RETURN TO 1998 ROD AR INDEX

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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WALTHAM , MASSACHUSETTS 02254-9149

REPLY TO
ATTENTION OF

October 17, 1997

Programs/Project Management Division

David Dickerson
U.S. Environmental Protection Agency
Office of Site Remediation and Restoration
JFK Federal Building
Boston, Massachusetts 02203-2211

New Bedford
44
214207

SDMS DocID 000214207

Dear Mr. Dickerson:

The enclosed memorandum with attachments presents the results of the Corps of Engineers' effort to estimate the quantity and quality of leachate that would be released from confined disposal facilities along the New Bedford Harbor shoreline. The initial effort took place as part of the Engineering Feasibility Study completed in 1989 and a final effort was completed this week.

I can be reached at (617) 647-8895 if there are any questions.

Sincerely,

Mark J. Otis
Acting Chief, Environmental
Project Management Branch

Printed on Recycled Paper

CENAE-PD-E October 17, 1997

MEMORANDUM FOR THE RECORD

SUBJECT: New Bedford Harbor Superfund Site/ Estimates of Contaminant Loss (through leachate) from Confined Disposal Facilities

1. This memorandum has been prepared to summarize and document efforts by the Corps of Engineers (New England Division and Waterways Experiment Station (WES)) to estimate the quantity and quality of leachate that would be released from confined disposal facilities constructed in New Bedford to contain the contaminated dredged material from the harbor.

2. Numerous evaluations have been performed as EPA's proposed plan for remediating New Bedford Harbor has evolved from 1989 to the present time. Estimates have been developed for capped and uncapped CDFs as well as for those located in a shoreline and upland settings. Estimates have been modified as the predictive tools used in the analysis have been modified and improved. The reports and correspondence associated with these efforts are listed below in chronological order and attached to this memorandum.

* Attachment 1: Engineering Feasibility Report (EFS) #11 (April 1989) estimated contaminant (PCB and metals) losses through various pathways associated with the remedial alternatives (developed by the Corps of Engineers) presented in this report. Site specific information generated during the EFS was used in making these estimates of contaminant loss. Estimates of the quality of leachate were based on the results of leaching tests performed on New Bedford Harbor sediment (EFS Report #5). Estimates of the quantity of leachate leaving the CDFs assumed that the foundations are free draining which represents a "worst case" scenario.

* Attachment 2 is a memorandum dated October 28, 1992 from Daniel Averett at WES which contains estimates of leachate and contaminant loss from CDF location 1 (The cove on the New Bedford side of the upper estuary located just north of Sawyer Street).

* Attachment 3 is my request of February 10, 1993 for WES to evaluate leachate loss from the following CDF locations on the New Bedford shoreline:

a) CDF 1 mentioned above;
b) CDF 1B which is located north of CDF 1 in the northern portion of the estuary; and
c) CDF 7 which is located south of the I-195 bridges in the area known as the north terminal.

The physical dimensions of these CDFs were included with my request.

* Attachment 4 is a memorandum dated March 19, 1993 from Daniel Averett at WES which contains leachate estimates for CDFs 1, 1B, and 7 (both capped and uncapped).

* Attachment 5 is my letter to Gayle Garmen (EPA's RPM at that time) dated April 13, 1993 which transmitted the latest information from WES and addressed several questions received by EPA regarding the leaching of PCBs from CDFs. In this letter I took the leachate estimates from the March 19, 1993 WES memorandum and estimated the mass of PCBs that would be released from each CDF over a 20 year period.

* Attachment 6 is my request of August 15, 1995 for WES to re-visit their estimates of leachate/contaminant release for CDFs 1, 1B and 7. Through subsequent conversations and meetings this request was amended such that CDF locations A, B, C and D (current proposed plan) were evaluated. These CDFs are located along the New Bedford shoreline as described below:

a) CDF A and B are similar in location and size to CDF 1B described earlier. A gap was left between the facilities to allow for Commonwealth Electric's power cables that cross the harbor in this location.
b) CDF C ties into the existing CDF at the foot of Sawyer Street and extends south to the Coggeshall Street Bridge.
c) CDF D is in the same location as the previously described CDF 7 (North Terminal Area) with the current proposal being a larger facility.

* Attachment 7 contains the leachate and contaminant estimates for CDFs A, B, C and D which were prepared at WES and submitted in Ocotber 1997.

3. Samples of sediment were taken from New Bedford Harbor in the late 1980's and tested as part of the Engineering Feasibility Study. The information obtained from these tests on New Bedford sediment have been used in all of the evaluations listed above. No additional sampling and testing of New Bedford sediments was performed. Methods for estimating variables associated with conditions that would exist in an actual disposal facility have been refined over the years as have the predictive tools used in the evaluations. Each attachment that contains leachate/contaminant estimates will identify the critical assumptions and the predictive tools used in that evaluation. The original estimates contained in EFS Report #11 are the worst case scenario. Subsequent evaluations have included the impact of foundation conditions on leachate flow.

4. Estimates of the mass of PCBs leaching from capped CDFs are compared below and in Attachment 5 for informational purposes:

Year	CDFs 1,1B, 3, 12 (1989 estimate)[1]	CDFs 1, 1B and 7 (1993 estimate)	CDFs A, B, C, D (1997 estimate)
1		23 kg	5.0 kg
3	150 kg (years 1-10)	4.3 kg	5.1 kg
5		0 .0018 kg	2.6 kg
20	40 kg (years 10 - 30)	0.0108 kg	0.1665 kg
total	190 kg over 30 years	38.9 kg over 20 years	35.4 kg over 20 years

1) This estimate was presented in Appendix D of EFS Report #11. CDF location #12 was located in an upland setting.

Mark J. Otis
Acting Chief, Environmental
Project Management Branch

APPENDIX D: ESTIMATED CONTAMINANT RELEASE FROM DREDGING AND DREDGED MATERIAL DISPOSAL

Introduction

Background

1. Sediment to be dredged from the New Bedford Harbor Superfund Project is contaminated with polychlorinated biphenyls (PCBs) and heavy metals. Remedial alternatives for removing and disposing of this sediment will increase the release of these contaminants above existing background conditions for the period of time required to remove the contaminated sediment from the estuary. Impacts of these relatively short-term releases must be weighed against the benefits of removing the bulk of the contaminants from the estuary to improve water quality, aquatic resources, and public health for the long term.

2. Various project activities may release or increase the potential for mobility of contaminants to the environment. These activities include the confined disposal facility (CDF) dike construction for in-water sites, the dredging operation, effluent from the CDF during filling, surface runoff from the filled and capped CDF, leachate from the CDF, and the contained aquatic disposal (CAD) filling/capping operation. The primary migration pathways for transport of contaminants from these operations to the environment are surface water (for dike construction, dredging, CAD filling, and effluent from CDF) and ground water (for leachate). Other pathways are air and biological uptake by organisms in the CAD and CDF site.

Scope

3. This appendix presents estimates of the magnitude of contaminants, specifically PCBs and selected heavy metals, that may be released by the dredging and disposal alternatives being addressed by this Engineering Feasibility Study (EFS). The estimates are based on the data developed by EFS Tasks 4 and 6. Task 4 predicted sediment resuspension rates during dredging, modeled sediment transport and migration for the estuary, and evaluated existing PCB fluxes from the estuary. Testing protocols performed under Task 6 provided data for heavy metal and PCB concentrations for dissolved and particle-associated transport mechanisms from dredging and disposal operations

ATTACHMENT #1

to surface and ground water. The detailed results of Tasks 4 and 6 are presented in Reports 2-10 of the series.

Technical approach

4. Most of the Management Strategy (Francingues et al. 1985*) testing protocols yield a qualitative assessment of chemical quality for CDF effluent, runoff, and leachate and for open-water disposal. Quantification of contaminant releases from CDF effluent is straightforward. However, techniques for quantifying CDF leachate releases and for estimating releases from the dredging operation and from the CAD operation are not well developed or field proven. Results from the New Bedford Superfund Pilot Study (Otis and Andreliunas 1987) will allow refinement of these estimates by verifying bench-scale results and accounting for field conditions, prototype dredging activities, and site-specific conditions at the New Bedford Harbor Superfund Site.

5. The releases calculated herein are intended to be worst-case estimates. Contaminant concentrations during active dredging and disposal operations are based on testing of the EFS estuary composite sample (see Report 2), which has greater contaminant concentrations in the bulk sediment than the average bulk sediment that will be dredged in the estuary. In general, application of laboratory and field data and selection of values from the literature are conservative with respect to protection of the environment during dredging and disposal.

6. Scenarios for dredging and disposal alternatives involve dredging between the Wood Street and Coggeshall Street bridges, a number of different CDFs, and a combination of CDFs and CAD cells. This appendix will initially discuss contaminant releases in a general sense, followed by contaminant release estimates for the components, i.e., dredging, CDF effluent, CDF surface runoff, CDF leachate, and CAD filling. Finally, releases from the components will be combined into short-term releases (5 to 12 years of dredging operations) and long-term releases, i.e., after completion of dredging. Disturbance of contaminated sediment at the dredgehead, displacement of contaminated sediment during construction of in-water CDFs, contaminant release during and after filling the CDF with dredged material, and contaminant release during and after placing and capping dredged material in the CAD cell

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* See References at the end of the main text.

present avenues for release of contaminants to the environment. These operations and the primary environmental pathways potentially affected by these operations are discussed in the following section.

Description of Releases from Dredging and Disposal Components

Dredging

7. In a hydraulic dredging operation, large quantities of water mix with the sediment to form a slurry as the dredge works its suction pipe (usually equipped with a cutter, auger, or other dredgehead) into the sediment and pumps dredged material through a pipeline to the disposal facility. Operation of the dredge in the contaminated sediment will resuspend some sediment with attached contaminants and potentially release dissolved contaminants into the water column and affect surface water quality. Sediment resuspension by various types of dredging equipment is discussed in Report 10. The quantity of sediment resuspended will be minimized by selection of equipment that has been demonstrated to produce a reduced rate of sediment resuspension and by operation of the selected equipment in a manner to minimize sediment resuspension.

8. The heavier resuspended sediment particles from the dredging operation will settle on the bottom near the dredge. The finer sediment particles will disperse into the water column. Sediment concentration in the water column will decrease with distance downcurrent from the dredge. Contaminants attached to the suspended sediment will be transported with the sediment, and soluble contaminants will be transported with water movement. However, some of the soluble contaminants are expected to become reattached (adsorbed) to suspended sediment and will then be transported in the same fashion as suspended sediment.

Dike construction

9. Construction of in-water dikes where required for shoreline CDFs will involve hauling clean fill material from offsite and carefully placing this material into the estuary as the dike is built from the shore. Earthmoving equipment will shape and compact the material for the dikes. The filling operation will impact an area the length and base line width of the

dike (approximately 150 ft*). The sediment underneath the dikes, which is also contaminated with PCBs, will be disturbed, compacted, and partially displaced by the dike construction operation. Silt screens used during dike construction for the Pilot Study were effective in containing the suspended sediment that was produced. Compaction of the contaminated sediment beneath the dike will squeeze pore water through and out of the sediment. This pore water contains soluble contaminants in high concentrations compared with water quality criteria. However, the volume of pore water is very small compared with the volume of the estuary and is released to surface water at a slow rate. The effect of this release will be small compared with other components of the dredging and disposal operation.

