JASON M. CORTELL
AND ASSOCIATES INC.

Site: NEW BEDFORD
Break: 17.7.49
Other: 51925

Report

ENVIRONMENTAL ASSESSMENT
MAINTENANCE DREDGING OF
NEW BEDFORD HARBOR

PREPARED FOR:
U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION

PREPARED BY:
JASON M. CORTELL AND ASSOCIATES INC.
WALTHAM, MASSACHUSETTS

1978

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NEW BEDFORD HARBOR

1.0 PROJECT DESCRIPTION

1.1 Location and General Description

New Bedford-Fairhaven Harbor is located on the southeastern coast of Massachusetts. The harbor is the estuary of the Acushnet River. In 1966 a hurricane barrier was erected across the mouth of the River, effectively enclosing the harbor with the exception of a 150 feet break in the hurricane barrier. The project channel extends seaward into the embayment between Sconticut Neck and Clarks Point (Figure 1).

1.2 Existing Federal Project Description

The following sections outline the federally authorized projects in New Bedford Harbor.

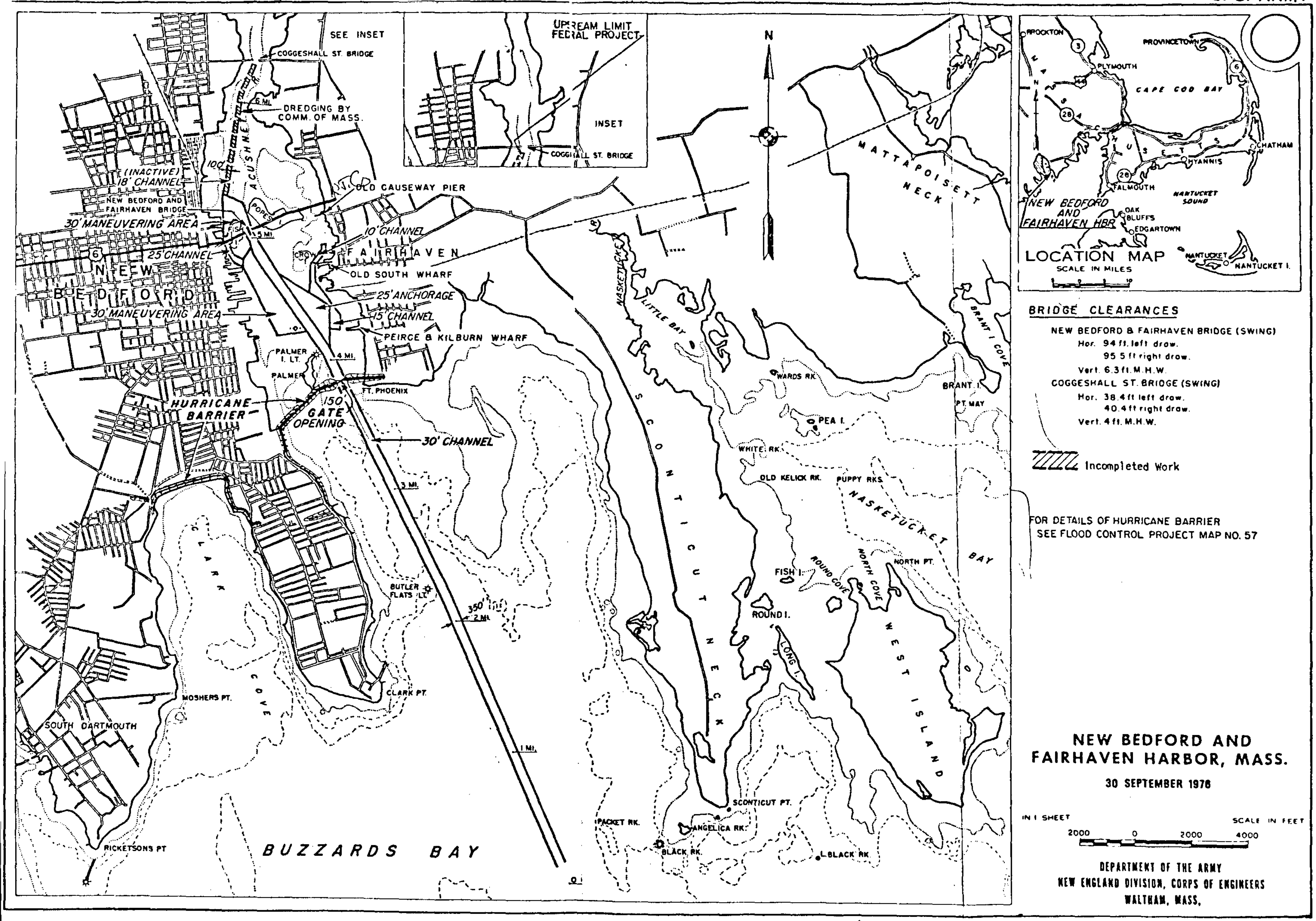
a. A channel 30 feet deep, 350 feet wide from Buzzards Bay to about 1/4 mile above the New Bedford-Fairhaven Route 6 bridge with increased widths for anchorage and maneuvering areas northwest of Palmer Island and above the bridge, The channel length is approximately five miles.

b. An anchorage area of about 44 acres and 25 feet east of the channel and north of Palmer Island.

c. A channel approximately 1,050 feet long and 25 feet deep along the New Bedford waterfront between the Route 6 bridge and the State Pier.

d. A channel about 1.0 miles long, 18 feet deep and 100 feet wide in the Acushnet River from the 30-foot Federal area north of Fish Island to the Coggleshall Street Bridge.

e. A channel about 2800 feet long, 15 feet deep and 150 to 400 feet wide, west of a line 50 feet channelward of Fairhaven Harbor lines, from the Pierce and Kilburn Wharf to Old South Wharf (D.N. Kelley and Son, Inc.), thence about 900 feet long, 10 feet deep and 150 feet wide to a point 1,000 feet south of Old Causeway Pier.



NEW BEDFORD AND FAIRHAVEN HARBOR, MASS.
30 SEPTEMBER 1976
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
LOCATION MAP
SCALE IN MILES
BROCKTON
PROVINCETOWN
PLYMOUTH
CAPE COD BAY
CHATHAM
HYANNIS
FALMOUTH
NANTUCKET SOUND
NEW BEDFORD AND FAIRHAVEN HBR
OAK BLUFFS
EDGARTOWN
NANTUCKET
NANTUCKET I.
BRIDGE CLEARANCES
NEW BEDFORD & FAIRHAVEN BRIDGE (SWING)
Hor. 94 ft. left draw.
95.5 ft right draw.
Vert. 6.3 ft. M.H.W.
COGGESHALL ST. BRIDGE (SWING)
Hor. 38.4 ft left draw.
40.4 ft right draw.
Vert. 4 ft. M.H.W.
Incompleted Work
FOR DETAILS OF HURRICANE BARRIER
SEE FLOOD CONTROL PROJECT MAP NO. 57
SCALE IN FEET
2000 0 2000 4000
SEE INSET
COGGESHALL ST. BRIDGE
UPSTREAM LIMIT FEDERAL PROJECT
INSET
DREDGING BY COMM. OF MASS.
ACUSHNET R.
(INACTIVE) 18' CHANNEL
NEW BEDFORD AND FAIRHAVEN BRIDGE
30' MANEUVERING AREA
25' CHANNEL
NEW BEDFORD
30' MANEUVERING AREA
OLD CAUSEWAY PIER
10' CHANNEL
FAIRHAVEN
OLD SOUTH WHARF
25' ANCHORAGE
15' CHANNEL
PEIRCE & KILBURN WHARF
PALMER I. LT.
PALMER
FT. PHOENIX
HURRICANE BARRIER
150' GATE OPENING
30' CHANNEL
BUTLER FLATS LT.
350'
CLARK COVE
CLARK PT.
MOSHERS PT.
SOUTH DARTMOUTH
RICKETSONS PT
BUZZARDS BAY
MATTAPOISETT NECK
NASKETUCKET R.
LITTLE BAY
SCONTICUT NECK
WARDS RK.
PEA I.
WHITE RK.
OLD KELICK RK.
PUPPY RKS.
NASKETUCKET BAY
BRANT I. COVE
BRANT I.
PT. MAY
FISH I.
ROUND COVE
NORTH COVE
NORTH PT.
ROUND I.
LONG I.
WEST ISLAND
SCONTICUT PT.
PACKET RK.
ANGELICA RK.
BLACK RK.
L. BLACK RK.

Figure 1

1.3 Previous Maintenance Dredging

New Bedford Harbor was last dredged in 1953, when 107,700 cubic yards of material were removed from the main channel and maneuvering area. In 1950, the Government hopper dredge LYMAN removed approximately 90,000 cubic yards of material. Disposal has been made at a site located near West Island in Buzzards Bay. The disposal site is a rectangular area 5,000 feet by 3,000 feet with sides running from North-South and East-West respectively. The center is at the intersection of a line bearing 10° true to the tower on the south end of West Island, distant 4,700 feet and a line bearing 310° from to Sconticut Point, distant 8,400 feet.

1.4 Project Maintenance

Periodic surveys will be scheduled to assess the condition of the various shipping channels and anchorages. If the survey results indicate that shoaling has resulted in decreases in the depths which have been authorized for the federal project, an attempt will be made to include funds for dredging in a future maintenance program.

1.5 Future Dredging

For planning and scheduling purposes only, it is estimated that maintenance of the New Bedford Harbor federal navigation project will involve the removal and disposal of 150,000 cubic yards of material in Fiscal Year 1981.

1.6 Disposal Area

At the present time a firm commitment on either an open water or land disposal site has not been made. Several potential land and water disposal sites are discussed in Sections 2.0, 4.0, and 6.0.

1.7 Project Authorization

The following table is a summary of the project authorization.

TABLE 1

Acts (River and Harborways Act)	Work Authorized
3 July 1930 30 July 1935	30 foot channel from Buzzards Bay to 1/4 mile north of Rte. 6 bridge [Section 1.2 (a)]

2 March 1907 30 March 1935	Anchorage area of 44 acres and 25 feet deep, north of Palmer Island [Section 1.2(b)]
3 March 1909	Channel 1,050 feet long, 25 feet deep along New Bedford waterfront [Section 1.3 (c)]
25 July 1912 3 August 1955	18 foot channel from end of 30-foot channel to the Coggleshall Street Bridge (Section 1.2 (d)
26 August 1937	15-foot channel west of a line 50 feet channelward of Fairhaven Harbor lines, from the Pierce and Kilburn Wharf to Old South Wharf, thence a 10-foot channel to a point 1,000 feet south of Old Causeway Pier [Section 1.2(c)]

2.0 ENVIRONMENTAL QUALITY WITHOUT THE PROJECT

2.1 Currents and Harbor Circulation

Work on the currents of New Bedford Harbor and adjacent areas of Buzzards Bay has been summarized by Eldridge (1978), Summerhayes et al., (1977), and Camp Dresser, and McKee (1974). The most detailed current information is presented by CDM in connection with a study of water circulation in the vicinity of New Bedford's sewage outfall at Clarks Point (Figure 2). A summary of their findings is presented in the following table:

TABLE 2

Station	Max Current*	Ebb-Flood Azimuths**
A	1.7 fps	250°-45°
B	1.39 fps	230°-35°
C	1.27 fps	265°-60°

* 15 minutes average
** Interpolated from current histogram

Currents presented in Eldridge (Figure 2, Stations D and E) average approximately 0.5 feet per second, except near high and low slack water which they are reported as weak and variable. In Buzzards Bay the currents are generally less than 1.6 feet per second (Summerhayes et al., 1976). In the opening in the hurricane barrier currents in excess of 4.0 feet per second have been reported.

Wave energy is moderately low with wave heights generally less than six feet. Due to the general coastline orientation the largest waves are from the south and southwest. The strongest winds occur during the winter and are most often from the WNW or NNW. These winds may cause clockwise surface circulation; however, they have little influence on wave generation in that they blow offshore.

In the harbor area the mean tidal range is 3.7 feet with a spring tidal range of 4.6 feet. Tidal currents are stronger in a flood direction than in an ebb direction. Freshwater input to the harbor is generally small. Summerhayes et al., (1976) reports a 7 day 2 year low flow of 0.7 cubic feet per second and winter flows of approximately 26 cubic feet per second.

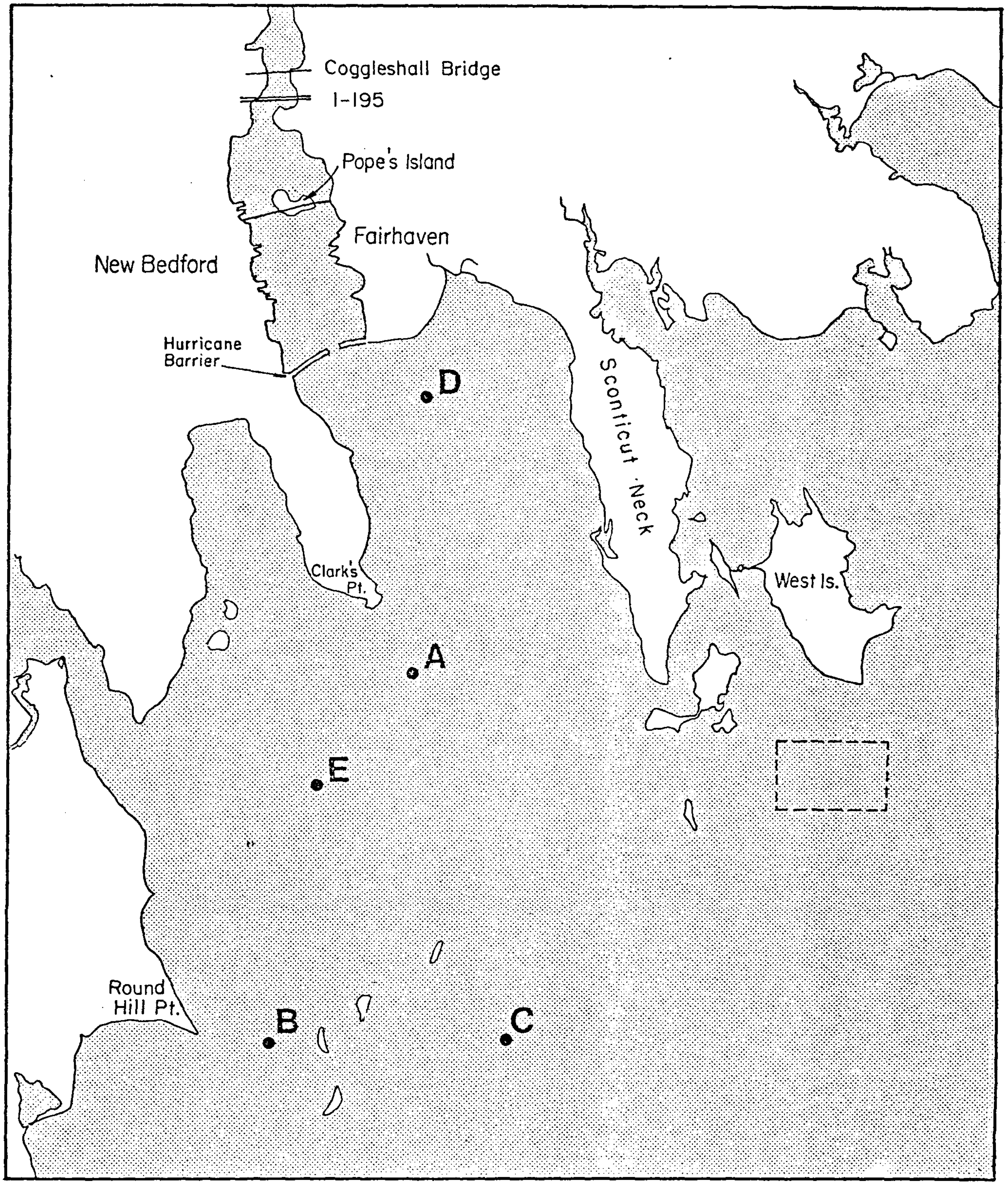
2.2 Harbor Sediments

2.2.1 Physical Characteristics

A considerable amount of surface sediment data on New Bedford Harbor and its approaches has been published by various authors including: Summerhayes et al., (1977), U.S. Army Corps of Engineers (1972), Moore (1963), and Hough (1940). The U.S. Army Corps of Engineers sampling program was confined to the federally authorized channel and anchorage areas. Summaries of grain size analyses from the sample stations, located on Figure 3, are presented in Appendix A. Of the fifteen samples which were classified, only three were not classified as organic clays with medium high plasticity (Unified Soil Classification - OG). Medium grain size for the twelve samples was 0.013mm with a standard deviation of 0.005mm. Sand sized particles were found just south of the hurricane barrier (KE-6) and in two locations seaward of Clarks Point (KE-10, and KE-15).

The most comprehensive study of the physical and chemical characteristics of New Bedford sediments has been carried out at Woods Hole Oceanographic Institute (Summerhayes et al., 1977). In addition to surface and core samples, 3.5 kHz echo-sounding profiles were run in the approaches to New Bedford Harbor. Results of the geophysical studies indicate essentially a late Tertiary or early Pleistocene drowned river valley system which has filled in with fluvial and marine sediments in the last 8000 years. Sediment thicknesses range up to 60 feet in portions of the buried valley of the Acushnet River. Away from the axis of the buried valley, thicknesses decrease to 8 feet and less on topographic highs. Test borings from the harbor reveal that more reduced, darker, and finer-grained sediments overly coarser sediments deposited under more oxidizing conditions. The upper 10 feet of harbor sediments reflect a stronger influence of man's activity than do the deeper units (Summerhayes et al., 1977).

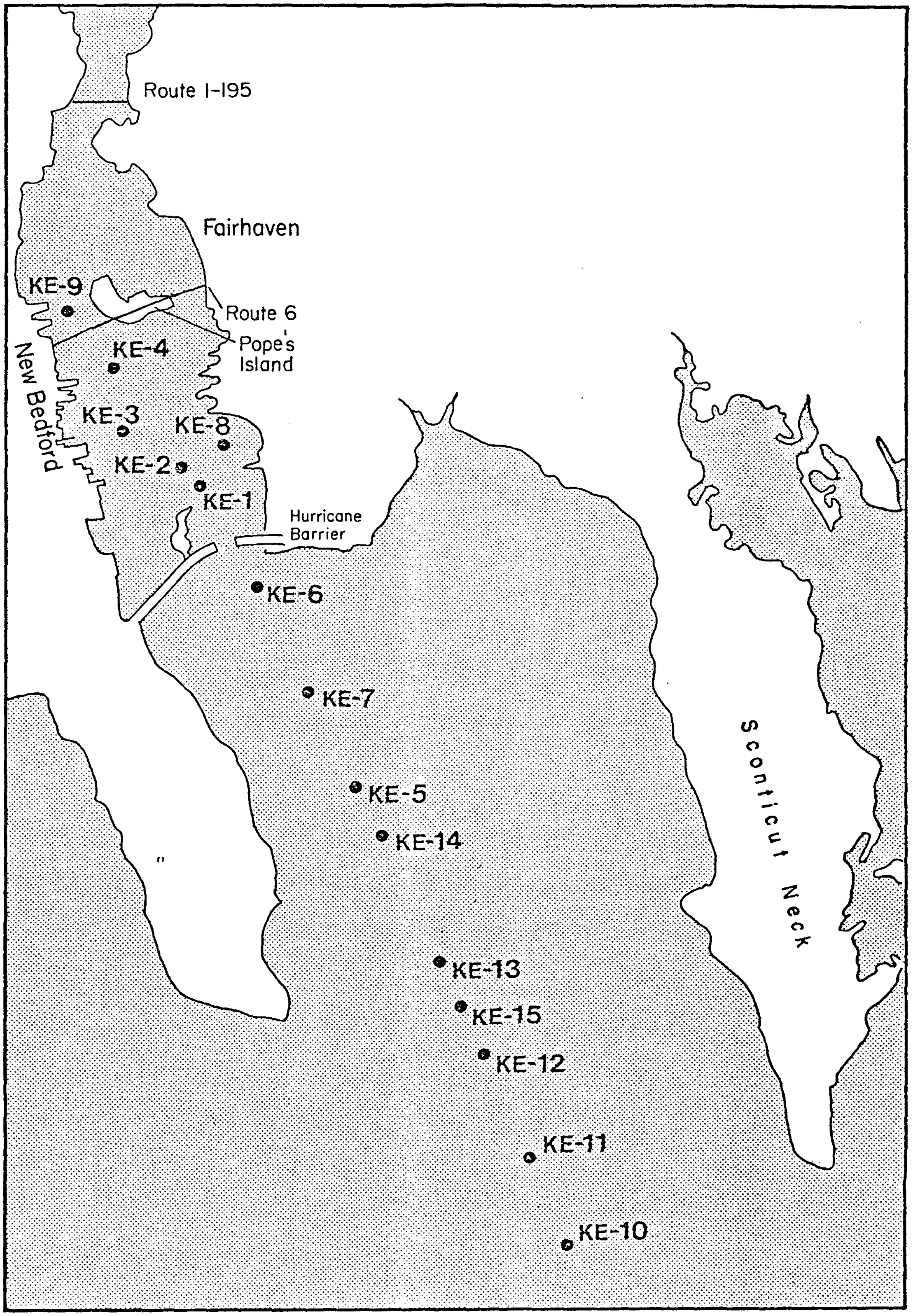
Figure 4 indicates the distribution of fine materials (mud, <63 microns) in bottom sediments of the harbor area. Several areas have been mapped as having greater than 75% mud. These include the vast majority of the project channels and portions of Buzzards Bay and Apponagansett Bay thought to overly pre-Pleistocene river valleys. These sediments are classified texturally as sandy muds and muddy sands. Coarser sediments, sand and gravel, are found in the Fairhaven Shoals, portions of Clarks Cove and on



