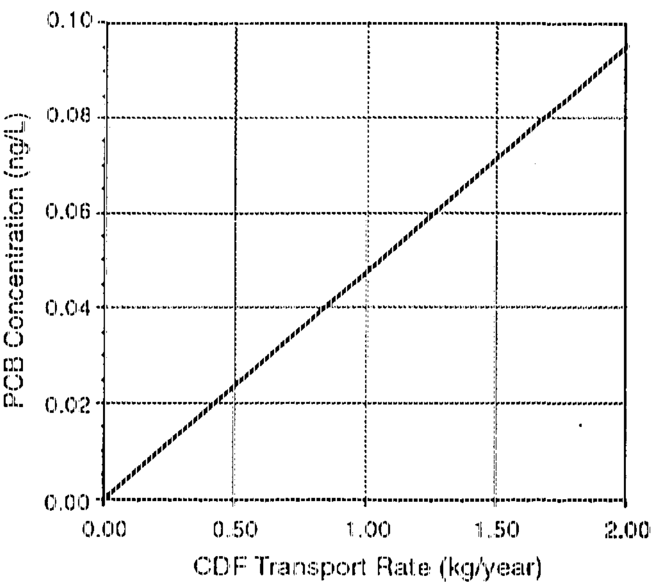

FIG. 15. Far-field model prediction of model segment 1 response to transport from the Saginaw CDF.

NEAR-FIELD/FAR-FIELD MODEL DISCUSSION

To put the results of these modeling studies into a water quality management context, the current federal PCB water quality criterion for human health at 10^{-6} risk, 0.079 ng/L (USEPA 1986), was used to describe the magnitude of the potential impacts of PCB transport from the Saginaw CDF. In this context, the far-field model results (0.05 ng/L per kg of PCB transported from the CDF) can then be used to determine the maximum annual rate of PCB transport from the CDF that can be sustained without *exceeding the 10^{-6} risk criterion, independent of* other sources.

The far-field model results indicate that the theoretical maximum sustainable rate of PCB transport from the Saginaw CDF would be approximately 1.58 kg/year. Transport rates greater than this value would result in water column PCB concentrations in excess of the federal water quality criterion. This estimate is based on the response of far-field model segment 1.

The near-field model estimates the cumulative mass of PCB transported from the Saginaw CDF to be on the order of 220 grams after 5,000 days of simulation, given the modeled sediment disposal conditions. Compared to the simulated rate of PCB loading into the CDF, about 340 kg for each sediment disposal operation, the theoretical rate of PCB transport from the CDF is small. This transport, while considerable (amounting to about 0.016 kg/year on an average annual basis), is not predicted to reach unacceptably large levels (>1.58 kg/year) over the 5,000-day time frame. The findings of the biomonitoring study may offer partial confirmation of this result. However, these results cannot completely address the issue of long-term contaminant transport.

Long-term near-field model predictions indicate that contaminant transport from the CDF will increase in time. Contaminant transport from the Saginaw CDF, and CDFs in general, may be a highly time-dependent process, perhaps requiring 20 years or more before easily quantifiable levels of contaminants are transported from the structure (analogous to retardation in the transport of hydrophobic contaminants through groundwaters or any porous media). The major mechanism for transport through the dike is believed to be hydraulic pumping, caused by fluctuating water levels within and outside of the dike. Substantial volumes of water enter the CDF during the course of any sediment disposal operation. Newly confined sediments will also displace additional water, causing noticeable changes in water levels within the dike as sediment disposal operations progress. This effect was observed during the course of the biomonitoring study (Rathbun *et al.* 1988). Additionally, water level fluctuations both inside and outside the dike can be caused by a variety of conditions, such as storms, wave-piling due to strong winds, and the naturally-occurring periodic variations in water levels, such as seiches. These water level fluctuations may provide a substantial hydraulic gradient, driving water and associated contaminants through the dike wall, eventually saturating and exceeding the sorptive capacity of the dike, potentially allowing contaminants to escape.

Volatilization is predicted to be the largest of all the possible PCB transport mechanisms. As the CDF is filled, and the depth of the ponded water decreases, the mass rate of volatilization from the CDF is predicted to increase. At the end of a CDF's active life, the structure may be capped with a layer of clean materials, such as clean fill. However, these capping materials may be porous and significant quantities of contaminants may nonetheless continue to escape the CDF due to volatilization, potentially posing a long-range, long-term hazard to the surrounding ecoregion. It should be noted that no attempt was made in the far-field model to consider the impact of contaminants volatilized from the CDF. An implicit assumption of this model is that volatilized contaminants are a long-range, long-term hazard that do not directly impact the area immediately surrounding the CDF. Additionally, it should be noted that as water quality standards are changed, the threshold transport rate resulting in a violation of the water quality criterion will also change, perhaps leading to a different interpretation of these results.