CDF during dredging

10. The CDF provides storage for the dredged material and will provide adequate volume to separate solids from liquid by gravity settling. After solids in the dredged material slurry settle in the disposal facility, excess water or supernatant is released from the disposal facility. This excess water that has been in contact with the sediment during the dredging process can be expected to contain dissolved and particulate-associated contaminants from the sediment. The CDFs proposed in this study will include provisions for the addition of polymers at the overflow from the primary cell of the CDF. These polymers will promote flocculation of fine particulates that may be removed by settling in the secondary cell of the CDF. Final effluent discharged from the CDF during the filling operation will contain nonsettleable particulates with associated contaminants as well as dissolved contaminants. Without additional effluent treatment, most of these materials can be expected to be transported away from the project area.

11. A second potential pathway of concern during filling of the CDF is volatilization of contaminants into the air. This release mechanism will be minimized by submerging the influent pipe below water level as slurry is pumped into the CDF and by keeping the contaminated sediment covered with water and saturated until the CDF is capped with clean material. Thibodeaux (in preparation) showed that the loss of PCBs from CDFs during filling is a significant pathway. Thibodeaux's calculations for the Pilot Study CDF

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 5 of the main text.

produced an estimate of 754 mg/hr PCB volatilization from the 60,000-sq ft pilot CDF. Using the same assumptions for PCB emission data, suspended sediment concentrations, and CDF configuration, and increasing the emission rate for the 2,700,000 sq ft of CDF area for the options considered in this study, a PCB emission rate on the order of 0.8 kg/day is estimated.

CDF after filling

12. The various pathways that may be affected by contaminated sediment in the CDF once the facility is filled are illustrated in Figures 7 and 8 of the main text. These pathways include surface runoff, biological uptake, volatilization, seepage, and leachate. Capping the CDF with clean dredged material will minimize the magnitude of the contaminant releases via the first three pathways mentioned. The pathway of most concern for the completed CDF is loss of leachate from the contaminated sediment through the bottom of the facility or seepage through the dike adjacent to the shore.

13. Loss of leachate from the CDF depends on hydraulic gradients and characteristics of the dike and foundation materials. The controlling hydraulic gradient for a free-draining foundation is directed downward in proportion to the static head produced by the height of saturated dredged material above the bottom of the CDF or above the water level on the outside of the dike, whichever is higher. Free drainage of pore water from the dredged material will slowly dissipate this head, but will force leachate through the bottom of the site.

14. The low permeability of the dredged material (10^{-6} to 10^{-7} cm/sec) limits the rate of infiltration of water downward from the surface of the CDF. Once the CDF is filled and capped, drainage will be provided to prevent ponding of water on the surface, and most rainwater will run off. Evaporation, and later evapotranspiration if the site becomes vegetated, will reduce the volume of rainwater and snowmelt transmitted downward, resulting in a layer of unsaturated dredged material near the surface of the CDF. Therefore, the primary contributor to leachate or seepage volume is the pore water associated with the dredged material placed in the site.

15. Modifying the bottom of the CDF to impede leachate flow or breaking the hydraulic gradient by collecting leachate at the bottom of the CDF will reduce leachate percolation from the bottom of the site. However, lining the CDF(s) for a remedial action at New Bedford will increase the overall cleanup cost. Lining large in-water CDFs also presents construction requirements that

have not been fully demonstrated in the industry, and long-term reliability of a liner is questionable.

16. Clean material used to cover the CDF will minimize losses through volatilization, bioturbation, or surface runoff. Thibodeaux (in preparation) showed that exposed contaminated sediment produced a much higher (3 to 4 orders of magnitude) PCB volatilization rate than capped sediment. Therefore, all CDF design options will include capping prior to exposure of contaminated sediment to the atmosphere. Rainfall runoff from the clean cap is not expected to present a problem with PCB release (see Report 4). Covering the CDFs with clean sediment and a geomembrane cap will cut off the bioturbation pathway.

CAD filling

17. Features of CAD options for this project are presented in Part V of the main text. The CAD facility is simply an area in the estuary that will be excavated to approximately 10- to 15-ft depth by dredging sediment to fill the CDF. Contaminated dredged material will be placed in the bottom of the CAD cell by a submerged diffuser attached to the end of the pipeline from the dredge. The diffuser is designed to release the slurry parallel to the bottom of the site and at a velocity sufficiently low to minimize upper water column impacts. However, the water that separates from the dredged material slurry as the sediment settles to the bottom will contain fine particulates with attached contaminants and contaminants dissolved in the water. These contaminants will be transported by currents created by the dredging operation and by currents in the estuary. The heavier suspended sediment particles will settle in the CAD cell, and some of the dissolved contaminants will become attached to finer suspended sediment that may eventually settle on their own or aggregate and settle more rapidly.

18. The dredged material slurry undergoes compression settling and self-weight consolidation in the CAD cell in a manner similar to that occurring in the CDF. These processes expel pore water from the sediment. This pore water may move upward into the water column or downward into the saturated zone below the CAD cell. Most of the consolidation and water loss will take place prior to placing the cap, and this represents a potential contaminant release during the disposal operation. Long-term releases from CAD disposal could result from a gradient caused by a higher water table on the shore compared with the water elevation of the estuary. This gradient may

push water through the contaminated material in the CAD and potentially through the cap (see Figure 9 of main text). The low permeability of the consolidated dredged material and the attenuation of contaminants through the cap will limit the magnitude of this source of contaminants to surface water. Quantification of this release rate requires extensive knowledge of groundwater movement and is beyond the scope of this study.

19. Transport in water is the primary pathway for loss of contaminants from the CAD filling operation. Volatilization losses will be minimized by maintaining the discharge pipe below the water.

CAD after filling

20. Placement of dredged material in the CAD facility returns the contaminated sediment to environmental conditions similar to those existing in the bottom of the harbor where the sediment originated. The advantage of the CAD site is that contaminants are separated from the water column by a layer of cleaner sediment. This clean cap prevents direct contact of the contaminated sediment with the water column, eliminates resuspension of contaminated sediment, attenuates contaminants that may move or diffuse through the cap, and reduces bioturbation with the contaminated sediment. As long as the integrity of the cap is maintained, contaminant losses from the CAD site will be minimal. Truitt (1986) reported on chemical studies of the Duwamish Waterway capping demonstration project, where vibracore sediment samples were collected at 4-cm intervals through a layer of capping material and a layer of contaminated sediment. Analyses of these samples for lead and PCB indicated that the cap effectively contained the contaminated dredged material.

Contaminant Release Estimates

Testing protocols

21. Procedures for estimating contaminant releases from dredged material disposal operations for several transport mechanisms have been developed and verified. Specific testing protocols available for various pathways and transport mechanisms are discussed in Francingues et al. (1985). Testing protocols for surface- and ground-water pathways have been applied to New Bedford sediment by this EFS. Applicable testing protocols and the transport mechanism(s) they address are listed below:

Testing Protocol	Pathway	Transport Mechanism
Modified elutriate	Surface water	Soluble and suspended contaminants from CDF during filling
Standard elutriate	Surface water	Soluble contaminants from open-water disposal
Leaching	Ground water	Soluble contaminants from confined disposal
Capping	Surface water	Soluble contaminants from CAD after filling
Surface runoff	Surface water	Soluble and suspended contaminants from CDF after filling

22. The estimates presented herein are based on results for elutriate and leachate testing of the composite sample collected for the US Army Corps of Engineers (USACE) EFS and evaluation of sediment resuspension and settling rates predicted by field studies and a vertically averaged, numerical sediment transport model.

Application of testing protocols

23. Laboratory tests. The principal data needed to estimate contaminant releases during dredging and disposal operations are the suspended sediment concentrations, particulate-associated contaminant concentrations, and soluble contaminant concentrations. Standard elutriate tests (Report 3), modified elutriate tests (Report 3), leaching tests (Report 5), and surface runoff tests (Report 4) were selected as the best available laboratory methods for providing these data. The standard elutriate has been applied to soluble releases during open-water disposal of dredged material (Brannon 1978), and the modified elutriate has been applied to soluble and particle-bound releases from diked disposal sites for dredged material (Palermo 1986). Leaching tests are applicable to releases of pore water and leachate from CDFs and CAD options. Surface runoff data are applicable to CDFs that have been filled and capped with a layer of less contaminated material (<100 ppm PCB) from the Upper Estuary.

24. Assumptions and basic data. Tables D1, D2, and D3 list the production data, sediment resuspension and release rates, and sediment escape rates used to estimate sediment flux at the Coggeshall Street Bridge during the dredging, CDF disposal, and CAD disposal operations, respectively. Production rates and fluxes are based on an 800 cu yd per day production rate, an in situ

water content of 111 percent, and a slurry sediment concentration of 125 g/ℓ. The ratio for volume of slurry produced per volume of in situ sediment dredged is 5.3.

25. Contaminant concentrations associated with suspended sediment and dissolved contaminant concentrations are based on standard and modified elutriate tests for the EFS composite sediment sample (Report 3). Total PCB Aroclor concentration of this sediment was 1,500 mg/kg. Water used for the elutriate tests was collected from the Upper Estuary.

Dredging

26. Sediment resuspension during dredging. Estimates of contaminant release from the dredging plant begin with the basic flux rate assumption of 40 g of sediment resuspended per second. This number is based on field data collected during the box-coring operation for collection of the composite sample for the USACE EFS (Report 2). Water column suspended sediment concentrations were measured during the box-coring operation at 5- and 50-yd radii of the sampling barge. Although this was a mechanical dredging activity on a relatively small scale, the barge was operating in shallow water and resuspended the material by direct contact with the bed and by prop wash, in addition to dropping and raising the corer. Average sediment concentrations 50 yd from the barge were 80 mg/ℓ above background. The concentrations observed were fit with a two-dimensional vertically averaged plume model to estimate the 40 g/sec sediment resuspension rate.

27. The sediment resuspension rate of 40 g/sec represents 0.4 percent of the sediment mass dredged and is equivalent to 2 kg sediment resuspended per cubic metre of sediment dredged. Nakai (1978) has reported sediment resuspension rates in fine-grained material from 5 kg/cu m to as high as 45 kg/cu m for a large dredge pumping a sediment with 35 percent clay. Sediment removal operations from the Upper Estuary will dredge a material with less than 20 percent clay and will employ specialized equipment, dredging operational controls, and silt curtains to minimize the rates of resuspension. Therefore, the assumed rate of resuspension (40 g/sec) is thought to be an acceptable estimate of the rate for project conditions. The New Bedford Superfund Pilot Study will provide site-specific field data to refine the estimates of sediment flux rate from dredging.

28. Sediment transport from the Upper Estuary. Only a portion of the sediment released at the dredge will be transported away from the site and

through the bridge. The values given as fraction of sediment escaping at the bridge (Table D1) are based on results from numerical hydrodynamic and sediment transport modeling described in Report 2.