Locations of Current Meter Stations

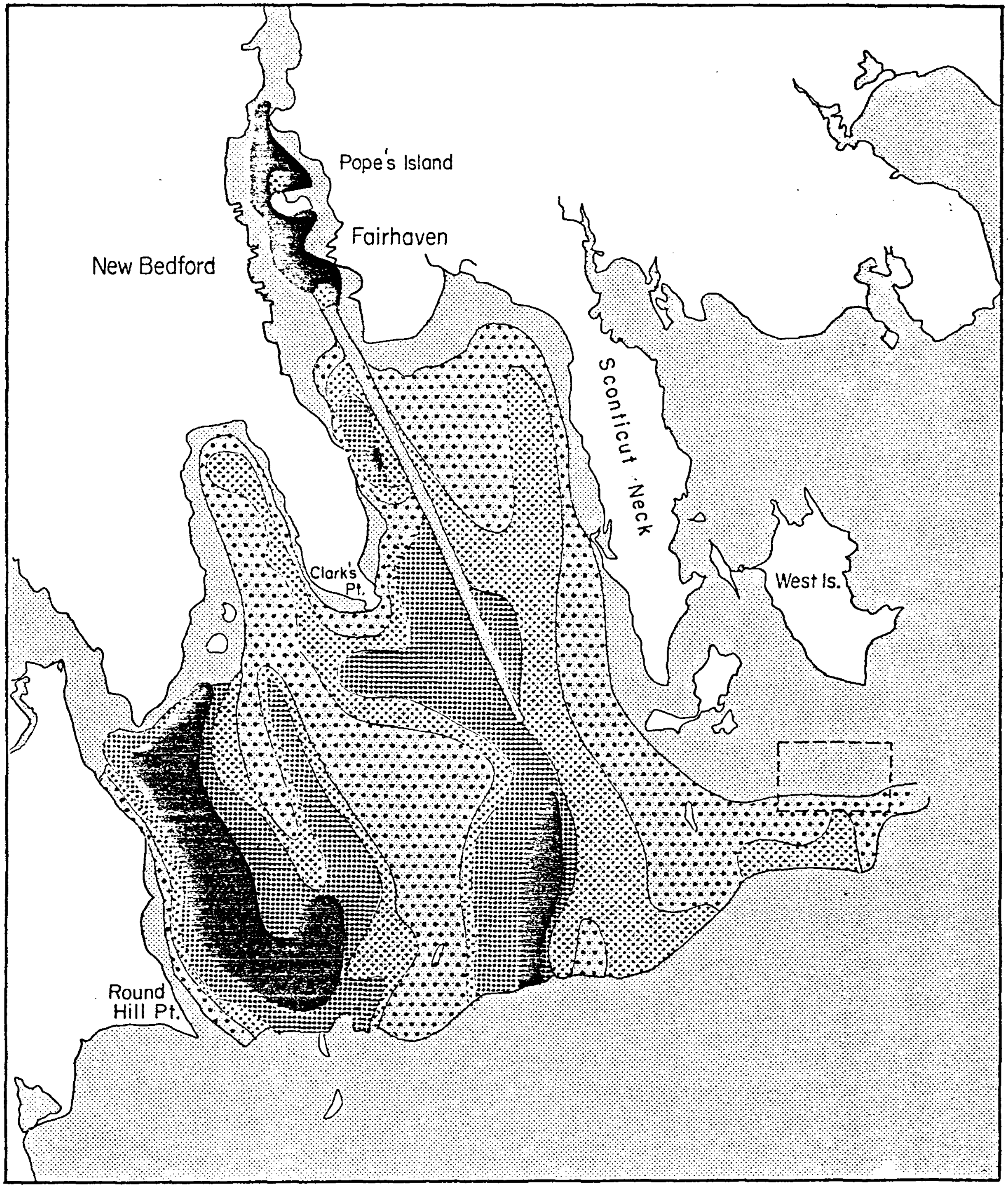
Stations A,B,C (Camp Dresser & Mckee, 1974)
C,D (Eldridge, 1978)

Figure 2



Locations of US Army Corps of Engineers Sediment Samples

Figure 3



Distribution of Mud (material < 63 µ)

Source: Summerhayes et al. 1976

% mud	
>75	
50–75	
10-50	
<10	

Figure 4

topographic highs which form ridges between the ancient river valleys. Transition zones between the "valley floors" and the nearby topographic highs are comprised of muddy sands and muddy gravels. In the inner harbor and many other areas which have been dredged there is a marked change in grain size downcore. In core NB81C4 (located south of the I-195 bridge) the percent mud is approximately 80% down to 60cm, a transition zone occurs between 60 and 80cm with the mud percentage decreasing to 10-20% below 80cm. This variation suggests a recent change in sedimentation patterns at this station and other similar locations in the inner harbor.

Sedimentation rates have been determined for the project areas using C-14 isotope dating. Sedimentation rates have been found to vary in a downcore direction, with the sediments in the upper section of the core accumulating at a faster rate. The change in rate has been a function of the hurricane barrier installation in 1966. These studies also show differences in sedimentation rates between more sheltered sections of the harbor as compared to those exposed to daily tidal flushing. At Station NB103 (Summerhayes, et al., 1977) sedimentation rates below a depth of 17cm were 2mm/year while above 17cm the rate was approximately 1.7cm/year; the change in rate occurs in 1966, the year in which the hurricane barrier was completed. The authors advise caution in interpreting these results until more dating takes place; however, preliminary indications are that in the last 11 years sedimentation rates have increased between five and ten times in certain portions of the harbor.

Based on these sedimentation studies and other estuarine studies (Meade, 1972, Pritchard, 1971, etc.) it is believed that net sediment movement is in a landward direction, from Buzzards Bay into the Acushnet River/New Bedford Harbor. The sediment moving landward is mostly fine in nature (silts and clays). The construction of the hurricane barrier in 1966 has acted to trap greater quantities of sediment which prior to 1966 might have been transported in a seaward direction.

2.2.2 Harbor Sediments Chemical Characteristics

Several recent data sources are available for information on the chemical characteristics of sediments in New Bedford Harbor and the approach channel. Chemical analyses conducted on cores collected by the COE indicated high

concentrations of trace metals. The Massachusetts Division of Water Pollution Control (Mass. DWPC) also sampled harbor sediments in conjunction with the Acushnet River water quality survey (1975). Woods Hole Oceanographic Institute (WHOI) has expanded these data with additional collections. In all, between the COE, Mass. DWPC, and WHOI, 153 samples have been analyzed for the horizontal and vertical distribution of trace metals, Kjeldahl nitrogen, volatile solids, some organic parameters, and physical sediment properties. More recently increasing amounts of effort have been focused on the chlorinated hydrocarbon situation (specifically PCB's) in the harbor and their impact on the marine resources of Buzzards Bay. The Commonwealth of Massachusetts, the EPA, and FDA have taken part in these studies.

The analyses from the cores collected by the Corps of Engineers are tabulated in Table 3. As indicated, the sediments are strongly reduced with redox potentials ranging from -248mv (KE-7) to -488mv (KE-9). There is little variation to be found in redox distribution in relation to the core location in the harbor and channel. Even into Fairhaven Bay, high redox values are found. At Station KE-1, KE-5, and KE-7 redox potentials of less than -270mv were found, but without any apparent relation to sediment grain size or physiographic features. Sediments whose mean was in the sand size range also had high redox potentials. Total volatile solids varied considerably ranging between 2.99% and 26.77%. Again, there appeared to be no consistent reasons for the variability.

Oxygen demands in the sediment regardless of location were high with an average COD concentration of 172,527 ppm (range 17,100 ppm to 259,700 ppm). The location of the high values for COD, total Kjeldahl nitrogen (4,830 ppm), and oil and grease (16,960 ppm) was on the Fairhaven side (core KE-4) where part of the fishing fleet docks. The lowest concentrations of total Kjeldahl nitrogen (830 ppm) and oil and grease (540 ppm) was at Station KI-6, which is several hundred feet on the seaward side of the hurricane barrier and is better flushed than other parts of the channel.

The analyses conducted by the Mass. DWPC indicated high concentrations of metals near to and above the Coggleshall Street Bridge. The data also indicated higher levels of these metals within the Harbor and in Fairhaven Bay. The average concentrations of metals were:

TABLE 3

NEW BEDFORD HARBOR SEDIMENT CHEMISTRY

SAMPLE	KE-1	KE-1	KE-2	KE-2	KE-3	KE-3	KE-4	KE-4
DEPTH (FT)	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0.-.17	1.0-1.17	0.0-.17	1.0-1.17
SED. pH	7.37		7.50		7.40		7.75	
SED REDOX POT. (MV)	-252.0		-377.0		-463.0		-415.0	
%Vol. Solids/ % Tot. Vol. Sol	6.84 / 17.2		5.99 / 15.93		10.5 / 2.99		11.5 / 26.77	
PPM COD	162,000		149,100		17,100		259,700	
PPM TOTAL KJDL Nit.	1,840		1,700		3,530		4,830	
PPM HEX Sol-Oil Grease	6010		5800		12950		16,960	
In (PPM) Hg	.96	.59	1.09	.59	1.56	1.01	2.25	1.49
Pb	135.1	79.0	92.7	40.0	199.8	134.3	261.7	237.7
Zn	278.6	188.0	238.3	88.5	461.9	318.9	631.3	577.3
As	11.9	5.9	13.3	2.3	10.8	<1.6	38.1	25.6
Cd	3.4	2.3	5.3	1.1	12.5	5.0	16.9	9.1
Cr	145.2	48.9	229.4	25.7	536.8	268.5	692.8	565.9
Cu	447.5	180.5	467.7	113.0	1036.2	671.3	1401.1	1335.6
Ni	23.6	18.7	29.1	9.7	43.7	29.4	53.9	44.1
V	50.7	56.4	53.0	20.0	93.6	50.3	123.2	90.6
% Carbon								
% H_2								
% N_2								
ppb PLYCHL BIPH								

SAMPLE	KE-5	KE-5	KE-6	KE-6	KE-7	KE-7	KE-8
DEPTH (FT)	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17
SED. pH	7.42		7.25		7.75		7.50
SED REDOX POT. (MV)	-268.0		-305.0		-248.0		-323.0
%Vol. Solids/ % Tot. Vol. Sol	10.28 / 23.92		2.63 / 16.13		7/72 24.08		3.84/ 12.20
PPM COD	230,600		151,100		232,300		111,000
PPM TOTAL KJDL Nit.	3,750		830		2,130		1,250
PPM HEX Sol-Oil Grease	7530		540		4310		3040
In (PPM) Hg	1.38	1.62	.38	.63	1.08	.64	.44
Pb	137.5	143.5	18.6	75.0	118.6	81.7	75.9
Zn	237.5	256.3	36.5	185.7	726.5	159.3	207.1
As	<3.0	21.4	≤.7	8.2	<1.3	<0.9	<.8
Cd	5.0	3.1	1.2	1.4	4.3	.25	4.8
Cr	218.8	98.4	19.2	46.4	178.0	50.6	207.1
Cu	357.5	272.7	47.1	21.14	352.7	148.7	483.3
Ni	35.0	25.6	8.0	17.9	23.7	18.0	22.1
V	87.5	61.5	18.6	92.9	64.7	49.0	38.0
% Carbon							
% H_2							
% N_2							
ppb PLYCHL BIPH							

TABLE 3

NEW BEDFORD HARBOR SEDIMENT CHEMISTRY

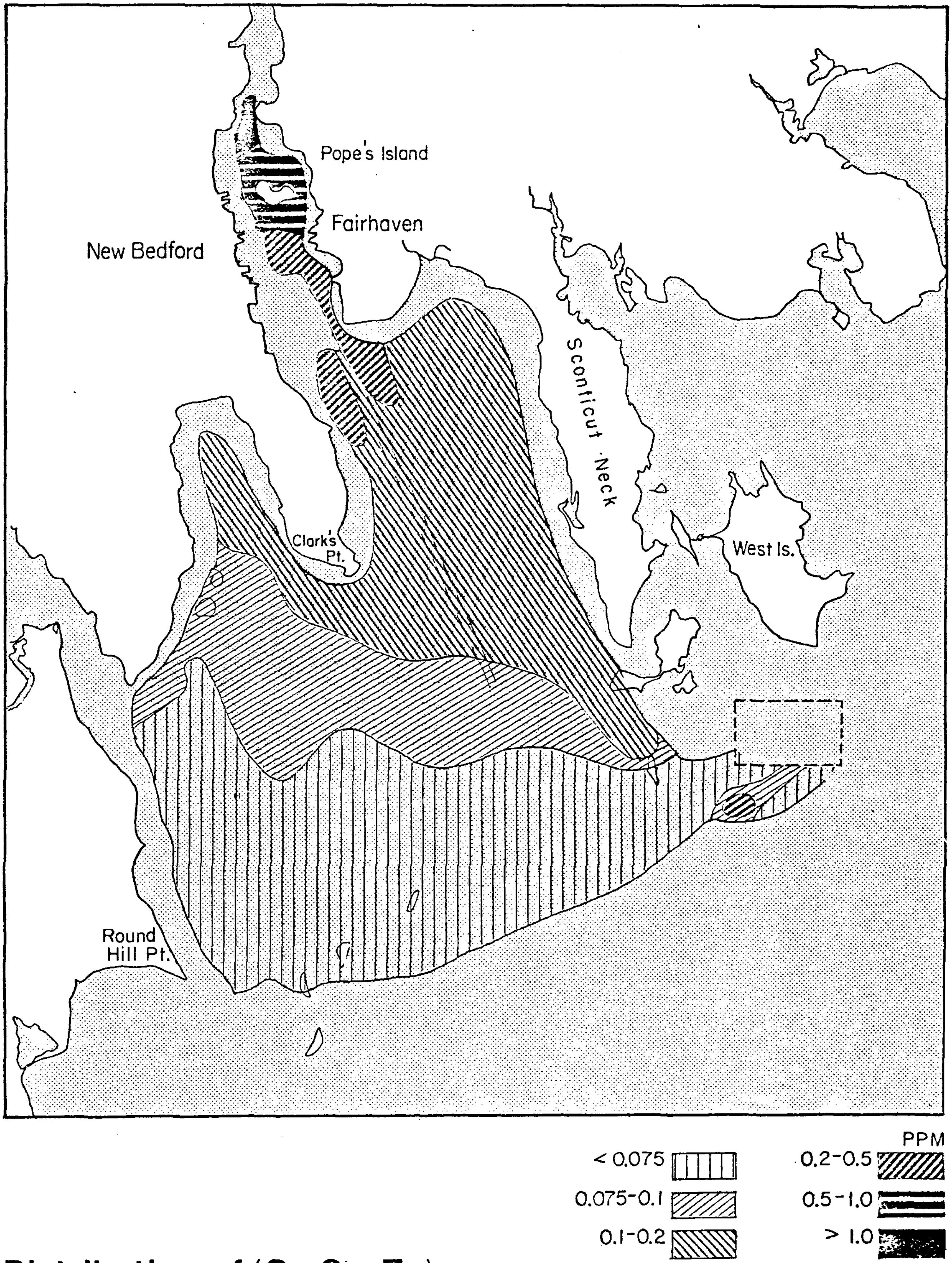
SAMPLE	KE-8	KE-9	KE-9	KE-10	KE-10	KE-11	KE-11	KE-12	KE-12	KE-13	KE-13	KE-14	KE-14	KE-15	KE-15
DEPTH (FT)	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17	0.0-.17	1.0-1.17
SED. pH		7.45		7.45		7.70		7.52		7.45		7.45		7.82	
SED REDOX POT. (MV)		-488.0		-383.0		-363.0		-430.0		-307.0		-405.0		-380.0	
%Vol. Solids/ % Tot. Vol. Sol		10.15 / 19.60		3.29 / 17.60		7.00 / 19.12		7.78 / 19.40		9.04 / 21.58		10.58 22.31		0.56 / 14.59	
PPM COD		186,500		166,100		181,600		184,500		206,700		214,200		135,400	
PPM TOTAL KJDL Nit.		3,470		1,080		2,860		3,120		3,320		4,250		60	
PPM HEX Sol-Oil Grease		16,090		390		1,350		3,490		4,710		6,140		90	
In (PPM) Hg	.40	1.18	1.63	.27	.10	.08	.30	.50	.38	.70	.36	.85	.62	.13	.99
Pb	40.7	249.3	492.4	40.5	11.3	79.8	66.1	130.4	98.3	119.4	92.9	142.3	156.1	15.8	14.2
Zn	87.3	616.8	790.2	80.3	33.9	177.5	138.8	190.6	184.9	209.5	183.2	235.9	278.0	18.4	16.5
As	11.0	31.5	44.6	29.3	9.6	23.8	11.3	45.0	*60.2	48.0	11.0	50.4	17.4	11.5	2.5
Cd	1.2	18.4	6.9	1.3	1.1	3.0	1.7	3.0	1.8	3.3	1.7	4.7	3.9	1.1	1.0
Cr	38.4	721.8	744.3	33.0	17.5	101.7	38.8	120.4	49.1	180.2	53.2	222.9	115.9	4.7	5.2
Cu	148.9	1535.4	2026.9	57.3	16.9	167.5	84.3	226.7	161.7	282.2	154.5	375.8	365.9	21.6	16.5
Ni	9.3	55.1	68.7	18.9	11.3	19.9	16.5	24.1	25.0	26.1	23.6	30.8	25.4	4.7	4.2
V	23.3	85.3	91.6	37.1	31.0	59.8	49.6	60.2	67.0	81.4	54.9	83.0	68.3	13.2	11.8
% Carbon															
% H_2															
% N_2															
ppb PLYCHL BIPH															

	Acushnet River Tidal Stations	New Bedford Harbor
Total Volatile Solids % dry weight	10.5	7.6
Iron mg/kg	5,615	5,135
Manganese mg/kg	127.0	106.3
Lead mg/kg	142.5	60.3
Zinc mg/kg	692.5	250.6
Nickel mg/kg	127.5	66.7
Chromium mg/kg	425.0	187.7
Mercury mg/kg	1.25	0.88

By far, the most complete synthesis of data on the trace metal distribution in the project area (and adjacent areas), is that of Summerhayes *et al.*, (1976). The distribution of copper, manganese, chromium, and zinc in the sediments are presented in Figures 5,6, and 7. Given the presence of major metals and alloy manufacturing on the waterfront, one would expect, as the data indicate, very high concentrations of these metals in the sediments. Of the four metals, copper has been found to exceed concentrations of 5,000 ppm in the sediments (8,054 ppm near the Coggleshall Bridge). Major concentrations extend through the harbor, the hurricane barrier, and into Fairhaven Bay. In essence, the entire federal project area is highly contaminated with copper, zinc, chromium, and lead. There are occasional slugs of other metals, the most consistent of which is at KE-4 where the highest levels of mercury (2.25 ppm), lead (261.7 ppm), and vanadium (123.2 ppm) have been found in the surface sediments. Were it not for the discharge of industrial wastes containing other trace metals near KE-9, the area at KE-4 would rank as the most contaminated location in the harbor.

Several vertical trends can be noted in the sediment data. The COE analyses at KE-4 indicate that the concentrations of trace metals decline with depth. Summerhayes *et al.*, (1977) indicates the contaminated sediments are generally confined to the upper two feet of sediment.

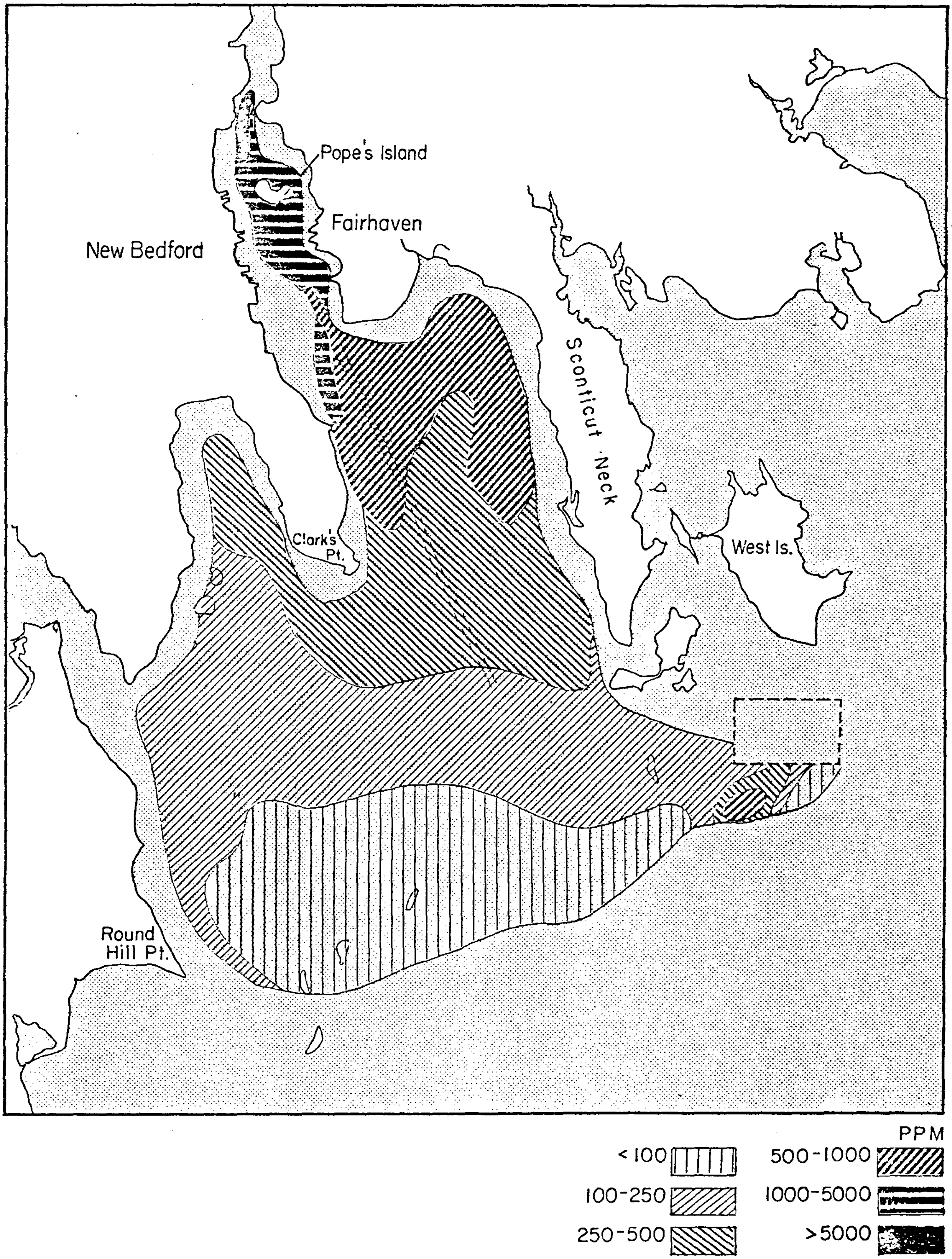
In addition to the trace metal pollution of the sediments, the polychlorinated biphenyl contamination is also severe. The EPA has, in a draft report on the PCB contamination of New Bedford Harbor, cited the firms of Aerovox Industries Inc. and Cornell-Dubilier Electric Corporation as the major contributors of PCB materials in New Bedford. Sediment 200