It is again worth stressing that both the near-field and far-field models were developed to provide screening-level estimates of the magnitude of contaminant transport from the Saginaw CDF and its impact on water quality in Saginaw Bay. The accuracy of these models is directly limited by the quality of the data available to parameterize them. As few data are available to characterize the Saginaw CDF, further development of these models will be limited until data that allow quantitative description of the dike wall and the surrounding environment become available. Despite these limitations, these models nonetheless are useful screening-level tools that provide initial estimates of the long-term effects of confining contaminated sediments in the Saginaw CDF after dredging as well as demonstrate the need for additional data.

SUMMARY AND CONCLUSIONS

A biomonitoring study was conducted at the Saginaw Bay CDF to preliminarily determine whether contaminants are transported through CDF dike walls. Biomonitoring involves the use of organisms (biota) at specific locations in and around the CDF to determine the occurrence, distribution, and/or availability of contaminants (in this case PCBs). Biota samples were collected and analyzed for PCBs. Principal component analysis (PCA), a multivariate method of statistical analysis, was used to examine the patterns of PCB accumulation in each of the biota and water samples collected. No distinct evidence of PCB transport from the Saginaw CDF was observed using this technique.

Modeling studies of the Saginaw CDF were also conducted. These models were used to assess 1) the rate at which contaminants can theoretically escape the CDF, and 2) the potential impact these contaminants have on water column contaminant concentrations in the receiving waterbody.

The near-field model was developed to assess the rate at which contaminants (PCBs) can theoretically escape the CDF. Model results indicate that the magnitude of cumulative PCB transport from the Saginaw CDF is expected to be on the order of 220 grams for the modeled sediment disposal conditions and 5,000 days of simulation. Transport through the dike, while considerable, is not predicted to reach unacceptably large levels over the active life of the CDF.

The far-field model was developed to assess the impact of contaminant (PCBs) transport from the Saginaw CDF on Saginaw Bay. Model results indicate that steady-state water column PCB concentrations are expected to increase by about 0.05 ng/L for each kilogram of PCB transported through the dike walls of the CDF. Model results also indicate that PCB concentrations are predicted to be greatest near the CDF and decrease as distance from the CDF increases. Based upon the current federal PCB water quality criterion for human health at 10^{-6} risk, 0.079 ng/L, the theoretical maximum rate of PCB transport from the Saginaw CDF that can be sustained without resulting in a violation of the 10^{-6} risk criterion is approximately 1.58 kg/year. Transport rates greater than this value would result in water column PCB concentrations in excess of the federal water quality criterion. This estimate is based on the response of far-field model segment 1. The predicted rate of PCB transport through the dike wall, 0.016 kg/year, in itself would not result in a violation of the current 10^{-6} risk criterion.

The field, interpretive, and theoretical methods explored through these pilot studies were initiated to develop a framework for future evaluations of the CDF contaminant retention/transport and contaminated sediment disposal impact issues. The results of the biomonitoring study, not fully reported here, suggested a number of study design alternatives that would improve the evaluation of CDF performance. These include: replicate stations at the reference, indike, and outdike sites (for improved spatial coverage), separating and analyzing the dissolved and particulate fractions of the whole water PCB samples (assuming that the dissolved PCBs are more likely to be transported through the dike wall), a full 10-day biota exposure period as recommended by the USFWS protocol, and conducting a biomonitoring study before as well as during sediment disposal operations (to investigate the potential for contaminant transport from an inactive and active CDF). Most of these improvements were incorporated into a subsequent biomonitoring study of the Saginaw CDF conducted in 1988 (Kreis *et al.* 1992). Similarly, interpretive techniques using additional significance tests, graphical representations, and a focus on low molecular-weight PCB congeners, those most likely to be transported due to differential partitioning to materials comprising the dike wall, should be examined.

The screening-level CDF modeling results also suggested a number of model refinements that would improve the evaluation of CDF performance. These include: revised descriptions of the indike environment, wave transmission and subsequent contaminant transport through the dike wall, and long-term contaminant transport through the dike long after the CDF is completely filled. For example, the indike environment was modeled as a homogeneous pond. The CDF dike wall was constructed to contain Channel and Shelter islands. For a more realistic simulation, the dike interior could be modeled as several segments including the pre-existing islands, mounds of exposed surface sediments created during sediment disposal, and the ponded water, as well as confined sediments underlying the CDF pond. Unfortunately, most of these model refinements require a degree of field data or theoretical sophistication that is currently unavailable.

At present, the pilot biomonitoring study did not suggest that significant contaminant transport occurred during the 1987 sediment disposal operations. The modeling efforts similarly do not suggest an extraordinarily great potential for contaminant transport from the Saginaw CDF. These parallel lines of evidence both suggest that the magnitude of contaminant transport from the Saginaw CDF is small.