29. Relationship of contaminants to sediment resuspension. The mass of contaminant associated with sediment resuspension by the dredge is based on total and soluble contaminant concentrations from elutriate tests (Report 3). The standard elutriate value was chosen for PCBs because this test has been more often related to effects on the water column (Ludwig, Sherrard, and Amende 1988). Modified elutriate data were used for the metals where quality standard elutriate data were not available. Concentrations on suspended solids were applied directly to the sediment flux from the bridge to calculate contaminant releases associated with sediment transport. Estimation procedures for mass flux rates for soluble releases from the dredge have not been developed. The approach used for this study is to relate the soluble contaminant concentration in the elutriate to the suspended solids in the elutriate and assume that the soluble releases are proportional to the sediment resuspension and transport rate. This approach represents a worst-case scenario since the elutriate test simulates mixing all of the sediment removed by dredging with site water. In reality, only the resuspended sediment and a fraction of the pore water mix with the water column during dredging.

30. Calculations. Step-by-step calculations of contaminant mass released at the bridge for PCB and heavy metals are presented in Table D1. Because of the uncertainties in dredge resuspension rates, variability in sediment characteristics, and the need for conservatism, a safety factor of 2 times the estimated contaminant release rates is applied to the release rates calculated by the above procedure. The releases that are presented represent the more contaminated sediment in the estuary and should be greater than the average release rates for dredging all of the Upper Estuary. However, actual releases are expected to sometimes exceed the daily release rates shown because of hot spots, unusual sediment physical characteristics for some areas, and extremes of production rates, tide ranges, and climatic conditions.

31. Controls to minimize dredging releases. Silt curtains or screens will also be employed around the dredging operation to reduce the transport of suspended sediment and associated contaminants away from the dredge. The contaminant release estimates do not account for this containment. However, the

containment effectiveness for the silt curtains will be similar for the dredging component of all of the options considered by this study.

Evaluation of CDF effluent

32. Effluent suspended solids. Estimates of the suspended sediment released from the CDF are presented in Table D2. Laboratory settling column data for the EFS composite sample were used in the procedure outlined by Palermo (1985) to estimate the effluent suspended solids from the primary cell of the CDF. Results from bench-scale jar tests performed for the EFS indicate that more than 50-percent additional suspended solids reduction can be achieved in the secondary cell following polymer flocculation. These estimates indicate that an effluent suspended solids concentration of 66 mg/ℓ can be attained. During the initial stages of filling of the CDF with contaminated sediment, much longer settling times will be available in the CDF.

33. CDF effluent contaminants. Contaminant release from the CDF discharge during dredging operations overflow is calculated directly from suspended sediment contaminant concentrations and dissolved contaminant concentrations observed in the modified elutriate test and from the dredge flow rate. Step-by-step mass fluxes of PCB and heavy metals are presented in Table D2. A safety factor of 2× is also applied to these fluxes for the same reasons described above.

Evaluation of CAD effects on the estuary water column

34. Suspended solids concentrations. A predictive tool for estimating the mass of suspended sediment released in the CAD cell during filling has not been developed and verified. The CAD cell could be considered as a semiconfined underwater settling area. The cells provide a volumetric retention time similar to CDFs. Minimum CAD volume is 16,000 cu yd for the 2-ft depth (CAD option A, cell B1). Application of settling test data in a manner similar to that for a CDF yields a suspended solids concentration on the order of 500 mg/ℓ or about 0.4 percent of the sediment dredging rate. All other CAD cells are 5 to 10 times larger in surface area and provide much longer detention times for settling.

35. Other studies of sediment loss during open-water disposal of dredged material, generally reported where dredging depths were greater than 50 ft, have estimated sediment losses in the water column on the order of 1 to 5 percent of the original sediment mass (Truitt 1986). Placing sediment in

the CAD cell with the submerged diffuser will more efficiently place sediment in the bottom of the cell than conventional open-water disposal. Use of the submerged diffuser for a Calumet Harbor, Illinois, project demonstrated that discharged dredged material was confined to the lower 20 percent of the water column with no increase in suspended solids above that point (McLellan and Truitt 1986). Directly comparable data for the release rate are not available. Calculations shown in Table D3 assume a sediment release of 1 percent of the dredging rate, which is greater (1,250 mg/ℓ) than the settling test prediction but lower than some estimates in the literature.

36. Contaminant fluxes. The PCB release rates for the CAD, which are presented step-by-step in Table D3, are based on suspended and soluble PCB concentrations from the standard elutriate test. Use of the standard elutriate test for estimating soluble releases during open-water disposal of dredged material is consistent with routine use of this test for evaluating open-water disposal of dredged material. Heavy metals releases are based on results from modified elutriate tests of estuary sediment (Report 3). A 2× safety factor was also applied to calculated flux rates to yield the estimates used in this report.

Estimates of leachate contaminant releases

37. To calculate the rates of contaminant loss from CDFs and CAD cells, the concentrations of contaminants and the rate of leachate seepage through the dikes and/or foundation of the site must be estimated. Evaluation of leachate quality is presented in Report 5. Results from the batch leaching tests provide a basis for a conservative estimate of leachate and pore water quality for dredged material placed in CDFs and CAD cells.

38. Leachate quality. Leachate quality will be estimated from batch leaching test data available for the first step of the sequential batch leach test using saline water as the fluid, as recommended in Report 5. Estimated leachate concentrations are given in Table D4. These concentrations are worst-case estimates because they are based on the WES estuary composite sediment and because batch leaching tests generally overestimate pore water concentrations for a flow-through system. Peak PCB concentrations for permeameter leachate tests were an order of magnitude lower than the batch leachate value shown in Table D4. Peak permeameter values for metals were

generally higher than the batch test values, which was explained as the salinity washout phenomenon in Report 5.

39. Table D4 compares the estimated leachate concentrations with the maximum contaminant levels (MCL) established under the Safe Drinking Water Act and with marine water quality criteria. The estimated leachate concentrations do not exceed MCLs for any of the metals tested. Average leachate concentrations for PCB, copper, lead, nickel, and zinc exceed the chronic criteria for marine waters. The only acute water quality criteria exceeded are for copper and PCB. However, it must be recognized that the only locations these concentrations exist are within the dredged material. Passage of leachate through the dikes or bottoms of disposal facilities will attenuate contaminants to some degree. Once the contaminants reach the waterway, they will be quickly diluted. The only contaminant of major concern for migration with leachate is PCBs.

40. Leachate volumes for CDFs. The quantity of leachate crossing the CDF boundaries depends on local hydraulic gradients and the characteristics of the foundation materials. However, information on boundary characteristics and local ground-water flow is not available. Therefore, this analysis will assume that the foundation is free draining, i.e., there is no resistance to flow at the boundary of the CDF. This condition represents a worst-case scenario because it is physically impossible to have a foundation with no resistance to flow. Also, water flowing through the dredged material will be assumed to depend on drainage of pore water in the dredged material after initial settling, net water input from the surface of the CDF, hydraulic gradient in the CDF, and infiltration characteristics of the dredged material.

41. All design options that include CDFs call for placement of an impermeable cap on the surface of the contaminated dredged material to minimize the net freshwater input from the surface. Report 3 showed that washout of salinity from the dredged material had a marked increase on release of contaminants from sediment solids. Therefore, the cap provides both the benefit of reducing the flow of water through the dredged material and the benefit of reducing the desorption of contaminants from sediment to pore water or leachate.

42. Ground water beneath in-water CDFs is expected to flow toward the estuary. However, additional geohydrological data and modeling would be required to confirm site-specific flow patterns and rates for the CDF sites

and the estuary area. Leachate exiting the boundaries of the upland CDFs may enter the ground water or the estuary.

43. Estimates of vertical percolation through the CDF bottom were made using a water balance from consolidation of the dredged material and the US Environmental Protection Agency's Hydraulic Evaluation of Landfill Performance (HELP) computer model (Schroeder et al. 1984). HELP models hydrologic movement of water across, into, through, and out of landfills. It accepts climatologic, soil, and design data and uses a solution technique that accounts for the effects of surface storage, runoff, winter cover, infiltration, percolation, evapotranspiration, and soil moisture storage. The version (HELP2) of the model used for this analysis is adaptable to dredged material because it can account for the saturated conditions initially present in a CDF.

44. During a 10-year simulation period, HELP2 computed the percolation rate from the base of a typical CDF profile, including a geomembrane cap, to average 1.6 in. of water per year. At the end of the tenth year, the percolation rate was 0.36 in. per year. Leachate contaminant fluxes are based on 10 years at 1.6 in. per year and 20 years at 0.36 in. per year, yielding a total of 24 in. for the 30 years following placement and capping in the CDFs.

45. Prior to the percolation losses from CDFs after capping as predicted by HELP2, additional pore water is expelled from the dredged material slurry as the sediment consolidates. The change in elevation of sediment with time in a typical CDF design for New Bedford is illustrated in Figure D1. This figure was developed from output of the Primary Consolidation and Desiccation of Dredged Fill (PCDDF) model (Cargill 1985). One curve represents consolidation with a relatively free-draining foundation (hydraulic conductivity = 1 ft/day), and the other represents a less permeable foundation (0.0001 ft/day). The rate of consolidation differs for the first 1 to 2 years, but by the end of the third year, consolidation levels off for both conditions. The change in elevation and volume of sediment is accompanied by the release of an equivalent volume of water. This water is released in all directions, i.e., through the bottom, sides, and surface of the CDF. Water that is released to the surface is controllable by wastewater treatment processes. However, the evaluation of leachate releases for unlined CDFs will assume that all of this volume escapes the boundaries of the CDF.

46. Water balance for dredging and disposal. Quantification of fluxes from CDF and CAD alternatives must balance water present with in situ sediment and water added during hydraulic dredging against water losses as effluent, leachate, and water remaining with the disposed sediment. Figure D2 illustrates a water balance for dredging New Bedford sediment on the basis of 1 cu yd of in situ sediment. A volume of 4.3 cu yd of estuary water is added for each volume of sediment removed based on assumed sediment concentrations in situ and in the dredged material slurry. For the CDF alternative, additional precipitation will be added during disposal operations. Most of the precipitation will be removed as surface runoff or will evaporate. Figure D2 assumes that 24 in. of rainfall will infiltrate the surface during the 1- to 2-year operational period prior to covering of the contaminated sediment and consolidation of the dredged material. The water balance shows that an estimated 3.05 cu yd of effluent is produced, and 1.54 cu yd of leachate is produced for each cubic yard of sediment removed and placed in a CDF. The effluent is released to surface water, and leachate may be released to surface or ground water, or both.

47. CAD pore water losses. The CAD alternative does not have the rainfall contribution factor and produces an estimated 3.05 cu yd of water released to the water column during dredging and 1.18 cu yd of leachate, or pore water, lost. The CAD leachate will likely be released to the surface-water pathway.

Comparison of contaminant mass releases

48. Tables D5 and D6 present estimates of the total mass of PCBs released by the CDF and CAD options, respectively, considered in this study. Estimates for copper releases are presented in Tables D7 and D8. The numbers presented include totals for the project implementation phase of the project and for the postproject phase, which extends to 30 years after filling a CDF or CAD site. The bases for the numbers are the data presented in Tables D1-D3, the volume of sediment removed for each disposal option as described in the main text, the leachate and effluent volumes discussed above, and the leachate concentrations from the sequential batch leachate test.