Distribution of (Cr+Cu+Zn) in the Clay Fraction of Bottom Sediments

Source: Summerhayes et al. 1976

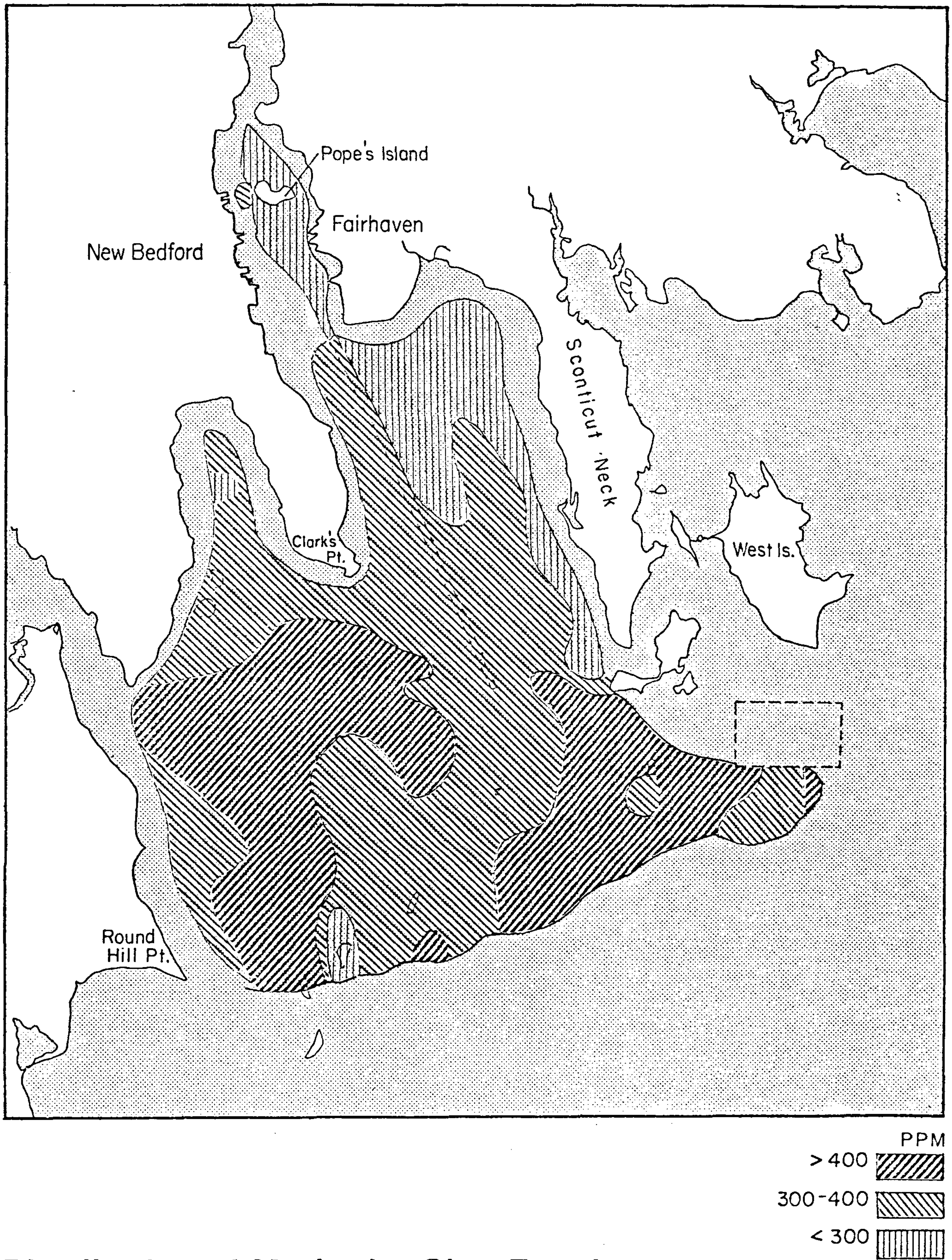
Figure 5



Distribution of Cu in the Clay Fraction of Bottom Sediments

Source: Summerhayes et al. 1976

Figure 6



Distribution of Mn in the Clay Fraction of Bottom Sediments

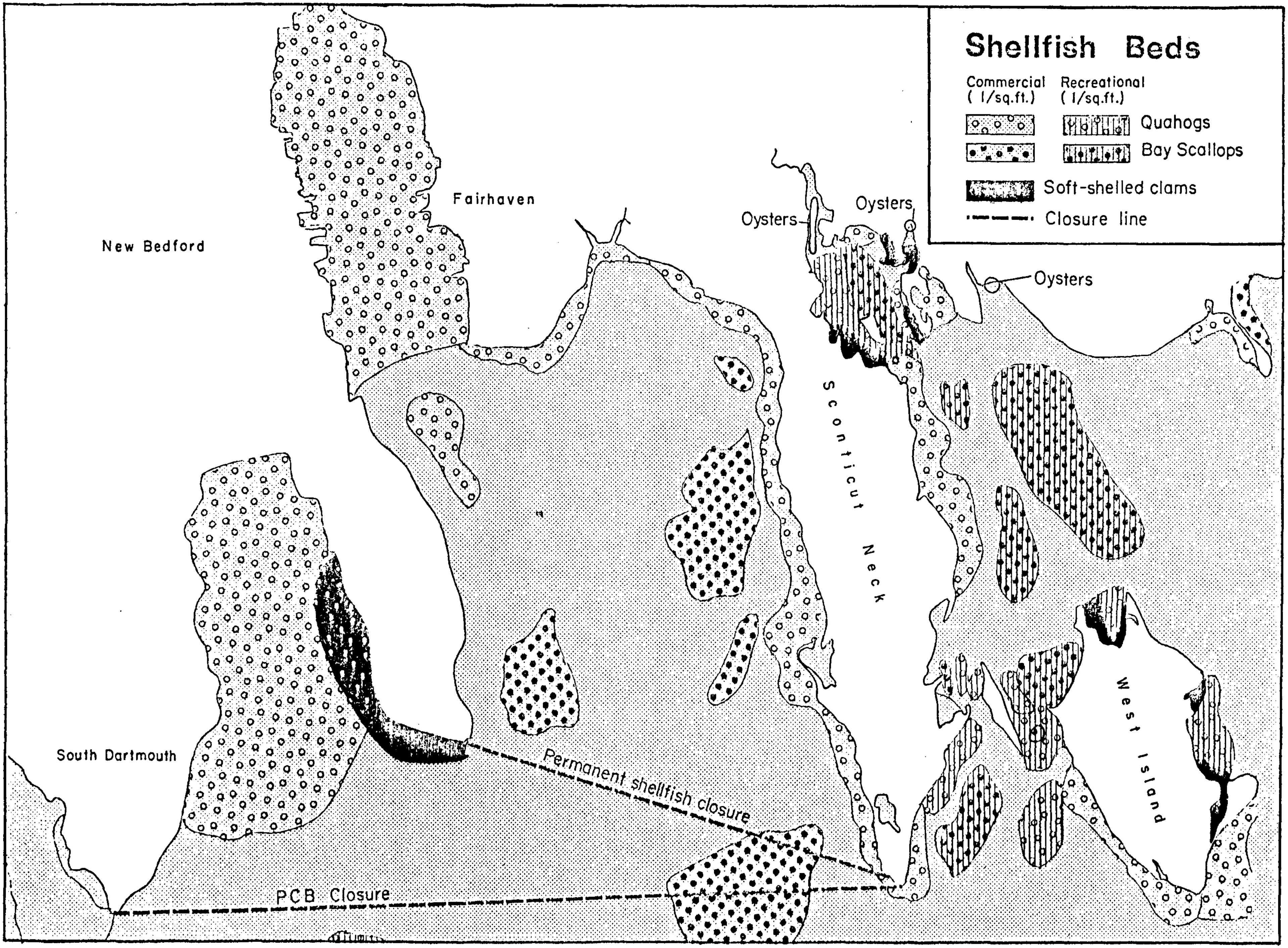
Source: Summerhayes et al. 1976

Figure 7

feet downstream of the Aerovox effluent discharge has been found to contain 620 ppm PCB and sediment 550 yards downstream of the Cornell-Dublier plant was found to contain 143 ppm of PCB. Other sediment analyses for PCB's in the Acushnet River in New Bedford and Fairhaven indicate concentrations to range from 0.3 ppm to 91.3 ppm. While it is known that a potentially serious pollution problem exists in the sediment from the PCB's, its specific extent either vertically into the sediment, or, horizontally into Fairhaven Bay and Buzzards Bay is not known (Environmental Protection Agency; T. McLoughlin - Massachusetts Department of Environmental Quality Engineering).

The insult from the PCB pollution to marine biota has been severe. Soft shell clams from the Acushnet River below the Aerovox plant were found to contain 21, 23, and 53 ppm of PCB's. Additionally, samples of eels, blackback flounder, blue crab, and lobster taken from the vicinity of Popes Island to Ricketsons Point on the edge of Buzzards Bay have been found to contain PCB's in excess of the FDA established limit of 5.0 ppm for fish and shellfish. As a result of the risk to human health, the Massachusetts Department of Public Health has restricted the taking of bottom feeding fish, eels, and shellfish including lobster from an area north of a line extending from Ricketsons Point to Sconticut Point (Wilbur Point) (Figure 8). An additional warning line for further potential PCB contamination extends north of a line from Mishaum Point to Gong 3 on Hursell Rock, to Rocky Point on West Island (Figure 8). The investigation into the extent of the PCB contamination is being continued by both the Commonwealth and the Federal government.

For purposes of comparison, the sediment data for the New Bedford project and information from other harbors and offshore areas in the region are presented in Table 4. It is recognized that in light of the most recent EPA/COE manual "Ecological Evaluation of Proposed Discharge of Dredged Material Into Open Waters" (1977), absolute concentrations of any parameter are no longer utilized in determining the acceptability of dredged material for ocean disposal. Comparative data can provide estimates as to the relative condition of the material. For the sediments reported in Table 3, there is a dissimilarity in terms of grain size versus the chemical constituents to be considered. In view of some of the analyses from the New Bedford project, however, the dissimilarity may be of lesser importance than realized, even though it is commonly



Shellfish Beds
Commercial (1/sq.ft.)
Recreational (1/sq.ft.)
Quahogs
Bay Scallops
Soft-shelled clams
Closure line
Oysters
Oysters
Oysters
New Bedford
Fairhaven
Sconticut Neck
West Island
South Dartmouth
Permanent shellfish closure
PCB Closure

Figure 8

TABLE 4 A Comparative Listing of Sediment Chemical Analyses.

	Rye Harbor Average	Buzzards Bay[1]	Boston Harbor 1975 cores[2]	Wallis Sands Beach NH[3]	Hampton Harbor NH[4]	Massachu-setts Bay[5]	East Hole Block Island Sound[6]
SED. pH	7.39			7.22	7.28		
SED REDOX POT. (MV)	*						
% Vol. Solids (EPA)	5.37		7.33	0.76	5.30		
% Total Vol Solids (EPA)	8.19	4.2	13.59	1.697	8.85		
PPM COD	70,667		125,437.50	3,866.67	76,833.33		
PPM TOT. KJDL Nit.	2,580		3,021.25	66.67	2,410.00		
PPM HEX Sol-Oil Grease	1,078	195	7,245.62	453.33	2,143.33		
Hg	0.086	0.21	1.23	0.03	0.0967	0.15	0.05
Pb	42.4	22.8	173.25	9.90	42.25	47.62	15.42
Zn	52.7	75.1	326.07	21.67	68.78	82.37	42.24
As	3.63	2.8	9.76	1.30	7.30		
Cd	2.40	1.6	5.70	0.50	1.42	1.47	<2.0
Cr	55.8	29.1	343.78	17.27	55.22	306.25 (7)	14.77
Cu	42.7	10.9	174.57	13.27	39.87	30.09	10.69
Ni	30.6	20.0	74.10	9.00	15.30	16.47	17.00
V	86.7	47.5	104.10	18.67	13.17		
% Carbon	2.46						
% H2	0.148						
% N2	0.072						
ppb PLYCHL BIPH	500.00	193.00		100.00	300.00		

[1] Summerhayes (1977)
[2] U.S. Army COE NED Cores collected 1975
[3] U.S. Army COE NED Cores collected 1972
[4] U.S Army COF NED Cores collected 1972
[5] Gilbert el al (1976) surface coastal sediments only
[6] NOAA (1976)
[7] Range 68-1042 ppm

TABLE 5. Water Quality Summary - New Bedford Harbor and Acushnet River

Parameter	New Bedford Harbor	Acushnet River
BOD5 mg/l	0.4 - 2.2* 0.4 - 1.4**	0.6 - 2.2 0.4 - 0.8
NH_3 - N mg/l	0.03 - 0.28* 0.04 - 0.22**	0.22 - 0.31 0.25 - 0.28
NO_3 - N mg/l	0* 0**	0 0
Total Phosphorus mg/l	0.02 - 0.08* 0.01 - 0.06**	0.06 - 0.08 0.05 - 0.06
pH	8.0 - 8.3* 8.0 - 8.4**	7.9 - 8.1 8.0 - 8.1
Alkalinity mg/l Total	104 - 112* 105 - 111**	102 - 104 104 - 105
Phth	-* 0 - 1.0**	- -
Solids mg/l Total	33,000 - 38,800* 32,700 - 35,200**	33,000 - 35,500 32,800 - 33,050
Suspended	0.5 - 6.5* 0.5 - 5.5**	1.5 1.0 - 2.5
Metals mg/l		
Chromium	50.0* 50.0**	40.0 20.0
Lead	350.0 - 400.0* 350.0**	350.0 350.0
Mercury	0.08 - 0.98* 0.14 - 0.55**	0.26 0.64

TABLE 5 . Water Quality Summary - New Bedford Harbor and Acushnet River

Parameter	New Bedford Harbor	Acushnet River
Nickel	150.0* 150.0**	150.0 150.0
Zinc	30.0 - 50.0* 20.0 - 50.0**	50.0 40.0
Iron	150.0 - 240.0* 150.0 - 200.0**	200.0 170.0
Manganese	50.0 - 150.0* 50.0 - 60.0**	50.0 50.0

* Low tide

** High tide

(1) Near Coggleshall Street Bridge

Source: Massachusetts Division of Water Pollution Control

TABLE 6. Water Quality of Potential Ocean Disposal Sites

Parameter	West Island[1]	West Falmouth[2]
Date of testing	5/73	2/76
pH	7.93/7.72[3]	-
Salinity ‰	32/33	-
Dissolved Oxygen mg/l	7.20/6.50	-
Total Phosphorus mg/l	0.074/0.054	0.027
Ammonium-N mg/l	0.060/0.065	-
Nitrate-N mg/l	0.010/0.025	<0.10
Nitrite-N mg/l	0.002/0.002	<0.01
Chlorophyll mg/l	0.0046/0.0044	-
Metals ppb		
Copper	7.8/6.0	23
Zinc	18.1/28.5	14.0
Cadium	1.43/1.36	0.7
Lead	2.94/5.6	2.0
Chromium	1.0/1.1	<4.0
Mercury	-	0.4
Arsenic	-	10.0
Nickel	-	1.5
Vanadium	-	<7.0

1 New England Aquarium 1973
2 COE 1976
3 Surface/29.5 feet

known that finer sediments adsorb higher amounts of trace metals and can be more reduced than coarser materials. The sediments from Wallis Sands, Rye Harbor, and Hampton Harbor are generally similar in that the median grain sizes fall into the medium sand category. New Bedford Harbor (with some exceptions), Boston Harbor, and Buzzards Bay sediments contain finer particles. By comparing the information in Tables 3 and 4, it can be noted that some parameters are comparable to, or exceed those, found in Boston Harbor. They are at an opposite from the cleaner sediments of Wallis Sands and Rye Harbor. The four main contaminants in the harbor sediments are copper, chromium, lead, and zinc. Their concentrations are significantly higher than concentrations in Buzzards Bay. While the hurricane barrier is aiding in the retention of sediment within the harbor, it is also a mitigating force in the control of further trace metal contamination.

2.3 Water Quality

Water quality in the Acushnet River and New Bedford Harbor have been evaluated by the Massachusetts Division of Water Pollution Control (Mass. DWPC) (1971, 1975). The data gathered during the 1975 survey are summarized in Table 5. The tabulation contains all data whether gathered inside or outside the hurricane barrier. Variations are notable both between locations and within a tidal cycle for many of the parameters. The 1975 were collected during July and August and dissolved oxygen concentrations were found to range from 5.6 to 8.4 mg/l at the top of the water column and from 5.3 to 6.9 mg/l on the bottom of the water column. A 24-hour study of oxygen levels on July 8-9 did not indicate any variations which could be attributable to diurnal production of oxygen by plankton. Rather, the ranges observed (4.4 mg/l at 0900 hours to 7.9 mg/l at 2055 hours) are more than likely variations within the normal seasonal range and do not indicate major changes induced by power generation.

Results from monitoring of bacterial concentrations (total and fecal coliform) are quite variable between locations and time and the designated classifications (SB inside the breakwater; SA outside the breakwater) have been exceeded on a number of occasions. Combined sewage overflows have been a serious problem in the harbor for many years.

The New England Aquarium report (1973) contains water quality information for the dumping ground off West Island. These data are summarzied in Table 6. Also presented in the tabulations are water quality data for the West Falmouth dumping ground (NEDCOE; 1976). In comparison, it can be noted that the waters inside and outside of the hurricane barrier are considerably higher in the concentrations of chromium, lead, nickel, and zinc (depending on the location in the harbor or water column) than are the waters at the various ocean disposal sites. It should be noted that concentrations of these trace metals in the NEA report were found to be several orders of magnitude higher than in the Mass. DWPC study than in the other two data sources. Whether or not this is attributable to an error in concentration designation or is fact, is not known at this time but is being checked. It must also be emphasized that the water quality in any of the tables are representative of conditions at the time of sampling and cannot be construed to be indicative of year-round conditions.

2.4 Biological Inventory

In recent years a moderate amount of biological studies have been reported in the New Bedford/Fairhaven area. Various reports have discussed phytoplankton, zooplankton, benthic macroinvertebrates, and finfish.

2.4.1 Phytoplankton

Phytoplankton studies of the project area are presented in a report by the Massachusetts Division of Water Pollution Control (1972). This study identified taxonomic orders of phytoplankton and analyzed for chlorophyll "a".

Most of the sample stations along the Acushnet River indicate organically enriched conditions. Green algae (Chlorophycea) were prevalent at nearly all of the freshwater sample stations. One station had a high abundance of rotifers with no other organisms present. This low diversity of organisms is an indication of a "stressed" environment. Chlorophyll "a" values ranged from 9.005 to 0.013 mg/l along the freshwater segment of the Acushnet River.

Lower abundances of phytoplankton were found at the saltwater sample locations in New Bedford Harbor. Diatoms were the most dominant group of algae. This is the most abundant phytoplankton group found naturally in marine waters. Chlorophyll "a" values ranged from 0.001-0.007 mg/l in the saltwater samples from New Bedford Harbor.

2.4.2 Zooplankton

Information on zooplankton densities in the harbor was obtained from the Massachusetts Division of Water Pollution Control (Mass. DWPC, 1972). Data on fish eggs and larvae in Rhode Island Sound was obtained from a report by the Army Corps of Engineers (COE, 1976).

The Mass. DWPC (1972) reported numerous crustacean larvae in samples throughout New Bedford Harbor. They ranged in densities between 1 and 3 aerial standard units per cubic centimeter. Crustacean zooplankton include copepods, amphipods, lobster, and crab zoeae larvae.

The fish eggs and larvae reported in Rhode Island Sound (COE, 1976) are likely to be found in New Bedford Harbor, as well. The larvae of cod, longhorn sculpin, mackerel, wrymouth bass, brassy sculpin, and yellowtail flounder were prevalent during early winter and spring. Other finfish larvae and eggs prevalent from late spring to fall included hake, butterfish, goosefish, cunner, weakfish, windowpane flounder, sea horse, pipefish, scup, tautog, whiting, and fluke.

2.4.3 Benthic Macroinvertebrates

Data on benthic faunal assemblages have been compiled from the Massachusetts Division of Water Pollution Control (Mass. DWPC) 1972, National Marine Fisheries (NMFS) 1977, and Kelley, 1977. A list of organisms found in New Bedford is presented in Appendix B.

The area above the Coggelshall Street Bridge has been inventoried by the Mass. DWPC and NMFS. The Mass. DWPC (1972) initiated a limited biological survey on sediment samples taken from above the bridge. Organisms found included a few *Littorina* (gastropods) and annelid worms. NMFS (1977), indicated the area had legal sized (> 51 mm) soft-shelled clams in densities of 1 per cubic foot. Mass. DWPC (1972) reported annelid worms and *Littorina* gastropods in the area between Coggleshall Street Bridge and the hurricane barrier. NMFS (1977) reported quahogs present in densities of 1 organism per cubic foot. Kelley (1977) found numerous polychaete worms such as Spionidae and Capitellids, as well as limpets (gastropods).

Various faunal assemblages occurred throughout the southern portion of New Bedford Harbor. Mass. DWPC (1972) and

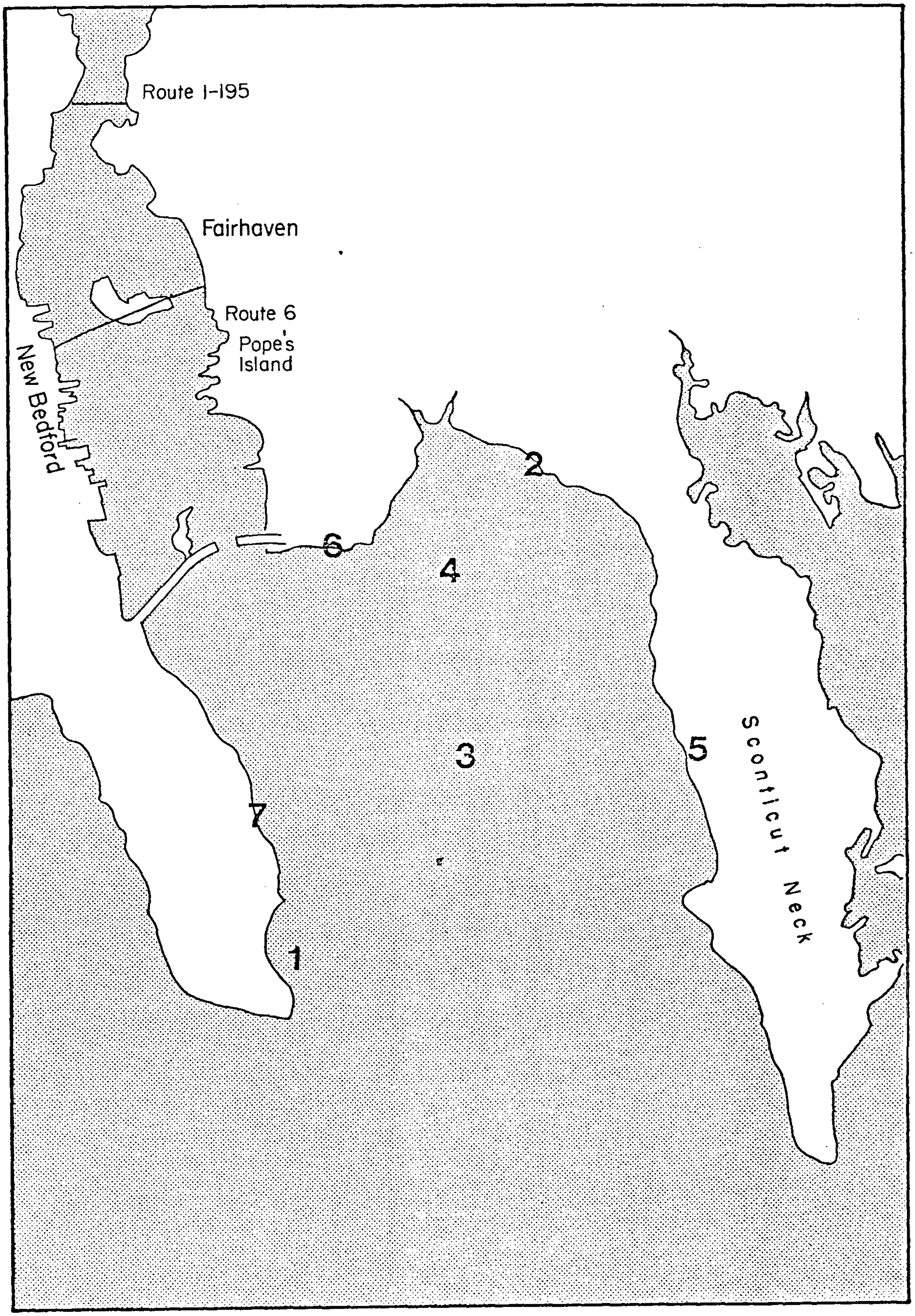
Kelley (1977), found an abundance of polychaete worms such as Capitellids. Additionally, Crepidula (slipper limpets) were abundant on rock outcrops. Bay scallop beds were found in the deeper areas of the harbor (NMFS, 1977). Quahog beds were located along the entire western length of Sconticut Neck. Nepthys sp., Nucula proxima, and Yoldia limatula were prevalent off Clarks Point.