ACKNOWLEDGMENTS

An investigation of this type depends heavily upon the efforts of others. The authors wish to express their appreciation to the following individuals and agencies for their efforts: Edward L. Lancaster (AScI Corp., Grosse Ile), Douglas D. Endicott (USEPA, Grosse Ile), William L. Richardson (USEPA, Grosse Ile), Mathew J. Zabik (Michigan State University), Robert B. Ambrose, Jr. (USEPA, Athens), Stephen McCutcheon (USEPA, Athens), Pamela Bedore (USAE, Detroit), Ernest A. Liebetreu (USAE, Essexville), Howard B. Zar (USEPA, Chicago), Timothy J. Kubiak (USFWS, Lansing), the U.S. Army Corps of Engineers, and USEPA-Region V. Graphics were provided by Kay Morrison (AScI Corp., Grosse Ile), Jennifer S. Witt (AScI Corp., Grosse Ile), and David S. Frey (CSC, Grosse Ile).

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Submitted: 6 November 1992
Accepted: 13 December 1992

1/24/96

WE THE NEIGHBORS AND ABUTTERS OF THE ACUSHNET RIVER ON COFFIN AVENUE DO NOT WANT THE LAGOON FILLED IN OR MADE INTO A TOXIC DUMP IN FRONT OF OUR HOMES. WE AS TAXPAYERS AND TENANTS LIKE AND ENJOY OUR LAGOON AS IT IS. WE OBJECT AND DO NOT WANT ANY FILLING OF THE LAGOON NOW OR EVER. IT HAS BECOME A SANCTUARY FOR WHITE TRUMPTER SWANS, DUCKS, CRANES IN THE FALL AND WINTER. WE ENJOY IT ITS ALWAYS BEEN THERE, DONT SPOIL IT, PLEASE!

SIGNATURES OF CONCERNED PEOPLE:

1 Manuel Sylvia – 97 Coffin Ave – N.B. – (owner)
2 Beryl Sylvia – 97 Coffin Ave – N.B. (owner)
3 Julie Carreiro 107 Coffin ave.
4 Connie Carreiro 107 Coffin Ave.
5 Bento Carreiro 107 Coffin ave
6 ✓ Michelle Chen 117 Coffin Ave. (tenant)
7 ✓ Mak Nae Kim 117 Coffin (")

8 Lun Ae Matias 117 Coffin Ave (owner)
9 Antonio Matias 117 Coffin Ave (")
10 Lisa Batista 117 Coffin Ave
11 [illegible] 137 Coffin Ave (?)
12 Maria Pereira 387 Belleville Ave (?)
13 Maria Barreiro 373 Belleville Ave (owner)
14 [illegible] Amaral 383 Belleville Ave. (owner)
15 Lori Valerio 383 Belleville Ave
16 [illegible] 35 Deane St (owner)
17 [illegible] Ferreira 35 Deane St (Tenant)
18 [illegible] 385 Belleville Ave (owner)
19 [illegible] C. [illegible] 433 Belleville Ave owner
20 maggie medeiros 418 Belleville Ave. (tenant)
21 Eduardo Teves
103 coffin ave New Bedford (owner)
22 Michelle Teixeira 101 Coffin (Tenant)
23 Joseph Teixeira Jr. 101 coffin (Tenant)
24 Carol Mendonca 101 Coffin (tenant)
25 Russell Sylvia 101 Coffin Ave (owner)
26 Humberto Vieira 93 Coffin Ave (owner)
27 Kevin W Vieira 104 coffin (TENANT)
28 Thomas Sylvia 97 coffin Ave - (Tenant)
29

13.436

Ward 2 Residents Meeting on New Bedford Harbor Cleanup

2:00 - 2:30	Informal Open House/Browse information stations
2:30	Introduction of Forum Members and Speakers Purpose/Rules of Order
	Background on Problem in the Harbor
	Recommended Solutions to Clean Up the Harbor
	Concerns of the Citizens/Q & A Session

ATTENTION !!!

RESIDENTS OF WARD 2

SPECIAL MEETING TO ADDRESS THE FUTURE OF THE COFFIN AVENUE LAGOON AND PROPOSED HAZARDOUS WASTE LANDFILL FOR RIVERSIDE PARK AREA.

SUNDAY, FEBRUARY 11, 1996
2:00 P.M.
CLUB RECORDACOES DE PORTUGAL
253 COGGESHALL STREET, NEW BEDFORD

RESIDENTS ARE INVITED TO ATTEND AND VOICE THEIR CONCERNS ABOUT THIS LANDFILL !!!!

TRANSLATOR SERVICES WILL BE PROVIDED

ATTENTION!!!

RESIDENTS OF WARD 2

YOU ARE INVITED TO ATTEND A SPECIAL MEETING
TO UPDATE YOU ON THE CLEANUP OF NEW BEDFORD HARBOR,
THE ACUSHNET RIVER AND COFFIN AVENUE LAGOON,
AND THE PROPOSED SEDIMENT DISPOSAL FACILITY
FOR RIVERSIDE PARK AREA

SUNDAY, FEBRUARY 11, 1996
2:00 P.M.
CLUB RECORDACOES DE PORTUGAL
253 COGGESHALL STREET, NEW BEDFORD

RESIDENTS ARE ENCOURAGED TO ATTEND AND VOICE
THEIR CONCERNS ABOUT THE CLEANUP PROPOSALS FOR THE LAGOON

TRANSLATION SERVICES IN PORTUGUESE WILL BE PROVIDED