49. CDF design options. Tables D5 and D7 show that the component contributing the majority of the contaminant loads for the CDF alternative is the dredging operation. For the design options that include effluent treatment, PCB removal is based on 90-percent removal of PCB associated with suspended

solids by filtration (options A2 and B2) and 99-percent removal of dissolved PCB by carbon adsorption or UV/hydrogen peroxide for options A3, B3, C, and D. The options that have lined CDFs (C and D) include carbon adsorption for leachate collected by the liner system. Copper removal by the effluent treatment processes is based on removal of only the copper associated with the suspended sediment.

50. Because dredging release estimates predominate in this analysis of contaminant migration, the more extensively controlled design options (C and D) lose some of their advantage due to the additional volume of sediment that must be dredged for these design options. For example, option A3, which consists of unlined CDFs and effluent treatment, produces less total PCB release than option D, which consists of lined CDFs and effluent/leachate treatment. This situation may not occur if the dredging releases are overestimated by a wide margin. If the dredging releases were reduced by a factor of 2, then the ranking follows the logical progression of more controls produce lower contaminant releases. This order is illustrated by the relation of the releases from the CDF component in Tables D5 and D7.

51. CAD design options. Tables D6 and D8 illustrate the life-of-the-project contaminant releases associated with the CAD design options. The CAD releases to the water column during placement of contaminated sediment in the CAD cell are the larger contaminant release component for options B and C. Releases from the dredge are greater than CAD filling for options A1, A2, and A3 because the more contaminated sediment is placed in a CDF for this option, reducing the losses during CAD filling.

Table D5

Total Mass PCB Released for CDF Design Options

			Alt No. CDF A1	Alt No. CDF A2	Alt No. CDF A3	Alt No. CDF B1	Alt No. CDF B2	Alt No. CDF B3	Alt No. CDF C	Alt No. CDF D
Sediment Volume cu yd		Dredge	484,000	484,000	484,000	514,000	514,000	514,000	574,000	633,000
		CDF	484,000	484,000	484,000	514,000	514,000	514,000	574,000	633,000
		CAD								
		PCB kg/cu yd	PCB kg	PCB kg	PCB kg	PCB kg	PCB kg	PCB kg	PCB kg	PCB kg
Dredge	Dissolved	0.00083	400	400	400	424	424	424	474	523
	Suspended	0.00053	254	254	254	270	270	270	302	333
	Total	0.00135	654	654	654	695	695	695	776	855
CDF	Dissolved	0.00050	244	244	2	259	259	3	3	3
	Suspended	0.00007	35	3	0	37	4	0	0	0
	Subtotal	0.00058	279	247	3	296	263	3	3	4
	Leach-short	0.00031	150	150	150	159	159	159	84	2
	Leach-long		40	40	40	40	40	40	21	0
	Total	0	469	437	193	495	462	202	107	6
CAD	Dissolved	0.00050								
	Suspended	0.00180								
	Subtotal	0.00230								
	Leach-short	0.00024								
	Leach-long									
	Total	0.00254	0	0	0	0	0	0	0	0
	GRAND TOTAL		1,123	1,091	847	1,190	1,156	897	883	861

CEWES-EE-R (200-1c) 28 October 1992

MEMORANDUM FOR CENED-PD-L/MR. MARK OTIS

SUBJECT: New Bedford Harbor Superfund Site, Confined Disposal Facility (CDF) Leachate Losses

1. In accordance with your request, I have reviewed the estimates of contaminant losses via leachate from the CDFs planned for containment of New Bedford Harbor sediment. You will recall that during our Engineering Feasibility Study (EFS) for this site we estimated losses by this pathway and reported our results in EFS Report No. 11.

2. The analysis provided with this memorandum uses the same approach as presented in Report No. 11. I used data from the batch leaching tests conducted here at the Waterways Experiment Station as an worst case estimate of contaminant concentrations, and I used the Hydrologic Evaluation of Landfill Performance (HELP) model to estimate the volume of leachate flowing through the bottom of the dredged material placed in the CDF. Important parameters and conditions used in the HELP Model analysis are as follows:

CDF surface area at dredged material surface	900,000	sq ft
Depth of dredged material	10	ft
Dredged material hydraulic conductivity	3.3E-07	cm/sec
(based on consolidation tests of composite sediment)		
Foundation hydrualic conductivity	3.3E-07	cm/sec
CDF not capped -- dredged material surface layer		
Runoff from site actively collected from site		

3. Results of the HELP analysis and estimated losses of PCBs and lead are presented in Table 1 for a 20-year period following filling of the site. The percolation rates are broken into two sections: the interior of the site and the perimeter area where the dredged material is underlain by a sandy material of higher permeability, as opposed to the organic clay assumed for the foundation of the interior. The analysis shows that the relatively low hydraulic conductivity of the dredged material controlled the percolation rate for the site even when underlain by the sandy material. The percolation rate maintains a relatively steady rate during the 20-year period, and the dredged material fill remains near saturation for all but the material near the surface, which is typical of what has been observed for CDFs confining fine-grained material.

4. Adding a well-designed and carefully-installed cap to the dredged material should reduce the percolation rate through the

ATTACHMENT #2

bottom of the CDF. Based on the laboratory evaluations conducted by the EFS, it is important to prevent fresh water washout of the salinity of the dredged material because of the increased mobility of the contaminants in fresh water. Based on the percolation rates presented in Table 1, this would take several decades.

5. Monitoring leachate from the CDFs will require installation of wells similar to those used for the pilot CDF. Several points around the perimeter of each CDF should have a cluster of wells designed to sample several depths, from just below the estuary water line down to bedrock or a layer of low permeability.

6. I hope this analysis will help you to answer questions concerning CDF leachate losses. I will mail you copies the HELP model output. We could followup this analysis with a sensitivity evaluation of key model parameters, with an analysis of a capped site, and with an evaluation of other CDF geometries. If you have any questions concerning this information, please call me at 601-634-3959.

Daniel E Averett

Encl

DANIEL E. AVERETT
Environmental Engineer
Environmental Restoration Branch

Table 1. Estimated Leachate Losses from CDF No. 1, New Bedford Harbor Superfund Site

Years after filling	Percolation Interior cu ft/yr	Percolation Perimeter cu ft/yr	Percolation Total cu ft/yr	PCB Conc. Leachate µg/ℓ	PCB Flux Leachate kg/yr	Lead Conc. Leachate µg/ℓ	Lead Flux Leachate kg/yr
1	198204	2889	201093	266	1.5	9	0.051
2	142579	16553	159132	266	1.2	9	0.041
3	145537	34776	180313	266	1.4	9	0.046
4	124586	31399	155985	266	1.2	9	0.040
5	119773	31431	151204	266	1.1	9	0.039
6	113345	29849	143194	266	1.1	9	0.036
7	114444	30834	145278	266	1.1	9	0.037
8	120957	33198	154155	266	1.2	9	0.039
9	114221	30108	144329	266	1.1	9	0.037
10	113933	30645	144578	266	1.1	9	0.037
11	128500	35859	164359	266	1.2	9	0.042
12	121151	32186	153337	266	1.2	9	0.039
13	114105	29997	144102	266	1.1	9	0.037
14	127744	35701	163445	266	1.2	9	0.042
15	136879	37715	174594	266	1.3	9	0.044
16	122020	31634	153654	266	1.2	9	0.039
17	105617	26714	132331	266	1.0	9	0.034
18	115192	31696	146888	266	1.1	9	0.037
19	123649	34148	157797	266	1.2	9	0.040
20	124855	33878	158733	266	1.2	9	0.040

CENED-PD-L February 10, 1993

MEMORANDUM FOR CEWES-EE-R/Mr. Daniel Averett

SUBJECT: New Bedford Harbor Superfund Site/Confined Disposal Facility (CDF) Leachate Losses

1. As we discussed yesterday, EPA has requested that we revise our estimates of leachate losses from CDFs to reflect the three facilities that will be identified in their Record of Decision. They would like to receive this information in early March to respond to comments from the Massachusetts Department of Environmental Protection. The time frames of concern to EPA include the first year, 5 years and 30 years.

2. The attached information shows the locations of CDFs 1,1B and 7 along with typical cross sections of the sites and a listing of their surface areas and volumes.

3. Your memorandum of October 28, 1992 included a value of 3.3E-07 cm/sec for the hydraulic conductivity of the dredged material and site foundation. It would be helpful if information relating to the derivation of this value could also be provided as it appears that this will be a critical component of the DEP's evaluation.

4. I appreciate your willingness to continue to support the project. Please give me a call at (617) 647-8895 if there are any questions or if additional information is needed.

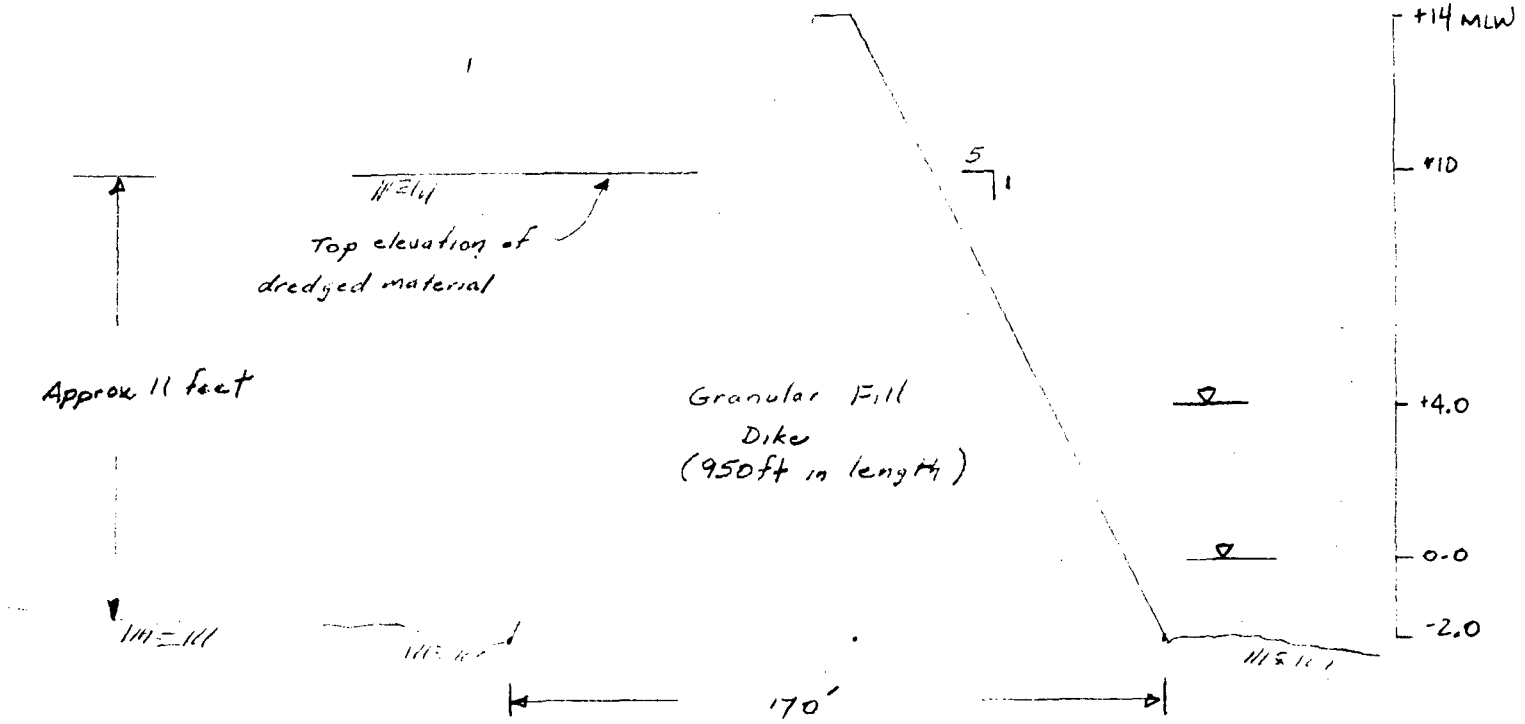
Mark J. Otis
Project Manager

ATTACHMENT 3

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT New Bedford Harbor Superfund Site
COMPUTATION Typical Cross Sections - CDF #1 & #1B
COMPUTED BY MJO CHECKED BY _____ DATE Feb 10, 1993