The faunal assemblages of neighboring Buzzards Bay have been well documented. Rhoads and Young (1970) have found two distinct faunal assemblages which are correlated with sediment textures. Deposit feeders such as polychaete worms and Nucula bivalves are found in silty sediments. These organisms rework the sediment thereby increasing the erodability of the bottom. Filter-feeders, such as ocean quahogs, are found primarily in sandier sediments. The grain sizes of New Bedford Outer Harbor are characterized by various sediment types (muds - gravel). Numerous deposit feeders such as the polychaete worms, Capitellidae and Paronidae, were found throughout the entire harbor. Numerous beds of filter-feeders such as bay scallops, quahogs, and soft-shelled clams were intermingled with the other faunal types.

The sediments from New Bedford Harbor are considered contaminated with heavy metals. A trace metal analysis of benthic organisms by Kelley (1977) found the highest copper, cadmium, and zinc sediment concentrations occurred above the hurricane barrier. High copper and cadmium tissue concentrations in the slipper limpet, Crepidula fornicata, were observed in this area. Zinc tissue concentrations in these organisms were relatively the same throughout the harbor. The slipper limpet may have some control over its accumulation of zinc, but not for copper or cadmium.

2.4.4 Finfish

Information on finfish species in New Bedford Harbor was obtained from various sources. The Army Corps of Engineers (COE, 1976) published a list of species most likely to be found in offshore waters. The Massachusetts Department of Environmental Quality Engineering (Mass. DEQE, personal communication, 1977) also had information on finfish species found within New Bedford Harbor. Information from these sources has been compiled into a species list and is presented in Table 7.



Sportfishing Areas

1 Bluefish, tautog, striped bass, flounder
2 Bluefish, striped bass
3 Bluefish, striped bass
4 Bluefish, striped bass
5 Bluefish
6 Flounder, striped bass, bluefish scup
7 Striped bass, bluefish, scup flounder

Figure 8a

TABLE 7

New Bedford Harbor Finfish Species List

Pomatomus saltatrix	Bluefish
Peprilus triacanthus	Butterfish
Tautoglabrus adspersus	Cunner
Paralichthys oblongus	Fourspot flounder
Lophius americanus	Goosefish
Brevoortia sp.	Menhaden
Macrozoarces americanus	Ocean pout
Ospanus tau	Oyster toadfish
Urophycis chuss	Red hake
Stenotomus chrysops	Scup
Myoxocephalus sp.	Sculpin
Clupea harengus harengus	Sea herring
Prionotus sp.	Sea robin
Merluccius bilinearis	Silver hake
Morone saxatilis	Striped bass
Tautoga onitis	Tautog
Merluccius merluccius	Whiting
Scophthalmus aquosus	Windowpane flounder
Pseudopleuronectes americanus	Winter flounder
Limanda ferruginea	Yellowtail flounder

SOURCE: Massachusetts Department of Environmental Quality Engineering (personal communication)
National Marine Fisheries Service (personal communication)
Army Corps of Engineers, 1976

The U.S. Army, COE (1976) compiled a list of finfish species which were caught off Browns Ledge in Rhode Island Sound. This list might be indicative of species which frequent the harbor. The most abundant species included winter and windowpane flounder and sea robin.

The Mass. DEQE (personal communication) used finfish species of silver hake, cunner butterfish, and winter flounder caught in New Bedford Harbor for a bioassay study of polychlorinated biphenyls (PCB). NMFS (personal communication) reported bluefish, tautog, striped bass, and scup were fished for sport within the Harbor.

Menhaden have been observed above Coggleshall Street Bridge. Two incidences of "fish kills" involving menhaden occurred in June and August of 1977. High temperatures, low dissolved oxygen, and high copper concentrations were observed on the dates of the "fish kills". Perhaps these adverse conditions had a toxic effect on the menhaden.

2.5 Commercial Fisheries

New Bedford Harbor has long been one of the leading fishing ports in Massachusetts. The fish landings information obtained from the National Marine Fisheries Service, indicates an annual revenue of $39 million. Shellfishing has been prohibited in New Bedford Harbor for the last decade due to bacterial contamination of overlying waters. Lobster fishing had been allowed until June 1, 1977 but was stopped due to lobsters being found whose tissue contained PCB concentrations over the FDA limit of 5.0 ppm for fish and shellfish. The impact to specific kinds of biota has been discussed in Section 2.2. The extension of a closure line to include the area north of a line from Ricketsons Point to Sconticut Point has now eliminated a recreational and commercial fishery, the value of which has not been estimated at present. Harvesting of bottom feeding fish, eels, and shellfish, including lobsters, from within the PCB warning area will be closely monitored. Within the project area, the only fishing that is allowed is for pelagic fish.

2.5.1 Fish Landings

The finfish and shellfish landed in New Bedford Harbor are caught throughout the Gulf of Maine and Buzzards Bay. A summary of landings information for the last 4 years is presented in Appendix C. Information was obtained from current fisheries' statistics of the National Marine Fisheries Service.

The most abundant finfish species landed were cod and flounder. Other fish included swordfish, whiting, menhaden, and numerous other species. Shellfish species landed included Jonah crabs, red crabs, lobsters, shrimp, scallop, conch, and squid. Lobster landings were quite lucrative with 223,136 pounds of unclassified, select, and large class sizes bringing in $406,246 in 1976. Although fewer pounds of finfish and shellfish were landed in comparison to 1975, 1976 was the most lucrative year bringing in $39,341,441.

A sport fishery exists within New Bedford Harbor. Figure 8 shows areas of heavy fishing pressure. Species fished for include bluefish, striped bass, flounder, scup, and tautog.

2.6 Disposal Sites

Discussions on potential locations for disposal of dredged material from New Bedford are divided into ocean sites and land (waterfront) sites. It is recognized that much of the material to be dredged may not be acceptable for ocean disposal. Ocean disposal is being discussed because of economic problems associated with in-harbor disposal.

Although there is no express prohibition against the use of federal funds for constructing bulkheads to contain dredged material, no such action has ever been undertaken by the New England division, COE. The problem in the case of New Bedford is that the Corps has no authority for the advancement or development of lands not owned by the government. Similar problems exist concerning the authorization to construct and operate containerized disposal facilities (Chase, personal communication, 1977).

What follows is a summary of existing policy concerning federal participation in land disposal projects.

> Section 150 of the Water Resources Development Act of 1976 authorizes the Secretary of the Army acting through the Chief of Engineers to establish wetland areas in connection with an authorized water resources development project if the Chief of Engineers finds the environmental, economic and social benefits of wetland areas justifies increased cost above the cost required for alternative methods of disposal of

dredged material for such projects. There is a limit of $400,000 on new projects. The Chief of Engineers must, where appropriate, report on the consideration of wetlands areas. He must assure wetland areas will not be substantially altered or destroyed by natural or man-made causes. Cost benefits: Benefits of establishing any wetland area shall be deemed to be at least equal to the cost of establishing such an area. All costs of establishing a wetland area shall be borne by the U.S.

Section 145 of W.R.D. Act of 1976 provides that the Secretary of the Army acting through the Chief of Engineers upon request of state may place on state beaches, beach quality sand which has been dredged, with the increased cost to be paid by state (for this alternative method of disposal.

Ownership of the land under consideration for filling or island creation must be established and the following considerations observed:

a. Within the three-mile limit from the coastline a state owns the ocean bottom (subject to navigation easements) and would have a valid interest in the land structure which might be developed on such submerged land.

b. If the land fill is attached to a peninsula or upland, infringement upon the rights of littoral owners may be involved.

c. Creation of islands will require an environmental impact statement, 42 USC 4332 (21) (c), since this would be considered a major federal action affecting the quality of the human environment.

d. If creation of islands or other land fills are contemplated they must be known at the time the project is recommended. The purpose, whether public or private must be established, in order to determine cost and whether a national interest is involved.

e. General proposals for island building after the project is authorized require modification of authorization of the project by Congress with a full report and cost-benefit analysis, and an opinion of national vs. local interests.

f. Under present requirements, local interests would, unless Congress decides otherwise, furnish all lands, easements and rights of way, diking, and contribution for portion attributable to purely local interests.

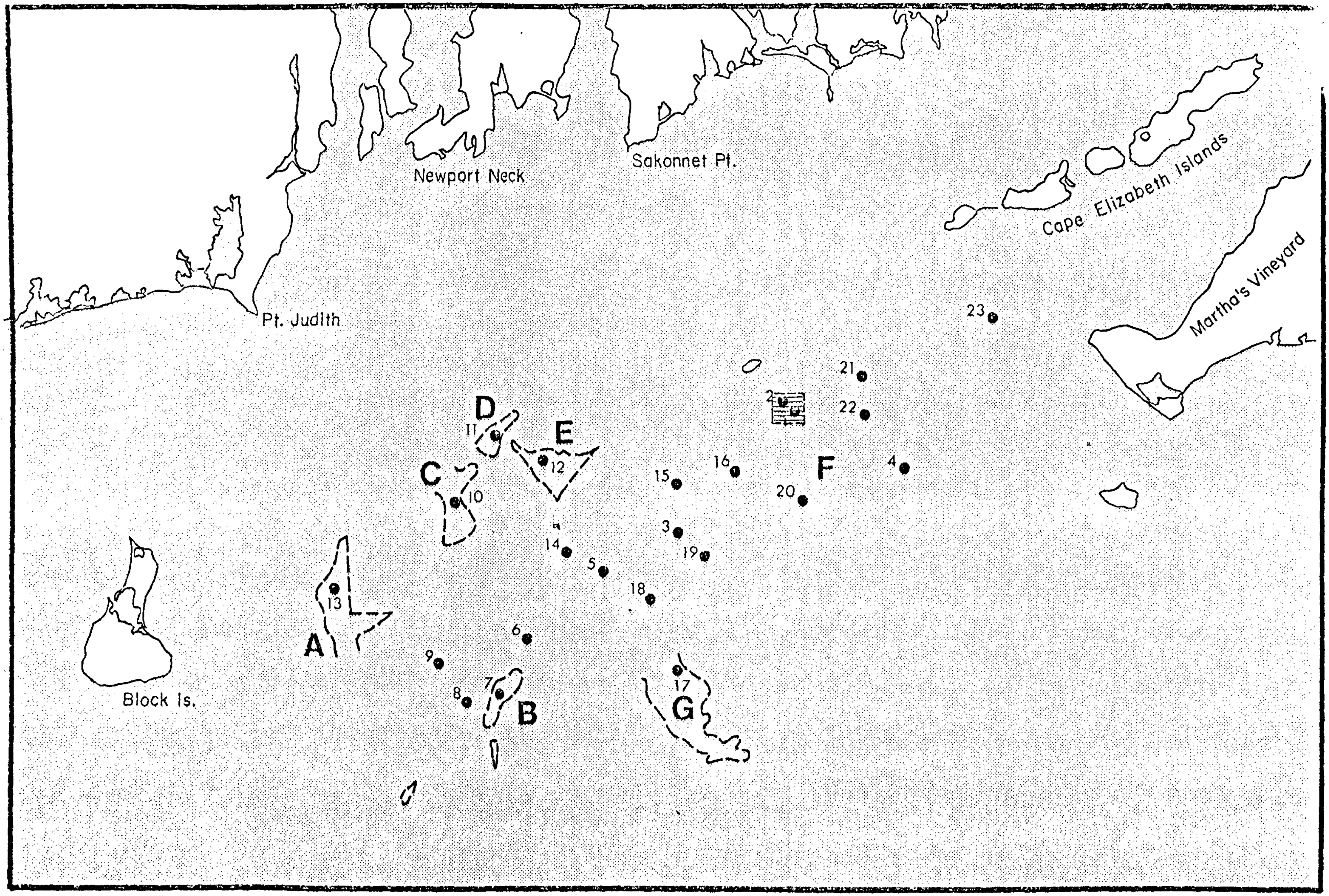
The Corps of Engineers further recommends that states should survey appropriate areas and establish areas which may be environmentally suitable. The state(s) should include in requests for public projects, the proposed disposal areas or sites for islands, with a statement as to the use to which they will be put. Assurances should be provided that all necessary rights to land will be obtained, environmental requirements will be met, and that maintenance of the structures will be assured. (NED, COE, 1978)

2.6.1 Ocean Disposal Sites

A number of ocean sites (Figures 2 and 9) are within feasible transport distance of New Bedford; some of which will receive more discussion than others. At the present time two Commonwealth approved sites are in the area. However, both sites are for disposal of clean material only. One site is the West Falmouth dumping ground at 41°36'N latitude and 70°41'W longitude. This site is principally used for disposal of material removed from the west entrance to the Cape Cod Canal. The site is situated approximately 3,000 yards offshore in waters with depths of 18-36 feet. The second site approved by the Commonwealth is on Cross Rip Shoals at 41°27'N and 70°22'W. This is, as the location name implies, a high energy area and dispersion of material is likely. The quality of material from New Bedford Harbor and potential adverse impacts preempt further consideration of these two locations.

2.6.1.1 West Island

Past federal dredging projects in New Bedford Harbor (the most recent being in 1953) have used an area near West Island (see Figure 2) located at 41°36'N and 70°41'W for disposal. This area is not approved by either the Commonwealth of Massachusetts or the Environmental Protection Agency. It is within the boundary of a Massachusetts Ocean Sanctuary, the Cape and Islands



Proposed Ocean Disposal Sites, Rhode Island Sound
(after Chase, 1977)

Figure 9

Sanctuary. Current information for the site is fairly limited. Eldridge (1978) indicates maximum spring tidal velocities of 0.7 knots in the flood direction and 0.9 knots in the ebb direction. Although there are surface current measurements, it is likely that the West Island Site is influenced enough by bottom tidal currents that it would not act as an effective containment site. Only scant sediment information is available for this disposal site and what is available, or in press, was collected on the southern edge of the site. During a survey of Buzzards Bay in 1973, the New England Aquarium collected a grab sample from the edge of the site and found the following concentrations:

Zinc	29.1 ppm	Nickel	7.4 ppm
Copper	6.5	Chromium	9.8
Lead	15.6	Vanadium	6.4
Cobalt	4.5	Mercury	0.20
Cadmium	1.4	Arsenic	1.64

It is difficult to estimate the relevance of this information to the true character of sediments taken from the harbor in 1953, and what is left of them within the dumping ground. Additionally, two sampling locations from the WHOI study are also located along the southern boundary of the site. These data are in press and may not be available until March, 1978. It is unfortunate that between these two surveys, cores were not collected well within the site to be representative. The New England Aquarium report also indicated that the sample from the dump site was found to contain the highest concentration of PCB (0.543 ppm) within Buzzards Bay. By comparison, the sediment from New Bedford Harbor contains considerably higher concentrations of trace metals than does the dump site sample, and there are some locations in Buzzards Bay which contain lesser or greater levels of trace metals than the dump site sample.

The area is fairly active as a biological resource. Some recreational harvesting of quahogs and bay scallops occurs in this area. Commercial harvesting of quahogs occurs along the eastern edge of Sconticut Neck, as well. Other benthic organisms would include polychaete worms, duck clams, and others. Numerous finfish species such as winter flounder, bluefish, tautog, and others are likely to be found in this area. This site is within the territorial sea and is covered by Section 404 of Public Law 92-500 (see Sec. 4.5).

2.6.1.2 Browns Ledge

The use of Browns Ledge has been investigated as a potential site for disposal of dredged material and/or as a regional disposal site.

The Browns Ledge site is located at 41°23'25"N and 71°17'58"W It is one nautical mile square and located about 2 nautical miles southeast of Browns Ledge proper. Detailed current studies of the Browns Ledge site have been conducted by U.R.I. as part of a Corps of Engineers investigaion into a regional disposal site (Pratt, S.D., and Heavers, R.N., 1975). Current meters were placed ten feet above the bottom at the site center and in the middle of the southern side of the site for over 34 days of measuring.

The average current speed at each station was 0.18 knots. No current speeds were recorded in excess of 0.55 knots (0.94 feet per second) and only one in excess of 0.5 knots. The non-tidal drift was found to be 0.3 nautical miles/day to the ESE at the southern end of the site and 0.7 nautical miles/day to the ENE at the center of the site. Considerable variation in drift direction and speed was encountered and was attributed to the wind systems influencing the site at the time of measurement.

Maximum spring tidal current speeds of 0.3 knots were recorded in a NNW-SSE direction. Unfortunately, these measurements do not reflect long term or worst-case conditions. It is thought by researchers at U.R.I. that wave induced currents may play a significant role in resuspension of sediments at the site.

A detailed summary of sediment investigations at Browns Ledge is presented in the Environmental Assessment of Fall River Harbor Dredging and Browns Ledge Disposal (URI, Applied Marine Research Group, 1975). Sediments encountered varied in grain size from gravelly sand to fine silty clay. None of the sediment results showed any correlation between sediment distribution and bottom topography. To quote the Environmental Assessment:

> "A tongue of relatively clean sand bisects the site. Near the center there is a localized concentration of gravel, comprising about 12% of the surface sample. Silt and clay fractions, comprising greater than 50

percent of the surface samples, is concentrated along the eastern boundary of the site and also in a small area in the southwest corner."

A bimodal distribution was detected in several samples. This may indicate fine suspended matter being deposited during calm weather and a transport of fine sand during periods of high waves or strong tidal currents.

Diver observations of the site (Chase, 1974) indicate a "decrease in grain size with increasing distance to either side of the ledge and seaward." A near-bottom turbidity layer was observed over fine grained sediments in the deeper portions of the site. Sand waves were noticed at the northern and central portions of the area, indicating bottom current activity, probably a combination of wave-induced and tidal currents.

Trace metal concentrations found in the sediments at Browns Ledge are presented in Table 8. As indicated in the tabulations, there is a wide variance in chemical characteristics at the Browns Ledge site. Compared with the data from New Bedford, trace metal levels of the project area sediment exceed the proposed disposal site in many instances by many orders of magnitude.

Biological inventories at the site have been carried out by the U.S. Army Corps of Engineers (COE, 1974, 1976).

Fish stomach analyses gave an indication of the bottom faunal assemblages. The area has numerous amphipods such as Leptocheirus pinquis and Ampelisca agassizi. Other dominant organisms included Crangon septemspinosus and Cancer sp. crabs. The ocean quahog (Arctica islandica) was found in the sandy mud sediments of Browns Ledge. However, the densities were not considered commercially feasible. Chase (1974) found moonsnails (Polinices sp.), plume worms (Cerianthus, Myxicola infundibulum) and Astarte snails.

Much of the fish landed in Rhode Island and New Bedford Harbor, Massachusetts is caught in Block Island Sound near Browns Ledge. Principal finfish species include winter flounder, summer flounder, yellowtail flounder, cod, red hake, silver hake, whiting, menhaden, sea herring, and scup. Some lobstering also occurs within the area.

2.6.1.3 Additional Open Ocean Sites

The remaining open ocean sites are found in Rhode Island sound (Figure 9). Chase (1977) carried out visual observa-

TABLE 8

HEAVY METAL CONCENTRATION
IN SEDIMENTS FROM BROWNS LEDGE

(Values in ppm)

	Hg	Pb	Zn	As	Cd	Cr	Cu	Ni	V
	00	25	48	73	1.1	14	20	11	36
PE-1	00	14	35	1.6	1.2	23	26	23	38
	00	29	38	8.83	.6	16	22	13	30
PE-2	00	8.6	35	1.3	1.2	17	26	11	41
	00	20	20	.57	1.1	14	11	11	28
PE-3		13	21	1.2	1.1	13	19	11	55
	00	14	33	.8	1.1	17	25	17	72
PE-4	054	14	20	.9	1.2	14	20	12	58
	027	14	23	.8	.6	14	11	11	37
PE-5	00	24	29	.42	1.1	13	19	16	48
	039	22	40	1.1	1.2	19	12	25	56
PE-6	00	25	36	1.6	1.1	17	25	17	56
	00	14	26	.8	1.2	20	17	20	29
PE-7	00	14	28	1.3	1.0	14	23	20	28
	00	24	21	.5	1.1	13	11	11	27
PE-8	00	28	26	5.1	1.5	13	49	18	44
	025	33	22	.8	1.1	14	11	11	47
PE-9	080	27	17	.9	1.0	12	15	9.8	67
	04	29	52	1.3	1.1	18	71	26	52
PE-10	00	32	71	1.6	1.1	26	89	37	53
	042	31	50	2.3	1.1	28	22	28	94
PE-11	00	35	89	1.0	1.7	43	55	49	98
	00	23	21	1.3	1.5	13	15	18	44
PE-12	00	23	26	.9	1.0	13	23	18	52
	062	36	41	.5	1.4	12	53	26	19
PE-13	00	40	83	.4	1.6	32	32	37	67
	00	41	38	.8	1.6	19	14	19	55
PE-14	00	39	36	.4	1.6	18	23	18	65
	00	30	39	1.1	1.2	21	21	21	39
PE-15	00	29	23	2.5	1.7	15	20	26	49
	00	26	19	.9	1.6	13	13	19	21
PE-16	00	36	19	.8	1.0	12	22	12	42
	043	28	29	.3	1.7	14	8.5	20	57
PE-17	00	26	30	1.4	1.1	30	24	13	46
	00								
GE-19		27	27	1.7	1.1	13	13	19	21
	00	33	21	1.1	1.0	13	13	13	51
GE-20									
GE-21	00	18	14	.8	1.4	6.8	11	11	38
MEAN	0.011	25.53	33.68	1.14	1.22	17.21	24.4	17.21	24.45

SOURCE: US ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION tions at 23 dive stations in the general vicinity of Browns Ledge. Observations were carried out in a two-man research submersible, NEKTON GAMMA. A summary of bottom sediments characterization based on diver observation and laboratory analyses is presented below in Table 9.