CDF #1 & #1B

TYPICAL CROSS SECTION - IN WATER DIKE

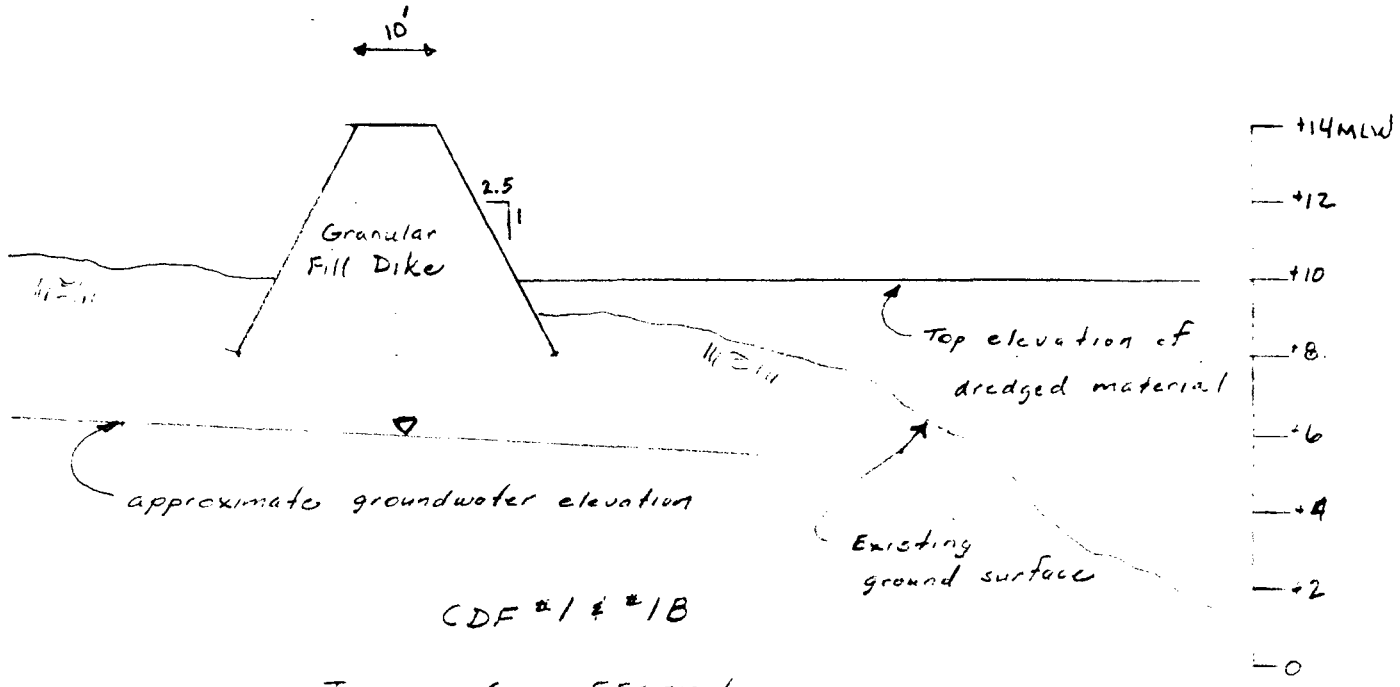
Granular Fill specification (Pilot Study)

Sieve Size (U.S. Standard)	Percent Passing by Dry Weight
1/2 inch	100
No. 10	30-95
No. 40	10-75
No. 200	0-15

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT NEW BEDFORD HARBOR SUPERFUND SITE
COMPUTATION TYPICAL CROSS SECTIONS - CDF #1 & #1B
COMPUTED BY MJO CHECKED BY DATE Feb 10, 1993



CDF #1 & #1B

TYPICAL CROSS SECTION
Land Dike

CDF 1 Characteristics

1) Surface Area 900,000 ft^2

2) Capacity 340,000 c.y.

Note: 1) Dredged material will come from the Estuary portion of the site
2) All CDFs will be capped with an impermeable cover installed 2-3 years after the completion of dredging.

CDF 1B Characteristics

1) Surface Area 394,000 ft^2

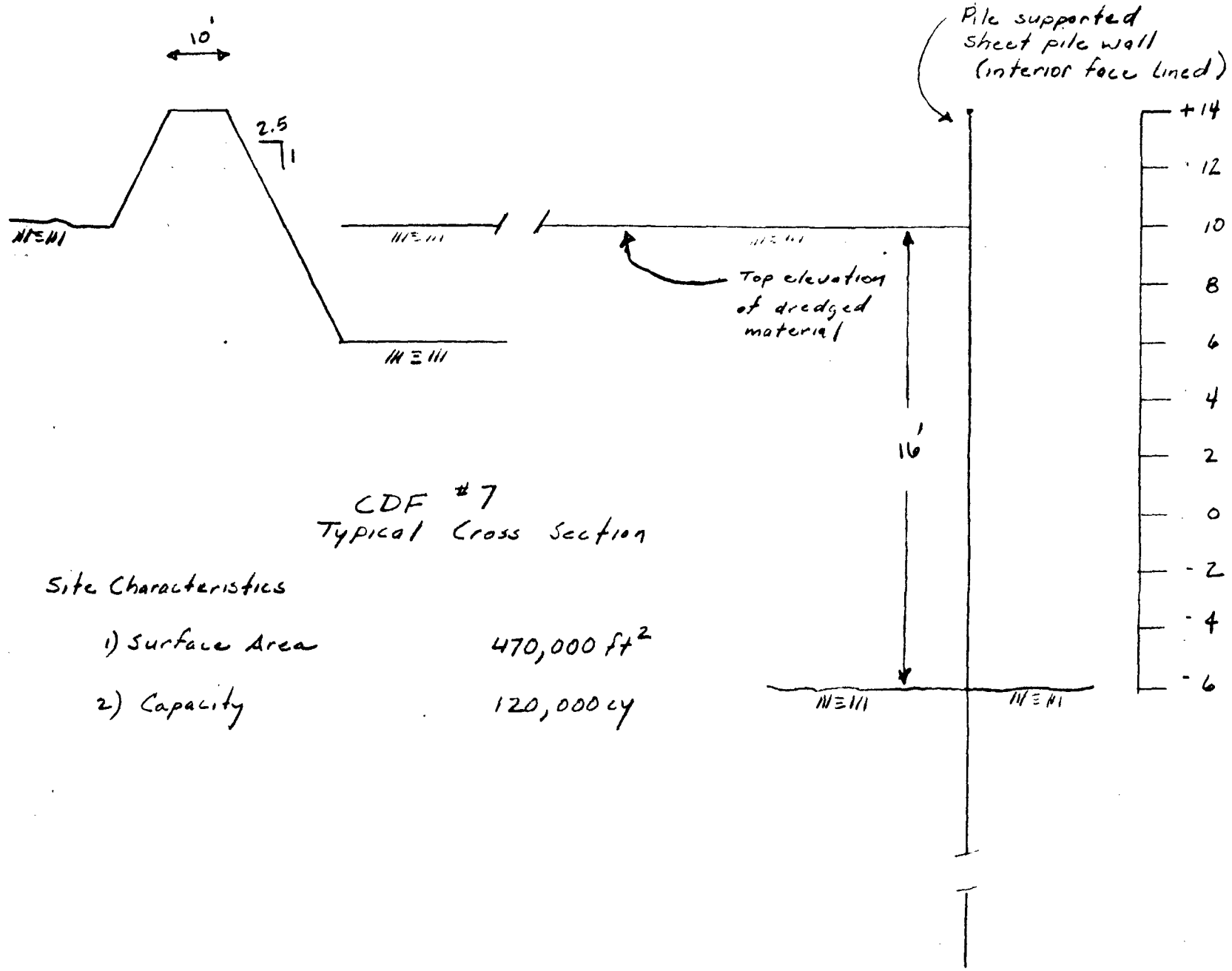
2) Capacity 120,000 c.y.

Note:
1) Dredged material will come from the northern portion of the estuary

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT New Bedford Harbor Superfund Site
COMPUTATION Typical Cross Sections · CDF #7
COMPUTED BY MTO
CHECKED BY
DATE Feb. 10, 1993
PAGE



CDF #7
Typical Cross Section

Site Characteristics

1) Surface Area 470,000 ft²

2) Capacity 120,000 cy

CEWES-EE-R (200-1c) 19 March 1993

MEMORANDUM FOR CENED-PD-L/MR. MARK OTIS

SUBJECT: New Bedford Harbor Superfund Site/Confined Disposal Facility (CDF) Leachate Losses

1. As you requested 10 February 1993, I have revisited the estimates of percolation rates from the CDFs proposed for containment of New Bedford Harbor dredged material. Estimates were made using the Hydrologic Evaluation of Landfill Performance (HELP) Model for CDF Nos. 1, 1B, and 7. The analysis was performed for each site without a cap and with a cap consisting of a 2-ft. vegetated upper layer underlain by a synthetic liner and a 2-ft. layer of compacted clay.

2. The results from the model evaluation are shown in encl 1. Encl 2 is the same data plotted on a semi-log graph. Encl 3 is a table of the values used in the graphs. The figures show that percolation is reduced considerably after the first two years. The higher values the first two years result from drainage of the water initially placed in the site with the dredged material. Once this water is released, the percolation rate is relatively steady and responds to changes in climatic conditions. Because the HELP model is one-dimensional and does not account for consolidation, it overestimates percolation through the bottom of the site. Part of the initial water is squeezed upward by consolidation and is removed as runoff or additional evapotranspiration. Capping each site with a relatively impermeable material and synthetic membrane, reduces the percolation after the second year to a minimal value.

3. I also looked at sensitivity of the model to two major assumptions used in the analysis--hydraulic conductivity and initial water content. Results of model runs for CDF 1 using adjusted values for these parameters are shown in encl 4. This figure shows that an increase in hydraulic conductivity for the bottom layer of the fill from 6.5E-07 to 1.87E-06 cm/sec allowed the fill to dewater during the first year rather than the first two years. A reduction in hydraulic conductivity to 1.0E-07 cm/sec reduced percolation during the first three years and retained more water in the CDF throughout the 20 year evaluation. The slower release may be more realistic for the in-water sites since the bottom of the site will be consolidated sediment. Increasing the initial water content increased the first, second, and third year percolation volume. Increasing the hydraulic conductivity and the initial water concentration gave high rates the first year.

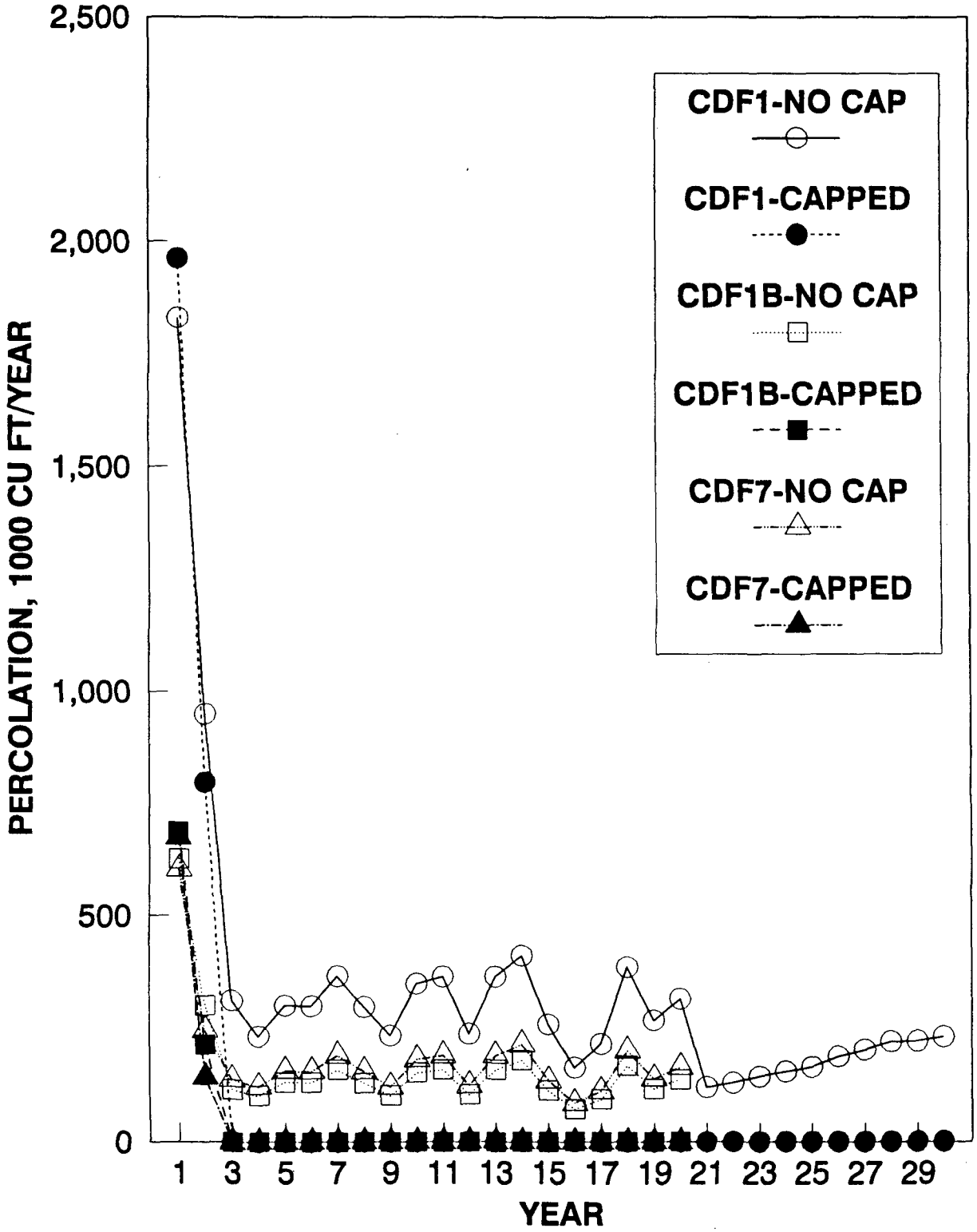
ATTACHMENT 4

4. The complete data for each run is included on the enclosed diskette (file listing is encl 5). If you have any questions concerning this analysis, please call me. I will be out of the office early next week, but if you will leave message on the voice mail system, I can call you back. If you wish, we can discuss this further when I see you in Dallas on 30 March.

5 Encls

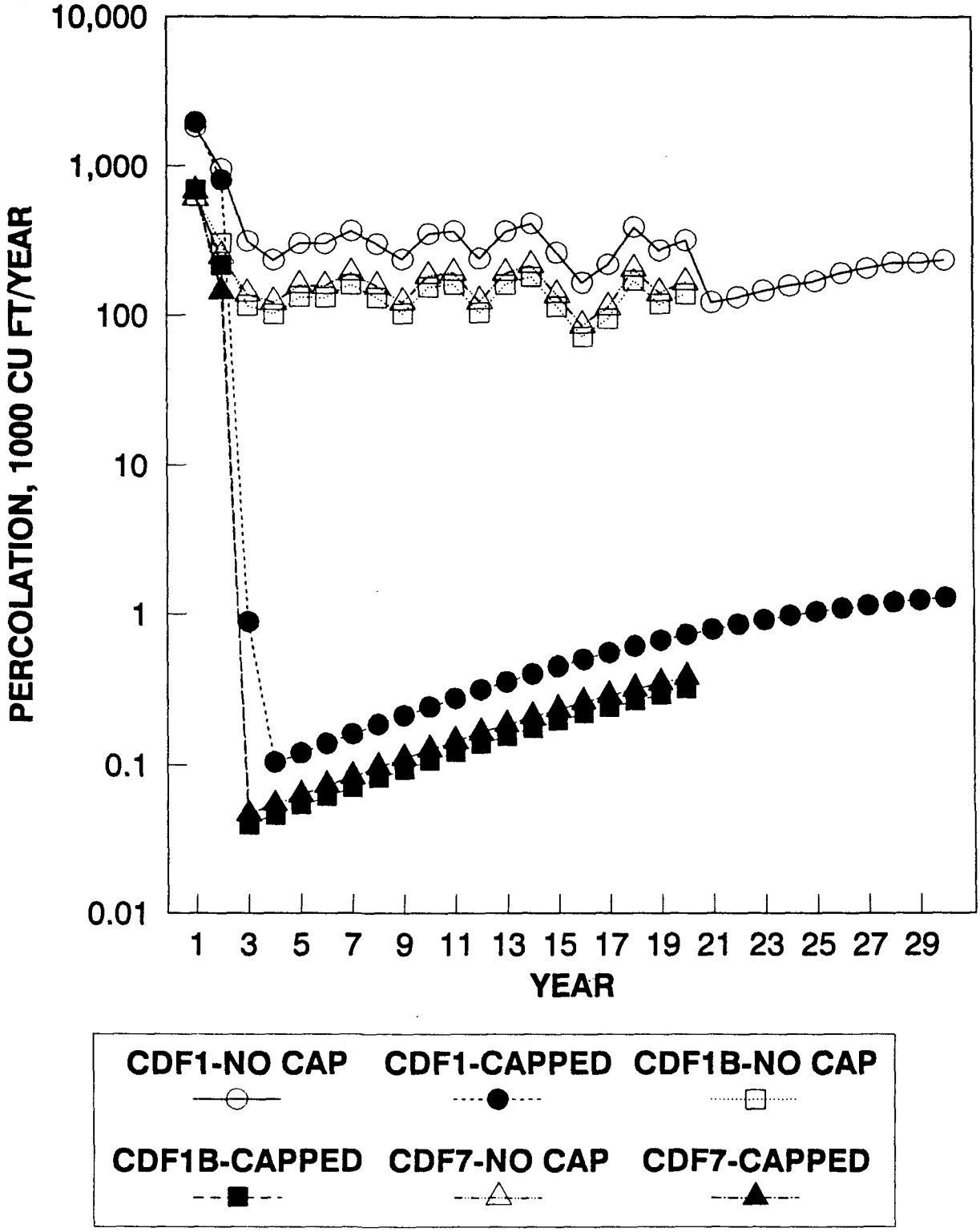
DANIEL E. AVERETT
Environmental Engineer
Environmental Restoration Branch

NEW BEDFORD HARBOR SUPERFUND SITE
CDF PERCOLATION ESTIMATES FROM HELP MODEL



Encl 1

NEW BEDFORD HARBOR SUPERFUND SITE
CDF PERCOLATION ESTIMATES FROM HELP MODEL



Encl 2

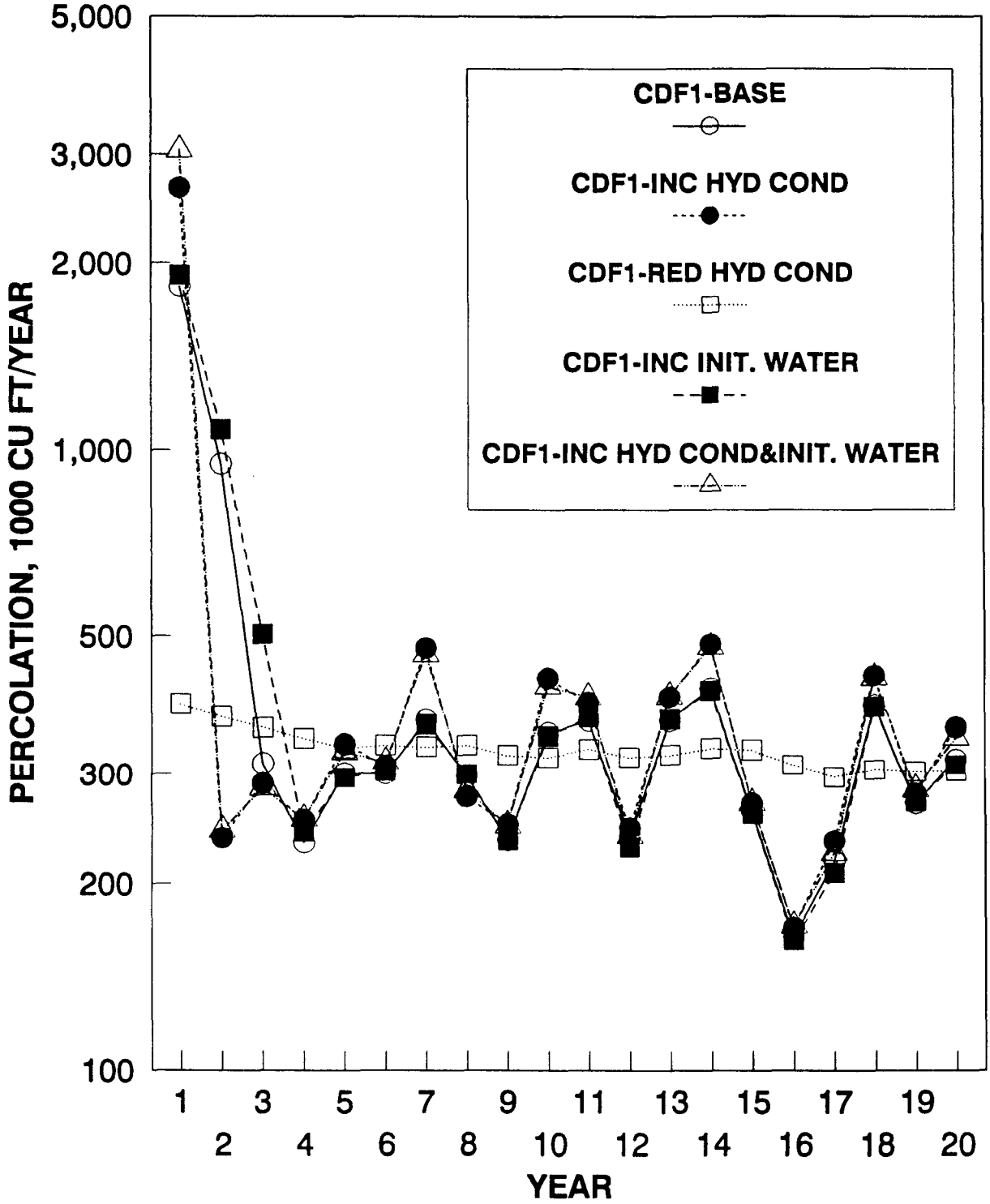
NEW BEDFORD HARBOR SUPERFUND SITE
CDF PERCOLATION ESTIMATES FROM HELP MODEL

(1,000 cuft)