Chase (1977) indicates symmetrical sand waves are found to depths of 43 meters in this area.

These sand waves are thought to be formed by oscillatory wave motion and probably indicate current reworking of bottom sediments.

Biological inventories for these sites are presented by Chase (1977). At disposal site A ocean quahogs (Arctica islandica) were observed in low densities. Three small sites collectively make up Site B at which cancer crabs and shrimp were found. Finfish species found included silver hake and red hake. Some of the red hake were found in burrow holes on the bottom. Site C (dive Station 10) exhibited very few live organisms, although lobstering is known to occur in this area. Sites D and E had quite a few cancer crabs and ocean quahogs (Arctica islandica). As with Site C, lobster pot trawls were observed in the vicinity of Site E.

Surveys in the vicinity of Station 4 (Area F) showed significant numbers of cancer crabs and stove crabs (Cancer Irroratus). Additionally amphipods, cumaceans, and bivalves were observed at this dive station. To the west and south of this site, ocean quahogs were noted. Examination of these bottom sediments also revealed the presence of red hake, along with caprellids and various species of shrimp (Neomysis americamus).

None of these sites appear to have the requisite properties to be a "containment" location in the strict sense of the word. Chase suggests as an alternative to 'point disposal', 'zone disposal' be assessed at any of these sites. With either technique, however, the natural quality of the environment versus the quality of the materials proposed to be disposed must be thoroughly evaluated. It appears highly unlikely that regardless of the disposal technique, or ocean location, that ocean disposal of much of the New Bedford material will be acceptable.

Table 9 NED, NEKTON GAMMA Dive Station Location Data

Dive No.	Loran A Coordinates	Depth-ft. (meters)	Compass Course(mag)	Bottom Temp(^{o}C)	Sediment Type	Visibility (ft.)	Current Velocity and Direction
1	3H4=6042 3H5=1594 1H7=2788	114-122 (34.7-37.2)	195° south	—	Varied--silt-sand, boulders, ripples, sand waves	4-5	.1-.2 knot 330° NW
2	Start 320° NW of center buoy and tracked diagnol to SE for approx. 1700 ft.	110-114 (33.5-34.7)	150°	11	Rocky, boulders silt-sand, ripples, sand waves	5-6	Pulse .2-.5 knots, NW
3	3H5=1650 1H7=2798	140-146 (42.7-44.5)	118°	10	Silt-sand Sand emergence Holocene deposits, Sand waves 1 ft. amplitude 3-4 ft. crest oriented 090°	10	.1 knot Swirling, no obvious direction
4	3H5=1548 1H7=2813	120-129 (36.6-39.3)	070°	12	Cohesive, gray sand-silt-clay. Much biological reworking	6-7	.2 kt. 090°-040° NE
5	3H4=5950 3H5=1684 1H7=5950	152 (46.3)	235°	9-8.5	Mud, silt-clay	10	.2-.5 kt. SE direction 135°
6	3H4=5913 3H5=1720 1H7=2800	162 (49.4)	230°-235°	8.7-9.6	Gray clay mud penetrated to 30-34cm	7	.1 kt. 090° E
7	3H4=5887 3H5=1739 1H7=2808	208 (63.4)	225°	9	Gray mud (silt-clay) Trawl tracks	4-5	Zero- .1 kt.

Dive No.	Loran A Coordinates	Depth-ft. (meters)	Compass Course(mag)	Bottom Temp(°C)	Sediment Type	Visibility (ft.)	Current Velocity and Direction
8	3H4=5880 3H5=1751 1H7=2805	167 (50.9)	273°	9	Mud	8-10	0.15 kt. 150° dir. SE
9	3H4=5980 3H5=1760 1H7=2795	132-137 (40.2-41.8)	285° to 315° and back	9.5	Sand, gravel sand waves	10-15	.1 kt. or less but surf. surge felt
10	3H4=5915 3H5=1740 1H7=2770	120 (36.6)	012°	10.5	Mud and shells	10-12	.1 kt. or less 000° N
11	3H4=5950 3H5=1720 1H7=2770	128 (39.0)	005°	11	Mud-sand	4-5	None
12	3H4=5940 3H5=1719 1H7=2760	123 (37.5)	060°-065°	11	Soft silt-clay- sand	5-8	.2 kt. 150° SE
13	3H4=5858 3H5=1800 1H7=2770	130 (39.6)	085°	10	Mud-sand	5-8	.1 kt. southerly 180°
14	3H4=5940 3H5=1700 1H7=2790	123 (37.5)	060°	10.5	Large sand waves, sand gravel, shell	10-15	None
15	3H4-5990 3H5=1647 1H7=2790	128 (39.0)	055°	11-12	Large boulders, rock, sand waves silty-sand	5-8	Pulses to .2 kt 000° N

Dive No.	Loran A Coordinates	Depth-ft. (meters)	Compass Course(mag)	Bottom Temp(^{o}C)	Sediment Type	Visibility (ft.)	Current Velocity and Direction
16	3H4=6012 3H5=1620 1H7=2795	128 (39.0)	072^{o}	12	Mud-sand boulders	6	None
17	3H4=5955 3H5=1660 1H7=2825	130 (39.6)	345^{o}	10	Silty-sand & shell	15	.2 kt 350^{o} NW
18	3H4=5959 3H5=1666 1H7=2810	136 (41.5)	070^{o}	11	Soft mud or muddy sand	10-12	.2-.3 kt 000^{o} N
19	3H4=5990 3H5=1635 1H7=2810	126 (38.4)	058^{o}	11.5	Sand, mud	10-15	.1 kt. setting 000^{o} N
20	3H4=6030 3H5=6031 1H7=2805	136 (41.5)	035^{o}	11	Sand, mud shell	4-6	.1 kt
21	3H4=6070 3H5=1564 1H7=2790	90-100 (28.3-30.5)	160^{o}	11	Soft mud mats of, tubes, quahog shell death assemblage	10-12	Pulse .1 N-S dir. surge
22	3H4=6068 3H5=1560 1H7=2799	88-94 (26.8-28.7)	065^{o}	11	Boulders & rock	10-15	.1 kt. 090^{o} E
23	3H4=6124 3H5=1503 1H7=2793	90 (27.4)	340^{o} to 060^{o} and back	12.8	Silty sand compact mats Amphipod tubes	10	.1-.2 kt. 160^{o} dir. S

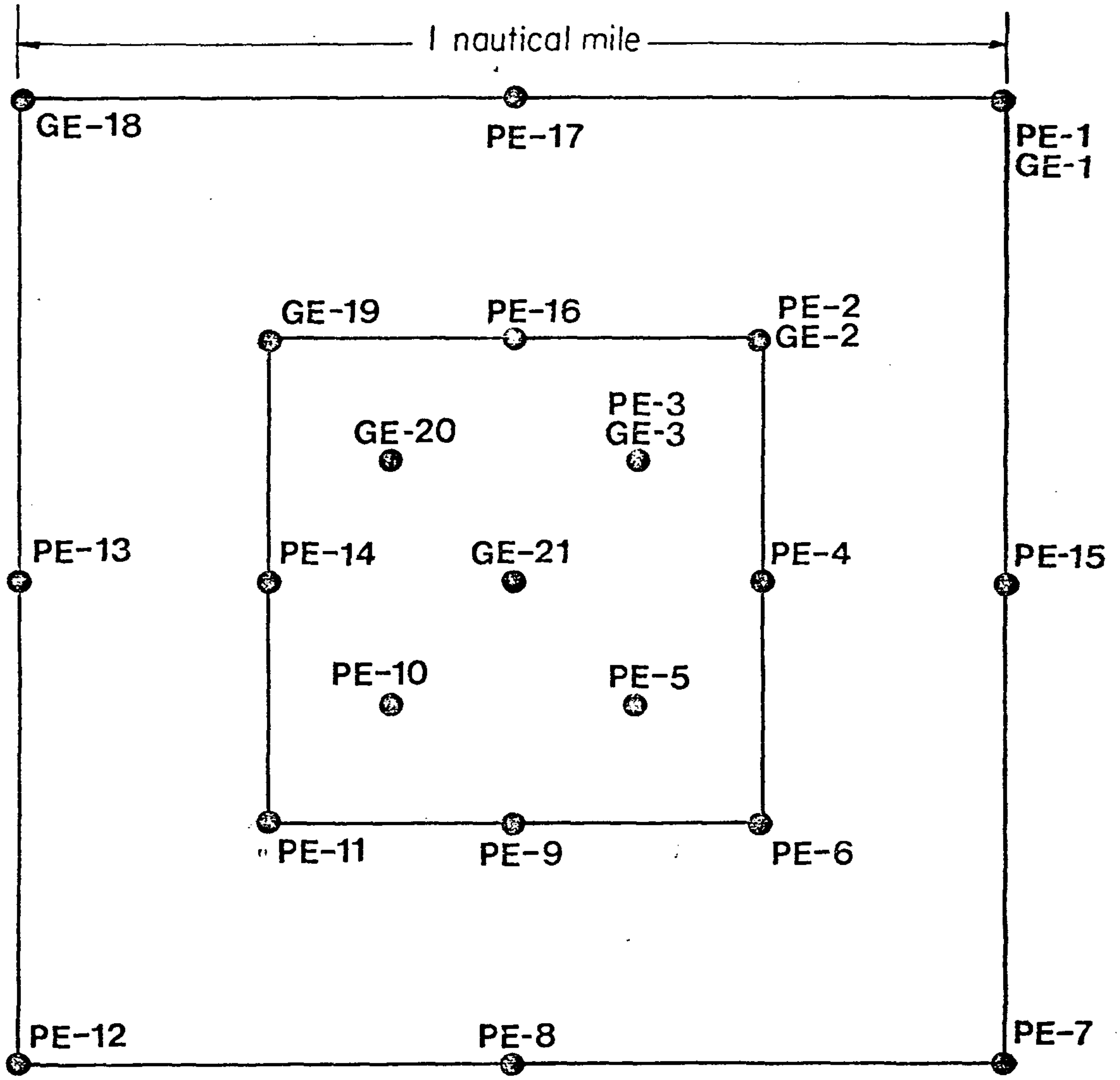
Chemical analyses of sediments from several stations have been tabulated in Table 9. As indicated in the tabulations, the data for New Bedford Harbor exceeds the analyses of the alternate site by many orders of magnitude.

2.6.2 Land Disposal Sites

In the literal sense, adequate land disposal sites to handle and contain the contaminated sediment are not available. Instead, the use of several sites within the Harbor on both the New Bedford and Fairhaven sides has been explored. The location of the sites considered are indicated on Figure 10 and the physical characteristics of the sites are tabulated in Table 10. While the selection of site B, in Fairhaven, was based on past correspondence between the COE, the City of Fairhaven, and local and state representatives and agencies; the selection of the other 5 sites was determined through a combined meeting between representatives of New Bedford, Fairhaven, and the COE. The use of these sites was also discussed with representatives of the EPA and the Massachusetts Division of Environmental Quality Engineering.

The City of New Bedford wishes to extend the area of Popes Island to the bulkhead line (Site E) for waterfront developement. Completion of the North Terminal area (Sites C and D) is in progress. However, it is being slowed considerably due to the limitations placed on marine traffic by the Route 6 bridge. For the City, the full potential of the North Terminal will not be realized until the clearance of the bridge is increased. Such plans are now underway in the Massachusetts Department of Public Works.

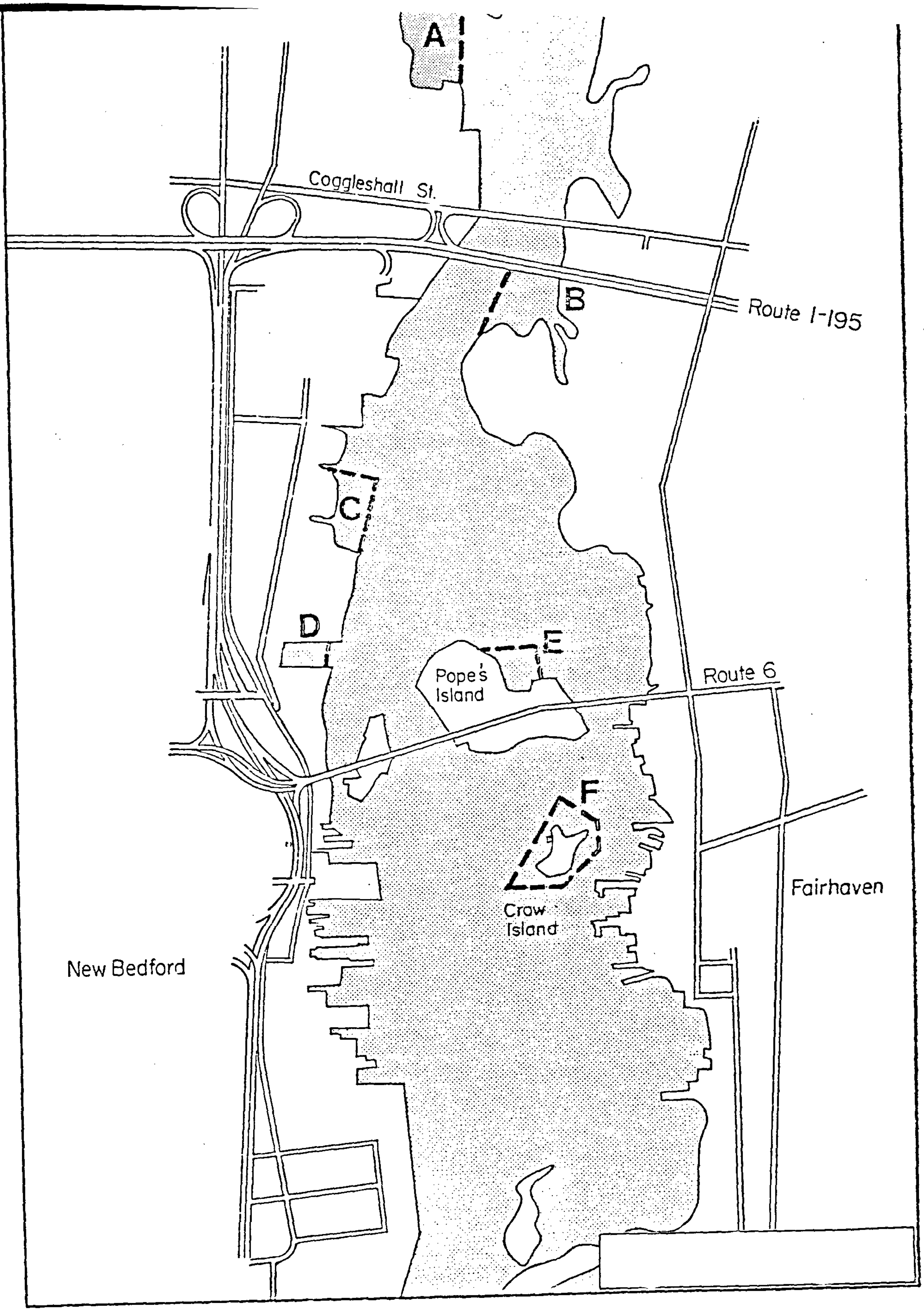
Between the two sites in the North Terminal, there is sufficient volume for the estimated 150,000 yd^3 from the maintenance dredging. The available volume at site C, however, is being slowly decreased since disposal of building rubble is now occuring. In all probability, with or without disposal of dredge material at sites C and D, the City of New Bedford will eventually fill these areas to the bulkhead line. Use of the remaining sites (A, B, and F) is considered limited at this time even though sites A and B have sufficient capacity. Site A has limited access for the federal project due to the clearance of the Coggelshall Street bridge and the crossing for Route I-195. This area might best be viewed as a potential site for disposal of highly contaminated sediment near the PCB sources.



US Army COE Sampling Stations, Browns Ledge

(See figure 9 for location)

Figure 9a



Land Disposal Sites

0 400 800 1500 FEET

— — — — Approximate extent of proposed diking scheme

Figure

Table 10 Proposed Land Disposal Sites, New Bedford/Fairhaven Harbor.

Disposal Site	App. Dimensions	Depth	Est. Volume	Dike Length	Cost	Cost/ Cubic Yard	Comments
A	600'x900'	8	160,000	850	3,191,000	±20.00	
B	750'x500' 250'x140'	10 11	153,000	900	2,728,000	±17.80	
C	800'x400'	13	154,000	1300	2,971,000	±19.30	
D	280'x450'	9	*42,000	280	924,000	±22.00	Site does not have enough area to accommodate entiret of material
E	600'x550'	12	147,000	1100	2,451,000	±16.70	
F		11	136,000				Even if fill is extended to bulkhead line there is insufficient room

Specific costs on construction schemes at each waterfront site have been checked and are illustrated in Appendix D.

It should be reiterated that under present legislation and COE funding programs, such costs must be borne by other than COE sources.

A dike constructed of borrow material is the most feasible method of bulkheading for containment of the dredged material. The dike could be constructed by truck from the shore by end dumping. Riprap would be placed on the harbor side of the dike as dike construction progresses. The dike should be set back a sufficient distance to allow future wharf or bulkhead construction at the bulkhead line. It should be noted that the dikes will occupy expensive space and volume. Steel sheet pile bulkheads could be used instead of dikes at most sites but would cost 4 to 6 times as much.

The most feasible method of transporting the dredged material would be placing the material in barges and towing the barges to the disposal site. A barge mounted crane or a crane mounted on the dike could then place the dredge material behind the dike. Moving barges will be severely restricted at sites located north of the Coggeshall Street bridge because of the 8-foot vertical clearance. Use of a pipeline would be subject to the same limitations as a hydraulic dredge. A pipeline would interfere with harbor traffic. As dredging progressed away from the disposal sites booster pumps would be required. The increase in dredged material quantity due to dilution water would also require larger disposal sites, dewatering of the dredge spoil, and treatment and disposal of the dilution water.

The cost of dredging and placing of the dredged material at the disposal site should be about $7 to $10 per cubic yard.

Based on the COE sediment data and test, results of April, 1975 on the upper two feet of the channel bottom, it appears that the dredged material will be 90% organic soil. This material would not be suitable for buildings, paved areas, or any type of structure susceptible to damage from settlement. Possible land use would be for a park area.

Dewatering of the disposal site and treatment of the supernatant should not be as much of a problem with bulk handling as it would be in a hydraulic dredge operation. Here water is displaced within a diked area as spoil is placed from a barge into the disposal area.

Depending on the amount and gradation of suspended solids in the water and the acceptable effluent quality, it is possible that disposal area effluent could be handled by treatment of water within the dike to accelerate flocculation and possible use of a sedimentation basin outside the diked area. The problem of handling supernatant water either from bulk handling or hydraulic dredging is discussed in greater detail in Section 5.1.

Disposal site costs exclusive of land acquisition should be about $16 to $20 per cubic yard of dredged material. One of the major cost items at the disposal sites is the impervious liner. Several types of liners were investigated but all estimates were based on the best liner available. Savings of up to $7 per cubic yard could be made by using less expensive liners. These costs do not include treatment of the supernatant. It should be noted that placement of an impervious liner under water is not a normal method of placing a liner and some problems may arise in this method of construction.

Lining of the entire disposal site may not be strictly necessary at all sites, but may be desirable at a location where highly contaminated material is to be placed or an impervious cover (pavement, etc.) is not planned. Liners should not be used in areas where piles are likely to be driven.

It is recognized there will be a loss of marine resources in any of the waterfront disposal sites. Specific reference to biological impacts from the filling of Site E (Popes Island) is contained in Section 4.3.4. All locations are potentially highly contaminated with trace metals and/or PCB's and in spite of losing a marine habitat, the more beneficial usage in the long term would be for containment of polluted dredge material.

2.6.2.1 Biological Aspects of In-Harbor Disposal

Benthic assemblages found in New Bedford Harbor are essentially similar with only minor location specific differences (See Section 2.4). All of the sites have overlying waters which are organically enriched. This is evidenced by the types of phytoplankton found in the waters. The benthic assemblages inhabit primarily a mud substrate. Quahogs are present in densities of approximately 1 organism per square meter. Other organisms found to inhabit the inner harbor are Spionids, capitelleds, limpets, and <u>Littorina</u> gastropods. Kelley (1977) found limpets in this area to have high tissue concentrations of copper, cadmium, and zinc. Various finfish species are also found in these areas.

2.7 History and Archeology

The early history of New Bedford Harbor is linked to the sea and its importance as a major whaling port. With an end to the demand for whale oil, the port declined until its rise as a manufacturing center. The chief points of historic interest in the area are its old and restored homes. According to the Massachusetts Historical Commission, no archeological or historical properties should be impacted by the proposed project.

Robert Cahil, of the Underwater Archeological Resources Commission (U.A.R.C.), has said that there are no archeological artifacts of interest to U.A.R.C. in New Bedford Harbor. However, U.A.R.C. should be contacted if artifacts are uncovered that are over 100 years old or are worth $5000 or more.

2.8 Socioeconomic Setting

New Bedford Harbor is a major commercial, industrial and recreational resource of the southeastern Massachusetts region. It is a natural harbor formed by the drowned river mouth of the Acushnet River. It is bounded on the west by the city of New Bedford and on the east by the Town of Fairhaven. The harbor has a basically north/south alignment and consists of an outer harbor, lying between Sconticut Neck and Clarks Point (See Figure 1), and an inner harbor separated from the outer harbor by a hurricane barrier and delimited in the north by the Route I-195 bridge.

New Bedford Harbor is an important fishing center and is one of the major fishing ports on the U.S. East Coast. The harbor is ranked second in volume of fish harvested in Massachusetts, after Gloucester, but is first in terms of the total value of its catch. Besides fishing, other activities of New Bedford Harbor are shipping and ship repair and servicing.