	CDF1-NO CAP	CDF1-CAPPED	CDF1B-NO CAP	CDF1B-CAPPED	CDF7-NO CAP	CDF7-CAPPED
1	1,830	1,962.000	626.0	686.000	603.0	674.000
2	949	799.000	301.0	214.000	246.0	143.000
3	312	0.890	116.0	0.039	138.0	0.046
4	233	0.104	102.0	0.045	122.0	0.054
5	301	0.120	132.0	0.053	157.0	0.063
6	300	0.139	131.0	0.061	156.0	0.073
7	366	0.161	160.0	0.071	191.0	0.084
8	298	0.186	130.0	0.082	156.0	0.097
9	235	0.213	103.0	0.093	122.0	0.111
10	349	0.244	153.0	0.107	182.0	0.127
11	365	0.278	160.0	0.122	191.0	0.145
12	238	0.317	104.0	0.139	124.0	0.165
13	365	0.357	160.0	0.156	191.0	0.186
14	411	0.402	180.0	0.176	215.0	0.210
15	260	0.450	114.0	0.197	136.0	0.235
16	164	0.502	72.0	0.220	85.9	0.262
17	217	0.555	94.9	0.243	113.0	0.290
18	386	0.612	169.0	0.268	202.0	0.320
19	269	0.670	118.0	0.293	140.0	0.350
20	316	0.733	138.0	0.321	165.0	0.383
21	122	0.793				
22	131	0.855				
23	145	0.917				
24	156	0.979				
25	166	1.034				
26	189	1.090				
27	204	1.144				
28	222	1.198				
29	223	1.241				
30	232	1.288				

Encl 3

NEW BEDFORD HARBOR SUPERFUND SITE
CDF PERCOLATION ESTIMATES FROM HELP MODEL
SENSITIVITY TO HYD. CONDUCT. AND INITIAL WATER



Encl 4

NEW BEDFORD HARBOR SUPERFUND SITE

COMPUTER FILES FOR HELP MODEL OUTPUT

19 MARCH 1993

Description of File	File Name
CDF1 open, years 1-20	NB1OPN1
CDF1 open, years 21-30	NB1OPN2
CDF1 capped, years 1-20	NB1CAP1
CDF1 capped, years 21-30	NB1CAP2
CDF1B open, years 1-20	NB1BOPN1
CDF1B capped, years 1-20	NB1BCAP1
CDF7 open, years 1-20	NB7PPEN1
CDF7 capped, years 1-20	NB7CAP1
CDF1 open w/ increased hydraulic conductivity	NB1OPEN2H
CDF1 open w/ reduced hydraulic conductivity	NB1OPNLH
CDF1 open w/ increased initial water content	NB1OPNWC
CDF1 open w/increased hydraulic conductivity and increased water content	NB1OPNHW

End 5

April 13, 1993

Programs/Project Management Directorate

Ms. Gayle Garman
EPA
Waste Management Division
J.F. Kennedy Building
Boston, MA 02203

Dear Ms. Garman:

This letter concerns the New Bedford Harbor Superfund Site and provides a response to questions received during the comment period on the proposed plan for the Estuary, Lower Harbor/Bay portion of the site that related to the leaching of PCBs from Confined Disposal Facilities (CDFs).

The Corps of Engineers evaluated the leaching of contaminants from CDFs during the Engineering Feasibility Study (EFS) conducted at the Waterways Experiment Station. Report 5 of the EFS describes the study conducted to evaluate the quality of leachate and Report 11 presents estimates of contamination released to the harbor from CDFs for the remedial alternatives that appear in that report.

Following the approach described in Report 11, the estimates of leachate loss have been recomputed by Mr. Averett at the Waterways Experiment Station (see Attachment A) to reflect the CDFs proposed for use in the remediation of the Estuary, Lower Harbor/Bay portion of the site (CDFs 1, 1B, and 7). Estimates of the volume of leachate flowing through the bottom of the dredged material in the CDFs were made using the Hydrologic Evaluation of Landfill Performance (HELP) Model. Important parameters and conditions used in the HELP Model analysis are as follows:

* CDF surface areas at the dredged material surface (see Attachment B which provides the physical characteristics of CDFs 1, 1A and 7);

* depth of dredged material (see Attachment B);

* dredged material hydraulic conductivity (6.5E-07 cm/sec - see Attachment C which provides information on leaching tests and consolidation testing performed on New Bedford Harbor sediment from which this value was determined);

* contaminant concentration in leachate - 266 ug/l (value determined from batch leaching tests, Report 5 of the Engineering Feasibility Study).

ATTACHMENT 5

Attachment A includes the results of the HELP model evaluation for both capped and uncapped CDFs. The sensitivity of the model to two major assumptions used in the analysis (hydraulic conductivity and initial water content) were also evaluated.

The results show that leaching is reduced considerably after the first two years. The higher values the first two years result from drainage of the water initially placed in the site with the dredged material. Once this water is released, the leaching rate is relatively steady and responds to changes in climatic conditions. Capping each site with a relatively impermeable material and synthetic membrane reduces the leaching after the second year to a minimal value.

CDFs are not likely to be capped for 2-3 years after they are filled with dredged material. This delayed installation of the cap is due to the need to allow for the dredged material to consolidate somewhat and for the caps to be designed based on the specific conditions encountered at each CDF site. Estimates for the mass of PCB released to the harbor in leachate from CDFs are shown in the following table. The leachate volume for an uncapped CDF is used in computing the estimate for the first 3 years of the facility's life. The values represent annual totals.

Year	CDF 1	CDF 1B	CDF 7
1	13.8 kg	4.7 kg	4.5 kg
2	7.2	2.3	1.9
3	2.4	0.9	1.0
4	0.001	0.0003	0.0004
5	0.0009	0.0004	0.0005

6-20 (Less than 1 kg in total is released from each facility from year 6 - 20.)

Note: Several studies have determined that approximately 1 kg of PCB is transported out of the upper estuary on each tidal cycle (2 kg/day or 730 kg/year) under existing conditions.

The sequence for building, filling, and capping the CDFs will be determined during the projects design phase. At this point it is anticipated that the CDFs will be constructed sequentially and will be at different stages relative to leachate losses throughout their life.

Please review this information and contact me at 647-8895 if there are any questions.

Sincerely,

MJO 4/13

Mark J. Otis
Project Manager

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT _____ PAGE _____
COMPUTATION _____
COMPUTED BY _____ CHECKED BY _____ DATE _____

CDF #1

year	Percolation Rate (ft^3)				(m^3)						
1	1,820,000	×	0.0283168	=	$51,819.744 \times 10^3$ =	51,819,744 l	×	0.266 mg/l	=	13.78 kg
2	949,000	×	"	=	$26,872.643 \times 10^3$ =	26,872,643 l	×	"	=	7.15
3	312,000	×	"	=	$8,834.842 \times 10^3$ =	8,834,842	×	"	=	2.35
4	104	×	"	=	2.945×10^3 =	2,945	×	"	=	0.00078
5	120	×	"	=	3.398×10^3 =	3,398	×	"	=	0.00090
20	733	×	"	=	20.756×10^3 =	20,756	×	"	=	0.0055

CDF #1B

1	626,000	×	0.0283168	=	17726.317×10^3 =	17,726,317	×	0.266	=	4.7152
2	301,000		"	=	8523.357	=	8,523,357	×	"	=	2.2672
3	116,000		"	=	3284.749	=	3,284,749	×	"	=	0.8737
4	45		"	=	1.274	=	1,274	×	"	=	0.0003
5	53		"	=	1.501	=	1,501	×	"	=	0.0004
20	321		"	=	9.090	=	9,090	×	"	=	0.0024

CDF #7

1	603,000	×	0.0283168	=	17075.030×10^3 =	17,075,030	×	0.266	=	4.5420
2	246,000		"	=	6965.933×10^3 =	6,965,933	×	0.266	=	1.8529
3	138,000		"	=	3907.718×10^3 =	3,907,718	×	0.266	=	1.0395
4	54		"	=	1.529×10^3 =	1,529	×	0.266	=	0.0004
5	63		"	=	1.784×10^3 =	1,784	×	0.266	=	0.0005
20	383		"	=	10.845×10^3 =	10,845	×	0.266	=	0.0029

CENED-PD-E August 15, 1995

MEMORANDUM FOR Daniel Averett, Waterways Experiment Station

SUBJECT: New Bedford Harbor Superfund Site

1. EPA has requested that we re-evaluate our estimates of PCB releases through leachate from CDFs that were included in Report 11 of the Engineering Feasibility Study.

2. The following information should be used in the evaluation.

CDF Locations: Sites 1, 1B and 7. The configuration of sites 1 and 1B is as shown in Report 11. I have attached several sketches of the conceptual design of CDF 7.

Liners: All dike sideslopes would be lined (sheetpile wall will be lined in the case of CDF 7).

Cap: All sites would be capped. Initially a cap would be hydraulically placed followed by an aggressive effort to consolidate the dredged material (wick drains, surcharging, etc.). A RCRA type cap would then be constructed. The time period from the completion of dredging to completion of the cap is likely to be 3+ years.

Foundation: Our initial analysis assumed a free draining foundation to provide a worst case estimate. EPA would like us to evaluate a realistic scenario using the available information on foundation conditions in New Bedford.

3. EPA will use this information in their discussions with the New Bedford Forum (a facilitated group of citizens/local officials that meets regularly to discuss the project). Forum meetings are scheduled every two weeks for the next several months. Please try to provide a revised estimate by the end of September.

4. I appreciate your willingness to support us on this project and please give me a call (617/647-8895) if there are questions or if additional information is needed. Also thank Tommy Myers for his efforts at the 25 July public meeting in New Bedford. He did a great job.