Access to New Bedford Harbor is provided by Interstate 195 and Rt. 6 for east/west traffic and Routes 18 and 240 for north/south traffic. Interstate 195 and Rt. 6 have bridge crossings over the harbor with the Route 6 Bridge presenting some constraints to harbor shipping traffic. Route 18 runs parallel to the harbor in New Bedford, and it provides access to northern sections and links Route 6 with Interstate 195. Route 240 has a similar function in Fairhaven.

Rail service is provided to New Bedford Harbor port facilities by Conrail, which maintains a railroad yard and spurs parallel to the waterfront on the New Bedford side of the harbor. This rail line, however, is presently in need of repair.

The municipalities in the vicinity of New Bedford Harbor are included in the New Bedford SMSA (Standard Metropolitan Statistical Area). The City of New Bedford is the urban-commercial heart of the SMSA with its many manufacturing companies being the area's major source of employment. Though manufacturing is the major employer, New Bedford has suffered from a general migration of manufacturing firms away from New England over the past years.

The population of the New Bedford SMSA in 1970 was 163,116. The City of New Bedford portion of this was 101,759. Population data is presented on Table 11. The 1975 Massachusetts State Census showed the population of the City of New Bedford to have decreased to 100,345. Population predictions indicate that this trend of decreasing numbers will continue through 1990. The population of Fairhaven was 16,005 in the 1975 State Census, with this figure also showing a slight drop since 1970. Population, however, is predicted to increase in Fairhaven in the near future.

Medium income in the City of New Bedford is in the low-medium range. It was $8230 in 1970. This compares with $10,835 medium income for Massachusetts and $9590 for the U.S. as a whole.

The unemployment rate in New Bedford was recently the highest in the state; it stood at 15% in April, 1975. It is now (November, 1977) at 6.9%, no longer the highest in the state, but above the state average of 5.1%. The present average for the U.S. as a whole is 6.4%

TABLE 11. Population Predictions - New Bedford SMSH

	1970 US Census Population	1975 Office of State Planning (a)	1975 State Census (b)	Projected Populations (c) 1980	1985	1990	1995	2000
Acushnet	7,806	8,822	8,439	9,850	10,450	11,000	11,650	11,850
Dartmouth	18,821	21,885	21,586	24,200	25,600	26,650	26,950	27,050
Fairhaven	16,332	16,527	16,005	17,850	18,550	18,900	18,900	18,950
Freetown	4,286	5,458	5,417	6,200	7,100	8,000	8,550	9,250
Lakeville	4,376	5,330	5,118	6,100	6,700	7,250	7,550	7,900
Marion	3,328	3,735	3,764	4,200	4,550	4,800	5,000	5,150
Mattapoisett	4,500	5,378	5,376	6,100	6,700	7,150	7,550	7,800
New Bedford	101,759	97,592	100,345	93,850	91,650	91,600	92,450	93,200
Rochester	1,908	2,234	2,284	2,600	2,900	3,150	3,500	3,900
TOTAL:	163,116	166,961	168,334	170,950	174,200	178,400	182,100	185,050

Source: (a) 1975 Massachusetts Office of State Planning (OSP) Estimates
(b) 1975 Massachusetts State Census
(c) SRPEDD Population Projection (Utilizing 1975 OSP Estimates as the Base Year) 32

2.8.1 Land and Water Use

Inner Harbor

Land use in the inner harbor is characterized by port related industries and a large amount of undeveloped land and vacant buildings. Figure 11 shows land use that exists in the inner harbor, divided into six categories. Total acreages and percentages are given on Table 12.

TABLE 12

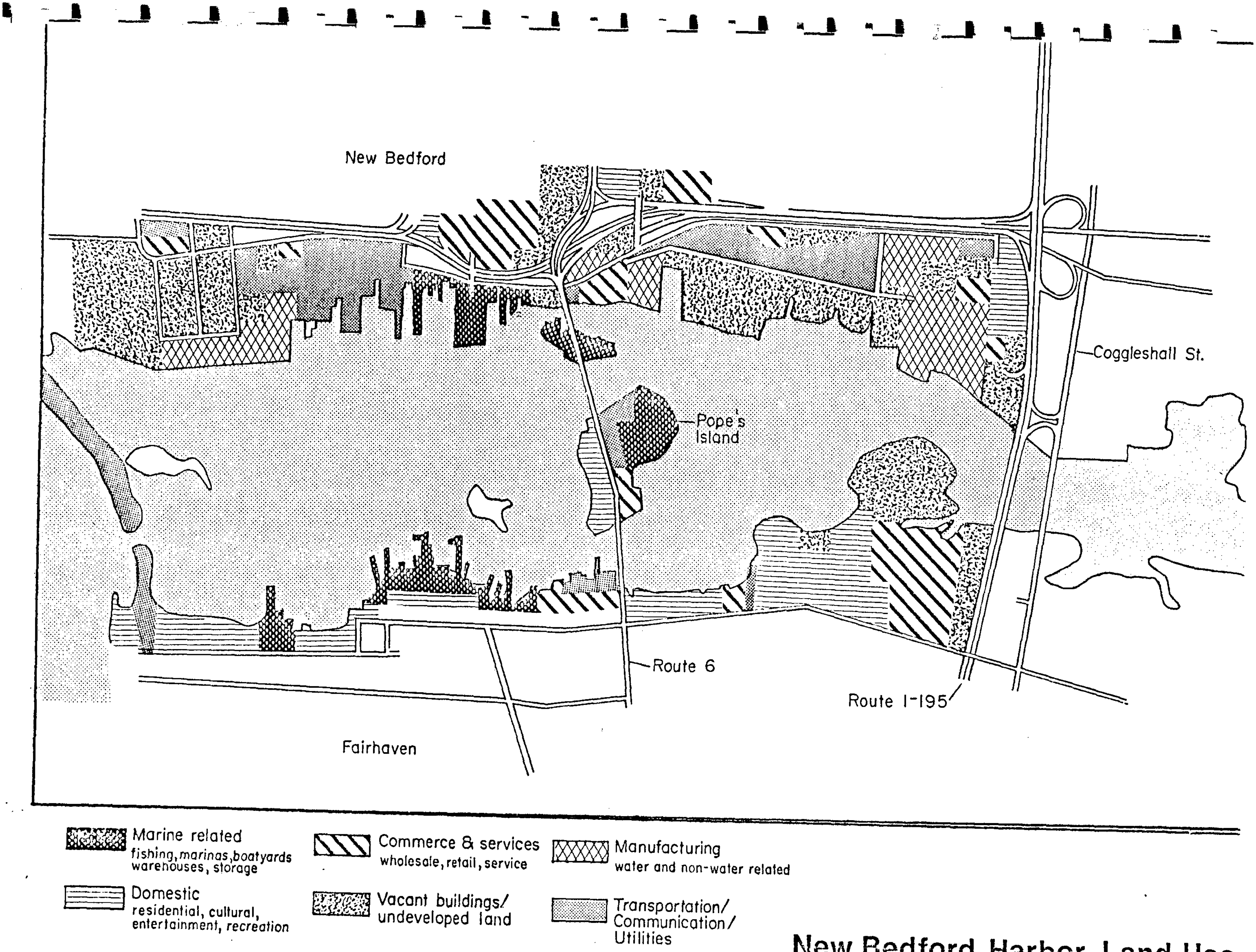
Land Use Tabulations

	Total Acreage	Percent of Total
Manufacturing	65.71	10.31
Domestic	95.07	14.91
Marine Related	27.68	4.31
Commerce and Services	79.45	12.46
Transportation, Communication Utilities	205.15	32.19
Vacant Buildings, Undeveloped Land	164.08	25.75

Source: New Bedford/Fairhaven Harbor Master Plan Land Use Study

The New Bedford side of the Harbor is dominated by transportation, utilities, manufacturing, and marine related land uses. Fairhaven is dominated by residential use but has a substantial percentage of the total amount of marine related property, and some commercial and vacant or undeveloped property.

The southern portion of the harbor (south of the Rt. 6 bridge) is more heavily utilized than the northern section. In New Bedford there is the South Terminal Urban Renewal Project, which is near completion; and included in it is the state pier. The South Terminal Urban Renewal Project includes most of the waterfront area from the Rt. 6 bridge to the hurricane barrier and has all of the various categories of land use excluding domestic. The state pier contains marine related facilities and commercial and service enterprises. The New Bedford Gas and Edison Company operates a facility for the generation of electricity on Cannon Street in the South Terminal Urban



New Bedford Harbor Land Use

Renewal area. The facility utilizes a thermal oil-fueled steam turbine and relies on water transport for its fuel supplies.

The Fairhaven side of the southern portion of the harbor is about half in residential use and about half devoted to marine related uses.

At the harbor's entrance, in the extreme southern end, there is a hurricane barrier constructed by the U.S. Army Corps of Engineers in 1966. This protects the harbor and shore from tidal flooding and greatly decreases the likelihood of damage to fishing and shipping concerns.

The Route 6 bridge bisects New Bedford Harbor at roughly its center and traverses Fish and Pope Islands, two of the four islands located in the harbor. Fish Island is almost entirely devoted to marine related activities. Pope Island has a diversity of land uses including some residential area.

North of the Route 6 bridge, in New Bedford, the North Terminal Urban Renewal Project dominates the waterfront. All public improvements to this project have been completed; however, no land sales have been made. There are a number of manufacturing firms, including fish processing plants and some commercial/service establishments, located on the northern New Bedford waterfront not included in the North Terminal Project. The Quaker Oats Company owns a large building on the waterfront which has been recently vacated. On the north side of the Route 6 bridge in Fairhaven, the largest section of waterfront property is in domestic (residential) use. There is also a section devoted to commercial and service use and a section of undeveloped/vacant property.

Outer Harbor

Land use on the outer harbor is largely residential on both the New Bedford side and the Fairhaven side. There is a small section of industrial land just south of the hurricane barrier in New Bedford that is used for metal finishing and electrical equipment manufacturing operations. A portion of the New Bedford side is occupied by the Fort Rodman Military Reservation at Clarks Point. This installation encompasses approximately 200 acres and has been decommissioned. A portion of the fort has been made into a museum and appears on the National Historic Register. There is a beach maintained by the City of New Bedford on the shore near Fort Rodman. On the opposite side of the harbor is found Silver Shell Beach on Sconticut Neck in Fairhaven.

Water Use

Table 13 shows that a total of 6907 vessel trips were made in New Bedford Harbor in 1975. This represented a total commerce of 361,026 tons and the transportation of 12,400 passengers. The deepest draft range was between 25 and 27 feet with seven vessel trips falling into this range.

Approximately 140 fishing vessels berth in New Bedford Harbor, and the Coast Guard operates a station there where it maintains five vessels.

There are a number of marine facilities, such as mariners and public docks and boat launches, located in the inner harbor. There is one public boat launching ramp located on the outer harbor in New Bedford. There are two public swimming areas located on the outer harbor, one in New Bedford and one in Fairhaven. The New Bedford beach, as mentioned, is located near Fort Rodman. The Fairhaven beach, Silver Shell Beach, is located about halfway up Sconticut Neck from the hurricane barrier. Some problems with water quality do exist at these beaches. The New Bedford beach has had to be closed during certain periods because water quality did not meet standards for public bathing. These periods have been infrequent and usually occur during spells of heavy rain when increased run-off lessens the ability of the municipal sewage plants to effectively treat wastewater.

The waters of New Bedford Harbor are of generally poor quality as they receive wastewater discharges from a number of point sources. Among dischargers are private firms, fishing boats, and the municipal sewage treatment plants in New Bedford and Fairhaven. Pollution sources further upstream on the Acushnet River also contribute to the poor water quality.

Along with swimming, other forms of recreation afforded by New Bedford Harbor are recreational boating in the inner and outer harbor and recreational fishing in the outer harbor. Fishing in the inner harbor has been banned due to high PCB levels.

2.8.2 Economic Base

Employment data for the New Bedford Labor Market Area is shown in Table 14. Manufacturing provides employment to the largest number of people in the area. Service industries account for a small percentage of total labor force when compared to other Massachusetts cities. Of the economic activities centering on New Bedford Harbor, fishing and fish processing are probably the most important. In 1976 the total volume of fish landings at New Bedford Harbor was 55 million pounds, valued at $21 million (NMFS). This makes New Bedford the most important fishing port in Massachusetts in terms of value of catch. The volume of fish, however, was larger in Gloucester (143 million pounds) where a good portion of landings are sold cheaply for industrial uses, such as fish meal for livestock and fish oil by-products.

The fishing industry in New Bedford, along with fishing in the New England region as a whole, has been experiencing a general decline. Efforts have been initiated to bring new vitality to the New Bedford fishing industry. The New England Fisheries Development Program is working toward developing a market for many fish that are caught but not sold because of consumer preferences. Conservation within the newly established 200-mile U.S. fishing limits and programs to promote fishing enterprises promise to bring development to the fishing industry in the long run or at least to stem the trend of decline.

The state pier, operated by the Commonwealth of Massachusetts and located in the New Bedford South Terminal area, is also important to the economic activity of the harbor. The lonshoreman's Union indicates that cargo shipments over the last five years have been generally increasing (from contact with the New Bedford Planning Department). Table 15 presents data on total tonage handled by the Longshoremen's Union and the wages paid to the longshoremen.

New Bedford Harbor is basically a receiving port. Commodities handled through New Bedford Harbor are listed on Table 16. The product that constitutes the largest volume is petroleum-distillate fuel oil and residual fuel oil. Fresh fish and shellfish account for the second greatest volume and lumber third. These figures indicate

TABLE 13. Commercial and Vessel Trip Statistics, 1975.

DRAFT RANGE	VESSEL TRIPS	TOTAL COMMERCE (TONS)
25-27	7	17,000
23-25	16	32,500
21-23	19	41,800
19-21	28	47,982
17-19	37	56,637
15-17	22	35,640
13-15	1708	55,667
others	5070	73,800
	6907	361,026

Source: U.S. Army Corps of Engineers, New England Division.

TABLE 14. Employment New Bedford Labor Market Area.

	Employment LMA (Ave.)	Percent Distrib.
1. Construction	1,911	3.6
2. Manufacturing	25,586	48.4
3. Trans., Commun. & Utilities	2,357	4.5
4. Wholesale & Rental Trade	12,080	22.9
5. Finance, Ins., & Real Estate	1,655	3.2
6. Service Indus.	7,876	14.9
TOTALS*	52,843	97.5

*The category of agriculture mining and fishing is not included in this table due to insufficient reporting of this category in DES data. For this reason, the percentage distribution totals do not add to 100% of the New Bedford labor force.

Souce: Massachusetts Division of Employment Security Data, unpublished.

that most of New Bedford's commodity trade is in a few specific items rather than general cargo. Fish are received through the fish wharfs and petroleum through special facilities. It is only the other commodities that make up the general cargo handled through the state pier.

TABLE 15

Tonnage Handled by Longshoremen's Union and Wages Paid to Longshoremen, New Bedford

YEAR	TONNAGE	TOTAL WAGES
10/72 - 9/73	54,863	$800,800
10/73 - 9/74	61,925	$723,492
10/74 - 9/75	53,890	$849.940
10/75 - 9/76	65,700	$910,000

Source: New Bedford Planning Department

Tourism is an industry which is gaining in importance to the New Bedford economy. Though not directly related to the harbor, tourists are attracted to the waterfront because of its fishing facilities and its reminders of the old whaling age. The major tourist attraction is the Whaling Museum, located near the waterfront.

The U.S. Coast Guard facility in New Bedford Harbor contributes to the economic activity generated by the Harbor through payrolls and supply purchases. Their yearly economic impact, according to data submitted by the Coast Guard Regional Office in Boston, equals approximately $2.8 million.

2.8.3 Economic Development Goals

There are a number of plans by local and regional planning organizations designed to stimulate the economy of the New Bedford area. The New Bedford/Fairhaven Harbor Master

TABLE 16. Commodities Handled, New Bedford Harbor, 1973.

COMMODITY	SHORT TONS
Residual Fuel Oil	269,913
Fresh Fish, Exc. Shellfish	71,340
Distilate Fuel Oil	38,730
Lumber	6,493
Sand, Gravel, Crushed Rock	6,221
Animals	4,799
Wheat, Flour, and Semolina	3,021
Misc. Food Products	1,885
Shellfish, Exc. Prepared	1,660
All other commodities	7,013
TOTAL:	411,075

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Vol. 1, 1973.

Planning Committee, consisting of members in the public and private sectors from both New Bedford and Fairhaven, strongly emphasizes the harbor's role in local economic development. One of their major goals is to promote activities that enhance the community's economic development by providing ample opportunities for stable employment by either maintaining or expanding existing harbor industries, retaining and protecting the existing fishing industry or introducing new harbor-related industries.

The New England River Basins Commission (NERBC) has made recommendations concerning the development of New Bedford Harbor in its Southeastern New England Study (NERBC,1975). They specifically recommend improvement of New Bedford's navigational facilities, including the deepening of some channels beyond currently authorized depths. More generally, their goals are to accommodate commercial fisheries and to encourage overall waterfront improvement.

The Massachusetts Coastal Zone Management Office (CZM), under the Executive Office of Environmental Affairs, has assembled a number of policies related to economic development of New Bedford in their publication, Massachusetts Coastal Regions. One of their policies stated therein is to encourage maritime-related development in the Buzzard's Bay area where the necessary infrastructure exists (such as in New Bedford Harbor). They affirm the need for maintaining and improving the approach, harbor channels, anchorage areas, turning basins, and state pier facilities to further harbor development (CZM, 1976, A).

The specific areas, related to the harbor, in which economic growth has been forecast and upon which development goals are focussed are tourism, the fishing industry, and possible outer continental shelf (OCS) development by oil companies. The latter would have the greatest impact on the harbor.

The New Bedford Planning Department has prepared a study on tourism that concludes it is possible for a substantial increase in income from the tourist trade. Plans to achieve this end include the establishment of historic districts, with funds for their up-grading, and the improvement of public facilities, such as repairing streets and sidewalks. Also important is rehabilitation of New Bedford fishing piers, which is planned, and the maintenance of a viable fishing industry to promote fishing activities as a tourist attraction.

Major growth in the New England fishing industry is generally anticipated due to new conservation measures and curtailment of foreign competition within the new 200-mile U.S. fishing limit. The dimensions of the anticipated increase in fleet size have been outlined by the Massachusetts Coastal Zone Management Office. To briefly paraphase their statement, they expect a doubling in annual landings and value of catch in waters off New England in the next five to seven years, with a 25% reduction in foreign fishing. They further state that commercial fishing fleet size will have to increase by 50% to allow New England fishermen to harvest this larger catch (CZM, 1976, B). The New Bedford Harbor Development Commission indicates that growth of the New Bedford fishing fleet can be expected, but that this is related primarily to market conditions favorable to the fishing industry rather than to any direct effects of the 200-mile limit. (Paul Saunders, personal communication, 1978). For New Bedford Harbor, it has been estimated that there will be a 30% increase in fleet size over the next five to seven years. With this predicted increase, the number of fishing boats would grow from the present 140± vessels to between 160 and 180 vessels (SRPEDD, 1977, A). The average number of crew members per trawler has been calculated at 5.5, so that fleet expansion could result in the creation of 258 jobs (SRPEDD, 1976, B).

Oil well siting on the outer continental shelf (OCS), now in a final exploratory stage, may bring a sizable economic gain to the New Bedford area and have important consequences for New Bedford Harbor. It is likely that New Bedford would at least serve as a temporary service base for OCS operations. It possesses all the requisites which normally attract the oil industry: proximity to the lease sites, normal port and marine facilities, truck and rail links, a favorable labor environment, machine shop facilities, and an adequate level of municipal services (NERBC, 1976, B). The North Terminal Urban Renewal Project site is being proposed as the optimum location for OCS related activity to occur.

3.0 RELATION TO LAND AND WATER USE PLANS

The proposed maintenance dredging project will have no negative effect on land and water use plans for New Bedford Harbor. It is, in fact, necessary for the carrying out of current local and regional development plans. Municipal zoning ordinances show a desire to perpetuate New Bedford Harbor's industrial character with planning authorities working to encourage new development in vacant industrial zones. Maintenance dredging will aid these efforts by contributing to New Bedford Harbor's attractiveness to potential new users (ie., oil companies in OCS development) and will allow continued use of the harbor for commercial fishing and general cargo activities.

There are no plans for new recreational development of the harbor waters or shore that maintenance dredging will have an effect on.

4.0 ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

4.1 Beneficial Impact

New Bedford/Fairhaven Harbor is one of the most valuable ports on the northeast coast. It has the highest dollar value for fish landings of any port in Massachusetts and the second highest total poundage of fish landed in the state. Maintenance dredging will allow commercial fishing, shipping, recreational boating, and possibly offshore oil support vessels to continue to use the harbor without undue hazards to shipping.

The economic value of the harbor to New Bedford and to the southeastern Massachusetts region is considerable. For the year 1976, fish landings alone in New Bedford Harbor were in excess of $21 million. The value of all types of cargo in 1976 just in terms of longshoremen's wages was nearly $1 million. The harbor is also the site of an active Coast Guard base, whose input to the city's economy is almost $3 million. Commercial ferry boats travelling from New Bedford to Block Island and Martha's Vineyard transported over 12,000 passengers in 1975.

Maintenance dredging is critical to the economic viability of the New Bedford/Fairhaven region and will be essential to anticipated growth, especially if offshore-oil support activities are located in the harbor. From a safety standpoint, it is important to maintain project depths to avert groundings or delays while awaiting high tide.

4.2 Dredging Associated Impacts

4.2.1 Dredge Site Impacts

Past maintenance projects in New Bedford/Fairhaven Harbor have been carried out with a hopper dredge. The dredged material has been transported in the hopper dredge vessel to the West Island disposal site. During the dredging process, ambient levels of suspended material can increase as a result of the disturbance of bottom sediments and through bucket loss. Settling times for the material being dredged can be calculated using Stoke's Law and the depth of water through which the sediment may settle. Grain size data provided by the U.S. Army Corps of Engineers was used to compute settling times. For a thirty foot depth, settling times range between 408 hours at KE-1 to 3.4 minutes at KE-15. The use of Stoke's Law for fine sized particles may lead to overly conservative results as it does not take into account particle flocculation. When clay sized particles flocculate, they will have higher settling velocities than measured in standard hydrometer analyses (or as predicted in Stoke's Law). Work carried out by Christodoulou (1974) presents settling tube data for "Boston Harbor Mud" undispersed and in sea water. These data indicate that over 90% of the "mud" settles out in approximately 100 hours. Grain size analyses of sheltered areas in Boston Harbor closely approximate inner harbor sediments from New Bedford so that settling times for "Boston Harbor Mud" could be used to estimate settling times for New Bedford. Although these calculations indicate it will take days for the finest particles to settle out, work by various authors indicates that the turbidity levels after several hours may be within the natural variations in turbidity. Bohlen (1976) measured turbidity effects at a clamshell dredging location in the Thames River, Connecticut. He found as much as a thirty-fold increase in suspended matter in the immediate vicinity of the dredge. However, dredging-related increases in turbidity were not detectable beyond 450 feet. Current velocities in the river during measurements were approximately 0.75 knots.

If a land disposal site is ultimately used for material dredged from New Bedford, it is unlikely that a hopper dredge will be used for channel dredging. Difficulties in off loading the hopper dredge onto land would favor the use of a clamshell dredge and disposal barges. The physical impacts at the dredge site would be similar, however, for clamshell and barge dredging as it would be for hopper dredging.

4.2.2 Water Quality Impacts at the Dredge Site

The most immediate problem facing dredging and dredged material disposal is the question of increased availability of trace metals and organic pollutants which may have a deleterious impact on water quality, and hence, marine biota. Depressions of dissolved oxygen and increased levels of turbidity can, in extreme cases, cause mortality to marine life not only in the immediate vicinity but downstream. The results of solid phase analyses of New Bedford Harbor sediments have been presented in Section 2.2. Unfortunately, liquid phase (elutriate) analyses have not been conducted on any of the harbor sediments, therefore making a clear definition impossible as to what constituents of the sediment may be released during dredging. Based on the data available, the rate of resolubilization is difficult to establish. Lee et al. (1975) feel that due to the variety of forms that metals can be found in sediments, "there would be little or no relationship between the bulk heavy metal content of a sediment and its impact on water quality during dredging and dredged materials disposal." Chen et al. (1976) concluded that the release of metals in the soluble phase is ecologically insignificant. There can, however, be potential problems with contaminants associated with organic and silt particles since these particles can be consumed by marine biota. Kelley (1977) found a good correlation between the concentration of copper and chromium in the sediment of New Bedford Harbor and the tissue level concentrations of the limpet *Crepidula fornicata*. High levels of metals were also noted in other organisms as well.

Some indications can be obtained by drawing on experience with similar harbor sediments. Sediments in Gloucester Inner Harbor (NEDCOE, 1978) are somewhat similar to those of New Bedford in the concentration of total Kjeldahl nitrogen, oil and grease, and on the average, many of the trace metals. Chemical oxygen demand in New Bedford sediments is considerably higher than Gloucester Inner Harbor. Elutriate analyses conducted on the sediment of the Inner Harbor indicated release of nitrogenous compounds (total Kjeldahl nitrogen), oil and grease, and an increase of BOD and COD. Of the metals in Gloucester, only zinc showed any release. One can be reasonably assured that liquid phase analyses of New Bedford Harbor material would indicate potential release of the same constituents during dredging. Although Summerhayes et al. (1976) found levels of copper and other metals many times higher than those in Gloucester Harbor, it is difficult at this point to indicate whether or not release of trace metals can be expected.

Based on experimental column data, it is known that cadmium, lead, and zinc are significantly released only under oxidizing conditions (Chen et al, 1976). The release of copper is directly related to increasing oxygen concentrations. In the reduced state, chromium is relatively insoluble; however, at circumneutral pH levels this metal may go into solution (Pratt & O'Connor, 1973). Chen et al., (1976), however, found no significant change in concentration of copper under redox conditions. As in fresh water environs, iron is soluble under reducing conditions and insoluble under oxidizing conditions. That is to say that when anoxic sediments become oxic, the release of iron to the overlying iron is in soluble form unless complexed by sulfide. Manganese behavior is similar to that of iron where considerable release takes place under reducing conditions, but very little in well-oxygenated environments. The behavior of nickel varies but generally more nickel is released under oxidizing than reducing conditions.

The presence of mercury in sediments has been correleated with particle sizes of less than 74 microns (Murakami and Takeishi, 1976). They also found little relation between the concentration of mercury in overlying waters and redox and normal levels of pH. They indicated that the soluble mercury diffused from sediments is very small. They also found that the resolubilization of other metals such as cadmium, chromium, and lead were so low as to be below detection limits for the sediment they were testing.

The most immediate impact on chemical water quality might arise when metals contained in the pore water of sediments disturbed by dredging are liberated. Other forms of metals which are ionically bound to sediment particles or complexes may then serve as a reserve until equilibrium is reached. If sulfide is present in the sediments (possibly in the more organic sediments of Rye) the insoluble metallic-sulfide complexes would be broken by oxidation. The metals can then be expected to be recomplexed with chloride, ferric oxide, ferrous sulfide, manganese oxide, or they can become ionically bound to fine negatively charged particles. These are common reactions with zinc, lead, and copper (Krauskopf, 1956). While release of mercury takes place under oxidizing conditions, it also can form chloride complexes or become absorbed to charged particles. Copper and cadmium also form chloride complexes.

Demands on dissolved oxygen from COD and BOD can be expected during the dredging. Given the complex chemical composition of the sediments, it is possible that the interaction of depressed oxygen concentrations (although not necessarily anoxic), increased turbidity and suspended solids with associated trace metals, petroleum residuals, and PCB's, could lead to a synergistic effect on biota resulting in some mortalities.

One important aspect of the dredging implications on water quality is the potential spread of PCB pollution. Much of the state-of-the-art experience in dredging PCB contaminated sediments is being obtained in New York State on the Hudson River and in Japan. The status of PCB information for New Bedford Harbor has been summarized in Section 2.2. While the concentration of PCB and analogs in the Hudson River are considerably higher than those found to date in New Bedford Harbor, valuable information into potential problems can be obtained from the New York experience. From research on the release of pesticide (including PCB) materials to the water column during dredging and disposal operations, Fulk et al. (1975) found:

a. The amount of soluble pesticide material added to the water column by dispersal of the sediment interstitial water is negligible at sediment-to-water ratios of 1:10 or less.

b. The amount of pesticide material desorbed from resuspended solids is negligible at sediment-to-water ratios of 1:10 or less.

c. Pesticide materials are transferred to the water column by means of the resuspended solids. The concentration of the suspended pesticide material decreased with time to levels at or near background water column concentration.

"In all settling tests, the amount of PCB material remaining in suspension ranged from water column background level to 0.03 ug/l above background level after settling periods ranging from 5 to 24 hr."

Murakami and Takeishi (1976) found PCB's associated with particles of less than 74 microns and Chen et al., (1976) found PCB's associated with organic and inorganic particles of 8 microns or less. PCB's are non-polar compounds and as such they have low solubility in water and are more commonly associated with strong polar materials such as oils and as mentioned before, fine particles. The Japanese investigators found the resolubilization of PCB's from bottom deposits to overlying water to be very small and not related to redox or pH. From experience on the Hudson River, Tofflemire (1976) found PCB to be more concentrated in the woody and more volatile organic portions as well as very fine sediments. Tofflemire also found that a scum which developed in the hydraulic disposal area was highly concentrated in PCB's. This was attributed to the amount of floating materials (wood chips and other organics) and oils. This scum was also noted to occur at dredge locations where clam shell dredges were used and at disposal locations where open water dumps were made (Tofflemire personal communication). The work by Fulk et al., (1975) noted the most common PCB compound in the United States was Aroclor 1254, while Tofflemire found Aroclor 1016 to be the most prevalent in the Hudson River.

It must be expected, therefore, that given the amount of petroleum residuals and volatile solids and fine sediment particle sizes, release of PCB materials to the water column will take place during dredging. Essentially, the magnitude will depend on the amount of sediment disturbance and resuspension that takes place. The vertical extent of PCB into the harbor sediment is not known. If only partial removal of the contaminated material was to take place, then release of PCB can be expected to continue perhaps on the order of 0.5 to 2.0 ppb of total soluble PCB into the water (Tofflemire, 1976). Fulk et al., found that PCB's are generally distributed in the upper foot of sediment of the harbors in the United States which they investigated. Whatever the case is in New Bedford, attempts should be made to remove all contaminated sediment in the project area even if over-dredging is necessary. Whether the literature source is from Japan or the United States, all cases of study indicate the most important controlling factor in PCB release is the amount of suspended material released to the water column.

4.2.3 Biological Impacts of Dredging

Various impacts will be associated with the dredging activities of harbor sediments from New Bedford. Most noticeable are the short-term impacts such as removal of benthic fauna and the creation of turbidity plumes. Long-term impacts would be a suspension of pollutants from contaminated sediments and assimilation of these contaminants by benthic fauna, filter feeders, and demersal fish.

Organisms most likely to be removed by the dredge would be infaunal species such as shellfish, capitellid and spionid worms, and less mobile crustaceans.

The dredging would affect a bed of quahogs between the Coggeshall Street bridge and the hurricane barrier. Some small fish may also be trapped. However, most finfish species will be able to evade the dredge.

Turbidity plumes of variable magnitude and duration are expected. Deposit-feeding organisms such as polychaete worms are not affected by turbid conditions as much as filter feeders (quahogs, soft-shelled clams, bay scallops). The Massachusetts Department of Natural Resources (1974) conducted a study of the effects of disturbing bottom sediments on commercially important fish and shellfish. Bay scallops showed the greatest sensitivity, with 50%, 96-hour mortality at suspended sediment concentrations of 1.8 g/l.

Burial of organisms on the flanks of the project area by resuspended sediments from the dredging activity is not likely due to the small quantity of settling material involved. In actuality, the resettling material may not approximate that resuspended and redistributed during storm conditions. Saila, Pratt, and Polgar (1972) found a number of common benthic organisms able to tolerate burial of up to 21 centimeters.

Initial recolonization of dredge materials and other faunal impoverished substrates is done by opportunistic species. McCall (1975) found the first recolonizing and most opportunistic species in nearshore communities were Streblospio bendicti, Capitella capitata and Ampelesca sp. Although Mulinia laterolis is considered to be a slightly opportunistic organism, McCall placed Nepthys incisa in a group designated as relatively stable recolonizing species which have few reproductions per year, low recruitment, and low death rate. McCauley (1977) found recolonization of dredged areas to occur within 28 days and R type species such as capitellid and nepthid worms were the first to recolonize the areas. Recruitment time can also be shortened if the dredging takes place close to the spring larval bloom.

Long-term impacts of dredging are associated with the suspension of toxic material from the bottom sediments and bioaccumulation of these by marine organisms. Kelley (1977) found 130 ppm of copper and 2.6 ppm of cadmium in slipper limpets tissues (Crepidula fornicata) in New Bedford Harbor. These were correlated with high metal concentrations in the sediments. Areas with lower metal concentrations occurred towards Buzzard's Bay. High zinc tissue concentrations occurred in the mollusks, Anadara *transversa* and *Busycon canaliculatum*. The biological uptake of metal concentrations in disturbed waters have been documented. Pesch (1975) found ocean quahogs to have varying concentrations of metals in their tissues in relation to dredge materials. Although the NMFS (1977) never determined the cause of the Menhaden kills in New Bedford Harbor during 1977, high water temperatures, high copper concentrations, and low dissolved oxygen were suspected. Similar conditions could also be produced during summer dredging and, as discussed in Section 4.2.2, a synergistic impact would result without a single obvious alteration of water quality.

High levels of chlorinated biphenyls (PCB's) have been found in New Bedford Harbor sediments. These contaminants have been found in the tissues of lobsters, demersal fish, and shellfish. The effect these contaminants have upon biological organisms has been documented by various authors. Mosser *et al*., (1972) found marine algal species of *Skeletonema costatum* and *Thalassiosira pseudonana* sensitive to PCB's. Harvey *et al*., (1972) found that PCB's reduced growth in young oysters (*Crassostrea virginica*).

Tofflemire (1976) reported a biological concentration factor for fish of PCB (Arochlor 1016) to be 50,000 to 250,000. The concentration factor was determined in conjunction with the dredging research on the Hudson River during which fish were exposed to PCB contaminated sediments in much the same manner required in the EPA/COE bioassay for dredged material. With or without the dredging, bioaccumulation of the PCB compounds will continue in the area since not all of the contaminated sediment is to be removed in this project. It is expected that the dredging will resuspend sediments and petroleum fractions (which will be highly contaminated with PCB) and unless mitigative measures are instituted (See Section 5.1), spreading of the problem is likely.

For water quality and biological related impacts from the dredging of New Bedford Harbor, solid and liquid phase analyses and bio-assays would more specifically address the issue. However, whether the approach to the biological impacts is autecological or synecological, a major gap in the information concerns the long term effects. Standard bioassays are generally run from 4 to 10 days and essentially only answer the question of acute impacts to the test population. The chronic sub-lethal effects are only documented as a result of a high level of effort and such programs are out of the ordinary. Tissue level impacts which might take longer periods to appear than allowed for in standard tests, are also rarely documented. A negative finding from a specific test does not necessarily mean no impact since it may take a cumulative build-up to threshold concentrations before an effect is manifested.

4.3 Disposal Site Impacts

4.3.1 Ocean Disposal Site Impacts

If ocean disposal is used for New Bedford Harbor sediments, using either barge or hopper dredge for transport, increased turbidity levels may be expected at the disposal site. Various authors have analyzed open water dispersion of dredged materials including Krishnappan, Gordon (1973), Johanson and Boehmer (1975), and Koh and Chang (1973). The Koh-Chang model can be used to predict a statistical measure of the horizontal extent of dredged material on the bottom at the end of the collapse phase. Johanson and Boehmer (1975) present several figures from which cloud radii and collapse sizes can be predicted. The following table summarizes these data for the West Island Disposal Site (30 ft. depth) and an average for the Rhode Island Sound sites (conservatively estimated at 140 feet).

TABLE 17

Site	Cloud Radius	Collapse Size
West Island	23'	120'
Rhode Island Sound	51'	225'

Field verification of predictions such as these are scarce; however, based on work in Connecticut (Gordon, 1973) and San Francisco Bay, Johanson and Boehmer concluded that bottom spreading in less than 150 feet of water probably amounts to about 300 feet. This conclusion, while simplified, gives an approximation of the area to be impacted by an individual discharge operation. Short dumping or movement of the disposal site buoy would result in a larger impacted area. An idealized sequence of events for open ocean disposal from barge opening to impact processes follows:

"1. A descent phase involves material with no initial velocity moving out of the scow, but increasing in speed due to its excess density (i.e., a turbidity flow).

2. If the material is homogenous, it initially moves as a single mass accelerating to some maximum speed.

3. The leading edge entrains water, loses density, grows in size, and is slowed by frictional forces.

4. An injection cloud develops as the material is injected into the water column.

5. A bottom phase occurs which includes impact, mounding, and horizontal spreading.

6. The type of bottom spreading which occurs is a function of material type and density. Where material density is great enough, a turbidity flow (density current) is likely.

7. As the material impacts the bottom, an impact cloud, consisting of dredged material and disposal site bottom sediments, is also formed.

8. This cloud is acted on by ambient currents."

(Johanson and Boehmer, 1975)

4.3.2 Sediment Transport at Ocean Disposal Sites

For the various ocean disposal sites, current data are only available for West Island and Browns Ledge. Sediment movement potential at other sites can only be inferred from bottom sediment characteristics. Schlee and Botman (1974) indicate that bottom sediments of the inner continental shelf between Cape Cod and Cape Ann are in approximate equilibrium with maximum observed current speeds, except in areas of relict gravel. Sediment descriptions provided in Section 2.6 indicate that most of the areas investigated by Chase (1977) in Rhode Island Sound had relatively fine, muddy bottom sediment occasionally capped by oscillation ripple marks. It would appear that bottom currents in these areas are not great enough to move significant amounts of fine grained sediments. However, the precise nature of the bottom currents regime in this area can only be defined through long term current monitoring.

Current data available in the vicinity of West Island (Eldridge, 1978) show maximum surface currents of nearly one knot, (1.68 feet per second). It is likely that when the bottom sediments and currents of this site are considered that the area would not be classified as a containment site.

Measurements of bottom currents at the Browns Ledge site were carried out by URI in 1974 (See Section 2.6). Maximum recorded tidal currents were 0.3 knots (0.5 fps) in a NNW-SSE direction. The study period during which these currents were measured was only 34 days so that maximum yearly currents (including storm-induced) were in all probability not measured. It was felt by the researchers at URI that given the depth of the site and the depths to which wave induced bottom currents are felt in this area, resuspension of dredged sediments at the site is likely.

As a general rule, grain size characteristics of the dredged material should be compatible with those of the disposal site. For the most part, this appears to be the case with the areas in Rhode Island Sound selected by Chase (1977). It may not be true at the West Island and over portions of the original Browns Ledge sites.

4.3.3 Water Quality Impacts at the Disposal Site

If one is to agree that at the dredge site there is a potential for release of nitrogenous compounds (measured as total Kjeldahl nitrogen), petroleum residuals, PCB, some trace metals, and an increase of COD and BOD; then it is also probable for the same to occur at the ocean disposal site. The water quality associated impacts of dredged material disposal at the Massachusetts Bay Foul Area were investigated by the New England Aquarium (1975). Following the discharge of a barge load of material from the Mystic River in Boston Harbor, a turbidity plume was noted with the highest trace metal concentrations at the middle and bottom of the water column. The levels of turbidity observed were not found to adversely impact primary production. Additionally, increased levels of ammonia, lead, copper, and zinc were noted in the plume. The copper and zinc concentrations were only two times over background levels but the lead in the plume had increased 30 times. The fate of these concentrations and decay rate were not explored.

In more detailed monitoring of dredge material disposal at the New London dumping grounds in Connecticut, suspended sediment levels were increased following a dump but returned to background levels within one hour. Observations on dissolved oxygen levels ranged from no alterations in concentration to depressions of more than 50% lasting only ten minutes. Surrounding waters were not impacted. Slight depressions were noted in pH and lasted from ten to thirty minutes, depending on the relation of the sampling site to the plume. No variations of Eh were noted in the plume or surrounding water. Return of volatile solids to background levels took as little time as 15-20 minutes for surface waters, and over two hours on the bottom of the dump site. Concentrations of trace metals in the water column showed no consistant trends that could be attributed to the disposal of the material. Monitoring of lobsters inhabiting the dredged material pile for bioaccumulation was taking place (Naval Facilities Engineering Command, 1975).

It is reasonable to anticipate the foregoing impacts with ocean disposal of material from New Bedford, but, the rate of release will ultimately depend on the cohesion of the material, specific chemical nature, and current regime at the dump site.

Since fish have been found in Fairhaven Bay with tissue PCB concentrations above the allowable FDA limit of 5.0 ppm, it is reasonable to expect the spread of PCB contamination with ocean disposal of the sediments. Tainting of tissue and the development of kidney concretions from the oily sediment might result to the ocean quahogs at or near the various Rhode Island Sound sites. Whether point or zone dispersal dumping is used, it can be expected that eventual winnowing of the spoils will result in increased concentrations of trace metals in the native sediments.

4.3.4 Biological Impacts at the Disposal Site

Due to the nature of the New Bedford Harbor sediments, the disposal of dredged material is likely to have an adverse impact on the biological communities at a given disposal site. Some short term impacts such as temporary depressions of dissolved oxygen and increased turbidity will be similar at all of the disposal sites. However, long term impacts such as bioaccumulation of contaminants could have different environmental implications for the various disposal sites.

Deep burial by dredged material will kill infaunal organisms such as polychaete worms, deposit feeding amphipods, and shellfish. Saila, Pratt, and Polgar (1972) found some benthic organisms such as Nepthys incisa, Streblospio bendicti, and Mulinia were able to withstand burial of up to 21 centimeters of dredged material. Finfish such as winter flounder, cod, and others should be able to avoid being buried.

With the point dumping of 150,000 cubic yards of material, burial becomes a moot point, especially within the collapse radius area. In outlying areas which will receive an increased amount of sediment from the turbidity cloud, much of the natural biota should be able to tolerate that increased level of sediment.

Some severe long term impacts could occur from the bioaccumulation of pollutants from the sediments. Note that Kelley (1977) found a correlation between the high cadmium and copper levels in New Bedford sediments and the slipper limpet Crepidula fornicata, and, that demersal fish, lobsters, and soft shell clams have also been found with high concentrations of PCB's in the harbor environs. These impacts will not only be found in the indigenous biota around the dump site, but can also apply to recolonizing organisms. Whether the disposal takes place in Buzzards Bay, Fairhaven Bay near West Island, Cross Rip Shoals or any of the alternate Rhode Island Sound sites, one should anticipate a recurrence of the contamination of ocean quahog populations such as has been documented for the Brenton Reef disposal of Providence River sediments (Pesche, 1975).

Impacts will vary as a result of different bottom topographies and sediment compositions. For instance, areas located west of Browns Ledge have sandy sediments, and the deposition of fine grain sized dredged material will hamper fast recolonization by surrounding organisms. Areas southeast of Browns Ledge are located within a deep area where sediments are composed of finer materials. Recolonization would be quicker due to compatibility of sediment type and indigenous biota.

The filling of the proposed waterfront areas is not expected to produce as great an impact as would the ocean disposal. Naturally inhabiting organisms will be killed; but, as discussed previously, the actual utility of these organisms to the natural environment as a food or energy source is expected to be limited since the contaminants contained in the tissues will only be passed through the food chain.

4.3.5 Land Disposal Impacts

The availability of land and/or waterfront disposal sites has been discussed in Section 2.6. As indicated in the discussions, the alternative to ocean disposal is the filling in of waterfront areas to the bulkhead line. Methods for the construction of bulkheading and/or dikes have been presented. Assuming double handling of dredged material (clam shell onto a barge and off loading at the waterfront site with a dredge), the greatest involvement of water related problems will be with the supernatant water as the site is filled. The water will be highly contaminated with nitrogen, petroleum residuals, PCB, suspended solids, and trace metals and low in dissolved oxygen. The uncontrolled release of such waters will result in localized water quality deterioration. With an impervious lining along the dike, leaching of contaminants will be precluded. Some localized problems with odors might be encountered during disposal but should abate once the upper layer of fill material is oxidized. The filling of waterfront areas is not expected to exacerbate flooding since the process is actually a displacement of water masses.

Other upland sites were considered as potential disposal locations; but for reasons of aesthetics, water quality, and/or access, they were eliminated.

An obvious impact associated with the filling of a marine area is the loss of habitat. The waterfront sites described in Section 2.6 have varying degrees of productivity. In degrees of floral and faunal diversity the sites might be ranked from high to low as follows: Site A Site B Site F = Sites C, D, and E. Even though some of the locations may have good species diversity, the actual value of the flora and fauna is anticipated to be low due to potentially extreme levels of tissue contamination. In the overall balance between in-harbor disposal and open ocean disposal in Fairhaven and Buzzards Bays, the better choice is considered to be containment of the material within the Harbor.

4.4 Socio-economic Impacts

The proposed project will be a socio-economic benefit to New Bedford Harbor with insignificant adverse effects. Maintained channel depth is necessary for the support of harbor activities that are important to New Bedford's economic base. These activities include commercial fishing operations and general cargo and petroleum shipping. Tourism also is indirectly related to the proposed project in that New Bedford's active fishing industry is a tourist attraction.