Mark J. Otis
Acting Chief, Environmental
Project Management Division

ATTACHMENT 6

NEW BEDFORD LEACHATE ANALYSIS

Predictions of leachate quantity and quality were generated for four nearshore confined disposal facilities (CDFs) and are reported in the following tables. The HELPQ (Hydrologic Evaluation of Leachate Production and Quality, Version 2) module (Schroeder and Aziz 1996) of ADDAMS (Automated Dredging and Disposal Alternatives Modeling System, Version 4) (Schroeder and Palermo 1995) generated the leachate flux predictions using contaminant partitioning, permeability, and settlement data. Contaminant partitioning data was obtained from Report 5: Evaluation of Leachate Quality (Myers and Brannon 1988). Permeability and settlement data were generated from consolidation modeling using the PSDDF (Primary Consolidation, Secondary Compression and Desiccation of Dredged Fill, Version 2) module (Stark 1996) of ADDAMS.

Sediment Characteristics

The dredged material is an organic clay (OH) with an average liquid limit (LL) of 94 and plasticity index (PI) of 62, approximately 23% fine sands and 77% fines. The specific gravity was 2.40 and the initial conductivity (salinity) was 14.7 mmhos. The initial concentrations of total PCB, lead, and copper were 1500 mg/kg, 2013 mg/kg, and 1730 mg/kg, respectively.

CDFs

CDF A is a nearshore confined disposal facility (CDF) having a surface area of 8 acres. The design consists of hydraulically placing 10 ft of material (post-disposal) above the existing foundation, allowing for sedimentation and self-weight consolidation during the disposal operation. The actual average thickness of material is likely to be several feet less due to slope of the bottom and slope of the inside dike face. Two additional feet of clean dredged material are placed on top of the contaminated material to serve as a temporary cap while the material undergoes consolidation. As such, it was assumed based on results of sedimentation testing and self-weight primary consolidation modeling without desiccation that the initial void ratio would average 3.5. The foundation was assumed to be a 5 ft thick layer of compressible material underlain by an incompressible sandy layer. The compressible foundation material was modeled to be identical to the contaminated dredged material. The compressible foundation would rapidly assume a permeability characteristic of the loading, approximately 1.9×10^{-7} cm/sec, and after capping the permeability would decrease to 1.4×10^{-7} cm/sec. The mean water table was assumed to be 3 ft above the foundation. Material was assumed to start desiccation 90 days after the end of disposal operations. Three years after disposal CDF A was assumed to be covered with a final cap consisting of 2 ft of vegetated soil underlain by a geosynthetic liner

ATTACHMENT #7

with 6 in. of bedding material.

CDFs B and C are identical to CDF A except for their surface areas. CDF B has a surface area of 7.2 acres while CDF C has a surface area of 8.4 acres. The foundation properties are assumed to be the same as described for CDF A. Also, the disposal and capping operations are the same as for CDF A.

CDF D is similar to CDFs A, B, and C, differing primarily in only a few of its dimensions. CDF D is a nearshore confined disposal facility (CDF) having a surface area of 19 acres. The design consists of hydraulically placing 17 ft of material (post-disposal) above the existing foundation, allowing for sedimentation and self-weight consolidation during the disposal operation. The actual average thickness of material is likely to be several feet less due to slope of the bottom. The temporary and final caps are identical to those for CDFs A, B, and C in design and scheduling. The foundation properties are assumed to be the same as described for CDF A, except that its permeability was lower due to the higher loading on it resulting from the placement of a thicker layer of dredged material. The compressible foundation would rapidly assume a permeability of approximately 1.4×10^{-7} cm/sec, and after capping the permeability would decrease to 0.86×10^{-7} cm/sec. The mean water table was assumed to be 5 ft above the foundation. Also, the disposal and capping operations are the same as for CDFs A, B, and C.

Modeling Assumptions

The consolidation data used in the PSDDF model were obtained from the model's default data base and selected based on the PI of the material. The appropriateness of the data was verified with data from the leachate permeameter tests report in Report 5 (Myers and Brannon 1988) and the geotechnical tests. Conservative parameters were selected for drainage and evaporation process descriptions.

The soil moisture retention properties used in the HELPQ model were selected to yield the same drainage of initial moisture as the predicted settlement from the PSDDF model. Specifically, the thickness and porosity were set to the initial conditions, and the field capacity was adjusted to yield the drainage from consolidation. The wilting point was then adjusted to yield appropriate unsaturated drainage properties.

The layer configuration used in the HELPQ model was selected to reflect the characteristics of the hydrologic processes. The 10-ft (17-ft for CDF D) dredged material layer was divided into three layers. The top layer was 10 inches thick and designed for accurately modeling runoff, evapotranspiration, and infiltration. The second layer was the rest of the dredged material above the mean low water level and assigned a permeability that resulted from a few years of consolidation in order to model the long-term unsaturated drainage of infiltrated water. The third layer (bottom)

was that portion of material below the mean low water level (3 ft for CDFs A, B, and C; 5 ft for CDF D). The 5-ft thick compressible foundation layer was modeled as a liner due to its low permeability.

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF A

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	160,600	1,038	80.0	68.8
2	160,700	1,039	80.1	68.9
3	165,400	1,069	82.4	70.8
4	101,000	653	50.3	43.3
5	81,100	525	40.5	34.8
6	68,500	443	34.2	29.4
7	65,400	423	32.6	28.0
8	61,700	399	30.7	26.4
9	58,100	376	29.0	24.9
10	54,700	354	27.3	23.4
11	42,400	274	21.1	18.2
12	6,300	40.9	3.2	2.7
13	5,500	35.6	2.7	2.4
14	4,800	30.8	2.4	2.0
16	3,900	25.4	2.0	1.7
18	3,600	22.9	1.8	1.5
20	3,200	20.8	1.6	1.3
25	2,700	17.3	1.3	1.1
30	2,100	13.4	1.0	0.9
35	2,100	13.4	1.0	0.9
40	2,200	14.2	1.1	0.9
50	2,100	13.4	1.0	0.9
60	2,100	13.4	1.0	0.9
80	2,100	13.4	1.0	0.9
100	2,000	13.0	1.0	0.8

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF B

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	144,500	934	72.0	61.9
2	144,700	935	72.1	62.0
3	148,900	962	74.2	63.8
4	90,900	588	45.3	38.9
5	73,000	472	36.4	31.3
6	61,700	399	30.8	26.4
7	58,900	380	29.3	25.2
8	55,500	359	27.7	23.8
9	52,300	338	26.1	22.4
10	49,200	318	24.5	21.1
11	38,200	247	19.0	16.4
12	5,700	36.8	2.8	2.4
13	5,000	32.0	2.5	2.1
14	4,300	27.7	2.1	1.8
16	3,500	22.9	1.8	1.5
18	3,200	20.7	1.6	1.4
20	2,900	18.8	1.4	1.2
25	2,400	15.6	1.2	1.0
30	1,900	12.0	0.9	0.8
35	1,900	12.1	0.9	0.8
40	2,000	12.8	1.0	0.8
50	1,900	12.1	0.9	0.8
60	1,900	12.1	0.9	0.8
80	1,900	12.1	0.9	0.8

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	144,500	934	72.0	61.9
2	144,700	935	72.1	62.0
3	148,900	962	74.2	63.8
100	1,800	11.4	0.8	0.7

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF C

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	168,600	1,090	84.0	72.2
2	168,800	1,091	84.1	72.3
3	173,600	1,123	86.6	74.4
4	106,000	685	52.9	45.4
5	85,200	551	42.5	36.5
6	72,000	465	35.9	30.8
7	68,700	444	34.2	29.4
8	64,700	419	32.3	27.7
9	61,000	395	30.4	26.2
10	57,400	371	28.6	24.6
11	44,500	288	22.2	19.1
12	6,600	42.9	3.3	2.8
13	5,800	37.4	2.9	2.5
14	5,000	32.3	2.5	2.1
16	4,100	26.7	2.1	1.8
18	3,700	24.1	1.9	1.6
20	3,400	21.9	1.7	1.4
25	2,800	18.1	1.4	1.2
30	2,200	14.0	1.1	0.9
35	2,200	14.1	1.1	0.9
40	2,300	14.9	1.2	1.0
50	2,200	14.1	1.1	0.9
60	2,200	14.1	1.1	0.9
80	2,200	14.1	1.1	0.9
100	2,100	13.5	1.1	0.9

LEACHATE AND CONTAMINANT MASS FLUX
FOR NEARSHORE CDF D

Year	Leachate Flux			
	Leachate Volume ft^3/yr	Total PCBs Mass g/yr	Lead Mass g/yr	Copper Mass g/yr
1	296,000	1,914	147	127
2	294,800	1,906	147	126
3	293,600	1,898	146	126
4	162,600	1,052	81.1	69.7
5	156,700	1,013	78.1	67.1
6	154,600	1,000	77.1	66.2
7	154,500	999	77.0	66.2
8	116,200	751	57.9	49.8
9	88,100	569	43.9	37.7
10	86,800	562	43.3	37.2
11	85,400	552	42.6	36.6
12	83,100	537	41.4	35.6
13	81,000	524	40.4	34.7
14	78,700	509	39.2	33.7
16	57,800	373	28.8	24.8
18	18,500	120	9.2	7.9
20	16,200	105	8.1	6.9
25	12,100	78.2	6.0	5.2
30	9,700	62.7	4.8	4.1
35	8,400	54.1	4.2	3.6
40	6,900	44.5	3.4	2.9
50	6,400	41.3	3.2	2.7
60	6,000	38.7	3.0	2.5
80	5,600	36.1	2.8	2.4
100	5,500	35.5	2.7	2.3

Comparison with 1989 Estimates

Flux estimates were presented in Averett et al. (1989) for the initial 30-year period after filling the CDFs. CDF Nos. 1, 1B, 3, and 12 were included in the evaluation. A revised estimate was prepared in 1993 for CDF Nos. 1, 1B, and 7. A comparison of the 1989 and 1993 results to the results for the scenario presented in this paper are provided below.

LEACHATE ANALYSIS COMPARISONS

Parameter	1989	1993	1997
CDF Surface Area, sq ft	2,400,000	1,500,000	1,800,000
In Situ Estuary Sediment Volume, cu yd	484,000	NA	450,000
Total Percolation through CDF Bottom, in., Years 1-30	23	NA	37
Total PCB Flux, kg, Years 1-30	190	40	37
Total Cu Flux, kg, Years 1-30	6	NA	2.4

Side by side comparisons are difficult because different criteria were used for the calculations and the data have been presented differently. The 1989 data were based on conservative estimates for CDF Nos. 1, 1B, 3, and 12. The 1997 results are sums of the areas, volumes, and fluxes of the four nearshore CDFs; the percolation is a weighted average per unit area of the four CDFs. The 1997 evaluation represents the 30-year period after disposal. It includes 3 years with a temporary cap and 27 years with the final cap, while the 1989 evaluation assumed final capping immediately after draining the ponded water, within the six months after disposal. This difference accounted for an additonal 18 inches of infiltration into the contaminated dredged material and an additional 17 inches of percolation during the first 30 years. Despite the larger percolation value in the 1997 evaluation the 1989 fluxes were greater by factors of 5.2 for PCBs and 2.5 for copper. The differences in surface area and volume provide an explanation for about a third of the difference. The rest of the difference is accounted by the earlier estimates using the maximum batch leachate concentration throughout the entire period, while the estimates presented in this paper

accounted for changes in leachate concentration with time.

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