Many economic development goals hinge on harbor development, for which maintained channel depths have been assumed. The city of New Bedford is interested in developing as many amenities as possible to attract new waterfront users. Maintained channel depth would be necessary to accomodate the possible siting of OCS facilities within the New Bedford North Terminal Project area. Maintenance dredging is also necessary to keep the New Bedford fishing industry vital and to ensure that fishing enterprises expand in New Bedford rather than possibly moving to other ports as the benefits of the new 200-mile U.S. fishing limit are realized. The New Bedford fishing fleet and upgraded fishing facilities are part of New Bedford's plan for increasing tourism, so it is also important for this reason that the fishing industry is not allowed to decline.

Pollution levels that exist in New Bedford Inner Harbor prohibit its use for fishing, swimming, and other water contact sports. As a result, the only recreational activity that would be disrupted by dredging would be recreational boating. In the outer harbor, water quality at the two swimming beaches in New Bedford and Fairhaven may be temporarily effected. Boating in the outer harbor may be temporarily effected, especially at the entrance to the inner harbor through the hurricane barrier. Conflicts between dredging and boating should be less in the outer harbor because there is more room for recreational boats to navigate around equipment. In all cases, the least effect on recreation will be incurred if dredging does not take place in the summer.

Mr. Richard Walega, City Planner for New Bedford, (personal communication, 1977) has stated that the maintenance of New

Bedford's existing channel and anchorage is essential to maintaining a healthy economic environment for the city.

4.5 Federal Regulations Concerning Impact Assessment

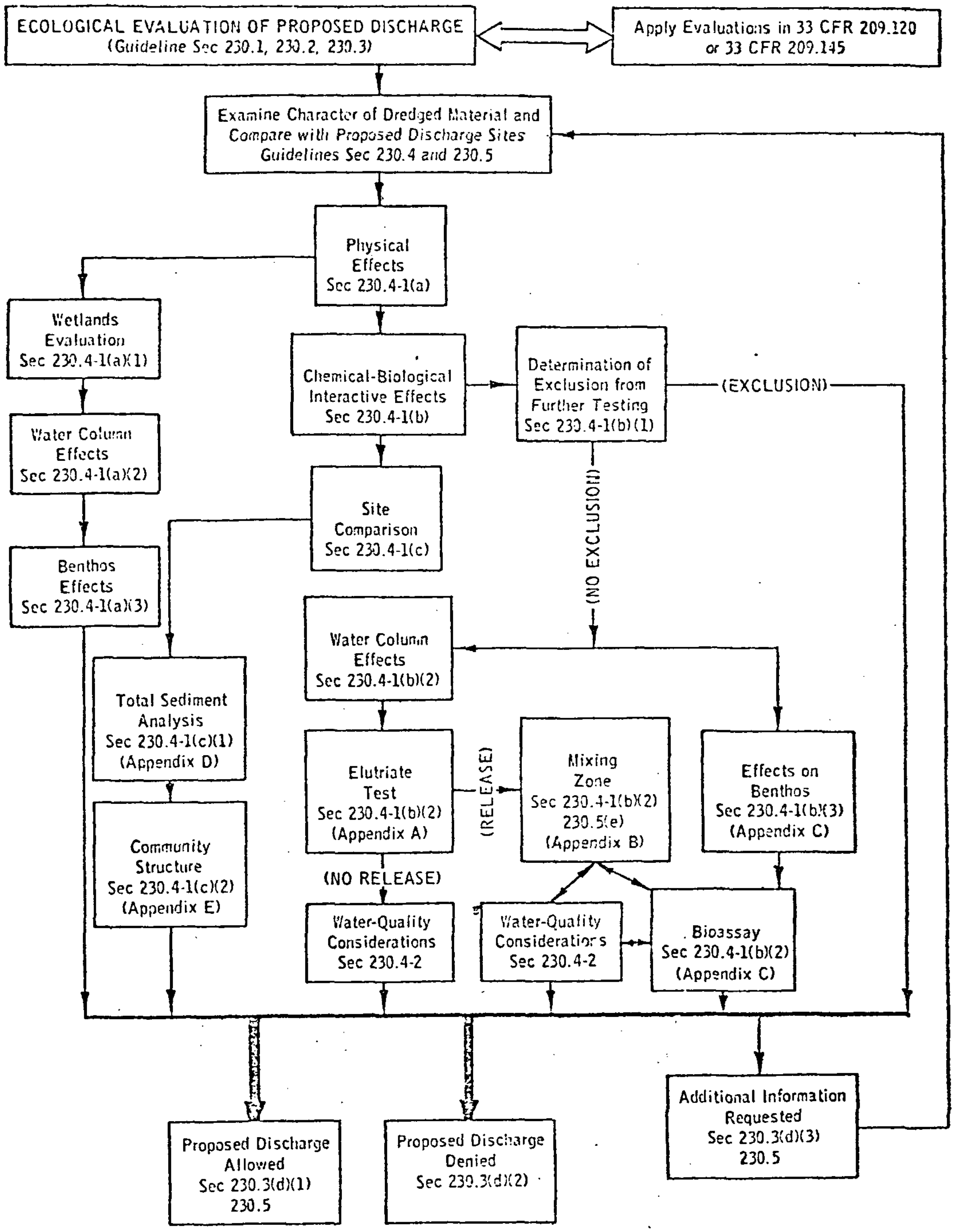
At the present time, subject to the location of various disposal sites, different Federal Regulations will have jurisdiction over the disposal process. For sites within the territorial baseline (3 miles offshore) Section 404(b)(1) of Public Law 92-500 (Federal Water Pollution Control Act Ammendments of 1972) will apply. The West Island, West Falmouth, Cross Rip Shoals sites would come under the jurisdiction of this act. The Massachusetts Bay Foul Area site (located beyond the three mile baseline) will come under the jurisdiction of Public Law 92-532, Section 103, the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA).

Section 404(b) of P.L. 92-500 specifies that any proposed discharge of dredged or fill material into navigable waters must be evaluated through the use of guidelines developed by the Administration of the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army acting through the Chief of Engineers. The District Engineer must make the evaluation in accordance with guidelines published by EPA in the Federal Register, Vol. 40, No. 173, Friday, 5 September 1975 placing special emphasis on Section 230.4 and 230.5 insofar as potential ecological effects are concerned. Ecological impacts can be divided into two main categories: physical effects and chemical-biological interactive effects, Sections 230.4-1(a) and (b) of the Federal Register respectively. Evaluation of the proposed discharge(s) generally follows the sequence presented in Figure 12.

The principal concerns over the consequences of open water discharge of dredged material are potential effects on the water column and benthic communities due to the presence of contaminants. These impacts are best approximated by various tests:

1. Release of chemical contaminants from the sediment to the water column may be simulated by use of an elutriate test.

2. Bioassays may be used to estimate effects such as toxicity, simulation, inhibition, or bioaccumulation.



Note: Section numbers within the boxes refer to the Register.

FLOW CHART P.L. 92-500, SEC.404

Figure 12

3. Comparisons of and suitability of the proposed disposal sites can be evaluated by the use, when appropriate, of total sediment analyses.

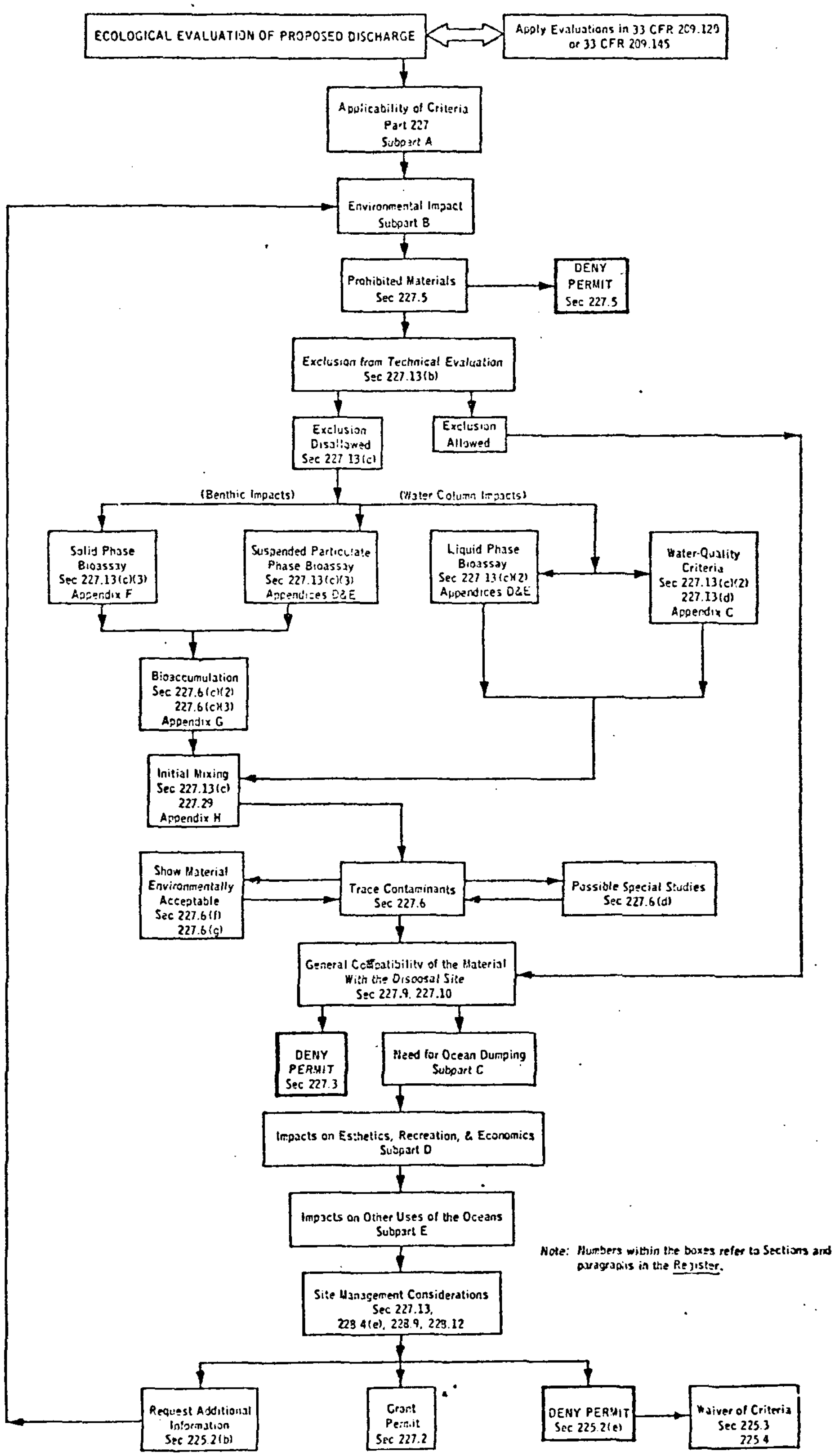
A summary of these techniques and other guidelines is presented in Ecological Evaluation of Proposed Dishcarge of Dredged or Fill Material into Navigable Waters, 1976, U.S. Waterways Experiment Station, Vicksburg, MS.

Although two different sets of regulations (those for navigable and those for ocean waters) are authorized by P.L.92-500, the Act states that the criteria on which both sets of regulations are based are to be "comparable."

Federal guidelines for the ocean disposal of dredged materials are presented in the Federal Register, 11 January 1977. An implementation manual describing the applicability of specific evaluative approaches and procedures has been published jointly (July, 1977) by the Corps of Engineers and the Environmental Protection Agency. Although many of the techniques presented in this manual are very similar to those covered in Section 404(b) of P.L.92-500, Section 103 puts added emphasis on bioassays and bioassessments.

In this document, sites are presented which are "approved for dumping the indicated materials on an interim basis pending completion of baseline or trend assessment surveys and designation for continuing use or termination of use." The "indicated materials" briefly, are materials containing less than trace concentrations than the following prohibited constituents: organohalogen compounds, mercury and mercury compounds, cadmium and cadmium compounds, oil, and known or suspected carcinogens, mutagens, or teratogens. In EPA Region I, which encompasses New England, the two designated sites are located at: latitude 43°33'00"N, 69°55'00"W longitude (1 nautical mile radius) and latitude 42°25'42"N, 70°35'00"W longitude (2 nautical miles radius). The former site is near Portland, Maine, while the latter (known as the Foul Area) is located off Marblehead, Massachusetts.

Section 102(c) of the MPRSA makes clear that the EPA Regional Administrator is to "designate recommended sites or times for dumping" and 103(b) that the Sec. Army (Corps Engineers) must "to the extent feasible utilize the recommended sites designated by the Administrator pursuant



FLOW CHART P.L. 92-532, SEC.1

Figure 13

to Section 102(c). The Ocean Dumping criteria 228.4(e) (2), permits the Corps of Engineers selection of a previously undesignated site only "in accordance with the site selection requirements of 228.5 and 228.6(a). It should be recognized however that the Administrator has the lead responsibility for ,site designation under Section 102(c) rather than merely "selected" by the Corps.

Under Section 404, para 230.7 (Sept. 1975) the "Advanced identification of dredged material disposal sites" requires that the Regional Administrator and District Engineer to consult the States. Only "after such consultation with the affected State or States, may at their discretion and consistent with the guidelines, identify areas which will be conisdered as "possible future disposal sites; or area which will not be available for disposal site specification".

Figure 13 presents a flow-chart for the ecological evaluation of proposed dredged material discharge under Section 103.

In all likelihood, before a permit is granted to dispose of dredged materials from New Bedford, bioassays of selected organisms will be required. The final decision to issue or deny a permit for discharge of dredged materials will rest with the Division Engineer, U.S. Army Corps of Engineers.

5.0 UNAVOIDABLE ADVERSE EFFECTS OF THE PROPOSED ACTION

The proposed action consists of the dredging of New Bedford- Fairhaven Harber and its entrance channel. It is estimated that 150,000 cubic yards will be removed in the course of the project. Historically, federal project dredging has taken place with a hopper dredge with disposal at a site SW of West Island. At this time it is not known whether or not the material to be dredged will meet the criteria set forth in recent Federal Guidelines for ocean disposal (Section 4.5).

Although this project will be subject to a number of constraints which act to minimize the extent of environmental damage, there are, nevertheless, certain minimum levels of adverse effects which would be associated with such an action. If this action is undertaken, these effects must be considered unavoidable.

5.1 Mitigation Techniques for Dredging Operations

In determining the unavoidable adverse effects of the proposed dredging action, it is necessary to outline the techniques that will be used to limit these impacts. These can be divided into dredging techniques, disposal techniques, and timing.

Researchers working with sediment contaminated with either trace metals (mercury in particular) or PCB compounds agree that control of suspended fines is of utmost importance in minimizing the release of these contaminants to the environment. As a result of the affinity of PCB compounds for polar materials such as petroleum fractions, the control of oil scums from dredge and disposal operations is also important. These controls can be effected in a number of ways.

The simplest but not always the most effective is to use oil booms for containment with subsequent pickup of the collected scums. The use of oil absorbants can also aid in the capture of oils and associated contaminants. More recently the design and deployment of silt curtains has been advanced. The curtains are generally constructed of nylon reinforced PVC materials in the form of a barrier which is maintained in a vertical position by floatation devices on the top and ballast chains on the bottom. Depths of the curtains are generally 5 to 10 feet. The principle function of the curtains is to control the flow of turbid water. Because of their limited depth, they do not contain or control fluid mud along the channel bottom. Field testing indicates that the curtains are most effective in sites where the current velocities are less than one knot per second and where frequent movement of the dredge is not necessary.

During hydraulic dredging of the Hudson River, treatment of the settling lagoon effluent water was necessary. The state of New York tested 20 chemicals and polymers and found three cationic polymers to be most cost effective in reducing turbidity and PCB levels in the return water. The materials were Drew floc 410, Nalco 7134, and Calgon cat floc B (Tofflemire, 1976). Application of the polymers to the suction line on the dredge resulted in reductions of PCB in the lagoon effluent from 50 ppb to 2-4 ppb. If a silt curtain is used around the dredge location, either skimming and/or application of a polymer within the enclosure could be appropriate. As an alternative to dealing with the waterfront fill areas and supernatant water, cycloning of the water could be considered. With clam shell dredging, the problems of handling are compounded, but the water quality implications are greatly decreased, hence clam shell removal is the preferred technique.

Mitigative techniques at the ocean disposal site will vary considerably. The site must be carefully selected as should the nature of the materials to be dumped (acknowledging that some of the outer channel sediments may be acceptable for open water disposal). Accurate monitoring of the barge releases will help to ensure that short dumping does not occur. This will act to minimize the area covered by dredged material.

In terms of being suitable for the disposal of dredged sediment, Chase has suggested that disposal sites be located away from rocky and physically diverse areas, and located on flatter topography. This will protect the lobster fishery on the rocky areas and the seasonal trawl fishery, and organisms (red hake and cancer crabs) that can better tolerate or avoid the dumped sediments.

Proper timing of the dredging projects can also minimize possible conflicts with harbor usage, particularly during the recreational season. Spring is a time when spawning may be taking place in the harbor and dredging activities could interfere with it. However, fishing has been curtailed in the harbor due to PCB's and other contaminants so that interference with it is not an issue. From an environmental and a recreational standpoint, fall dredging would appear to be most suitable.

5.2 Unavoidable Impacts

While liquid phase analyses for New Bedford Harbor are not available, experience from similar harbors on which such analyses have been conducted indicates that dredging of the harbor will produce localized increase of nitrogen compounds, petroleum fractions, PCB compounds, release of some trace metals, and increased levels of COD and BOD. Resuspension of sediments and increased levels of turbidity will also take place. These anticipated impacts apply to the dredge site and to any of the proposed ocean disposal sites. If the alternative of filling waterfront areas for containment of the dredged material is selected, there will be a loss of marine habitat; contaminated though they may be. If ocean disposal is selected, there is a good chance that the metal and PCB contamination of the harbor and Acushnet River will be spread.

It is unavoidable that the dredging will cause some impediment to marine traffic regardless of the timing. Small epifauna and infauna will be lost in the dredge areas and in the proposed alternative fill or disposal areas. Turbidity plumes at the dredge and disposal site can be expected to have a temporary deleterious impact on biota, particularly fish. Some slight air quality, noise, and aesthetic impacts on the harbor will also be unavoidable during the dredging.

6.0 ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed maintenance dredging of New Bedford Harbor include the no action alternative, method of dredging to be used, and the type and location of the disposal site.

6.1 No Action

The no action alternative to the maintenance of New Bedford involves adopting the position that the harbor and channel areas are not maintained to the federally authorized depths. The authorized depths are intended to accommodate recreational, fishing, and light to moderate commercial traffic. For New Bedford and Fairhaven, which are both committed to strengthening their economies through maximum utilization of the harbor, non-maintenance would have a devasting impact on the local economy. To allow for further marine-related growth, the city of New Bedford is also considering the deepening of the harbor to 40 feet to allow the entrance of larger and deeper draft vessels. Additionally, with the presence of the federal hurricane barrier and the impact the structure has on increasing sedimentation rates, the no action alternative would conceivably have a more immediate impact than in other New England ports.

6.2 Alternative Dredging Methods

In the New England area two basic dredging techniques are used: bucket (clam shell, orange peel, hopper) and hydraulic which includes side cast dredging. The last federal dredging in the harbor during 1950 was done with the federal hopper dredge LYMAN. Hydraulic dredging is used extensively in many regions of the United States, especially in projects such as the Mississippi River channel mainentance where much of the dredged material is piped onto an adjacent shoreline, where it may be used in levee construction, etc. Hydraulic dredges generally discharge a mixture of water and sediment (10-20% sediment; 80-90% water). The turbidity plume associated with hydraulic dredging is usually smaller than that produced during bucket dredging. Japanese engineers have perfected various devices which are attached to the dredge cutterheads to reduce the area of the turbidity at the dredge site. Additionally, many of these cutterheads are equipped with gas removal devices. Conventional hydraulic systems can pump sand sized particles approximately 22 feet above the harbor bottom (NEDCOE), either into barges for ocean disposal or into pipelines for land based disposal. This distance will increase slightly for finer sized particles such as are found in New Bedford Harbor.

The main problem arising from hydraulic dredging is the character of supernatant water from the disposal area settling lagoon. With contaminated sediments, treatment of the effluent water is sometimes necessary as has been the case on the Hudson River to prevent dispersion of PCB contaminated materials.

Side cast dredging is a variety of hydraulic dredging where the materials are pumped onto the dredge vessel and discharged to the side through discharge pipes onto the banks of the channel. The use of side casting is limited to channel depths of 15 feet or less. As one would expect, the discharge from side cast dredging can produce turbidity plumes, particularly with silty materials. Due to the project depths and chemical nature of the sediment, side cast dredging in New Bedford is not considered appropriate. The conventional hydraulic dredging approach has more disadvantages than advantages in New Bedford, especially if land disposal is chosen. The disadvantages include the length of the discharge line to the various disposal sites on the waterfront; the impediment the lines would cause to commercial and recreational traffic; and, the problem of adequately dealing with the contaminated effluent from the settling lagoons. The only advantage that can be foreseen is the one-time handling of the dredged material.

While the use of a hopper dredge is not precluded, given the nature of the sediments it is realistic to look at bucket or clam shell dredging as a preferred alternative. Material dredged in this method is loaded onto a barge and transported to a disposal site where it is unloaded. In the case of ocean disposal, a bottom open barge or a pump-out method from a barge is used. If land disposal is used, double handling of the material is generally necessary. A method must be chosen of unloading disposal barges onto land sites or onto trucks or rail cars which then proceed to land disposal sites. As a rule, bucket dredging is considerably slower than hydraulic dredging.

Johanson et al., (1976) discusses various open water disposal techniques and their limitations. They indicate that accurate disposal of barge wastes in the open water environment is not always accomplished due to safety, economic, or convenience reasons. At the present time, two general type of barges are utilized for open water disposal. Clamshell barges have split hulls whose halves are hinged together so that the hull behaves like a clamshell. These are generally hydraulically operated. Dump scows and barges are generally manually operated, with little or no on-board power. Dump scows are emptied by winching open the bottom doors on each of the barge compartments. Some modernized versions do, however, have hydraulically activated sliding bottom doors. Unloading time varies depending on the type of barge, its capacity and the nature of the load. On average for a 4000 cubic yard dump scow, off loading takes between 5 and 10 minutes. The following table summarizes the specifications of typical disposal barges.

TABLE 18

Typical Barge Specifications
(After Johanson et al., 1976)

Capacity cu. yd.	200	1000	4000
" tons	270	1350	5400
Overall length (ft.)	90	150	240
Beam (ft.)	20	35	54
Depth, amidships (ft.)	9	15	24
Draft loaded (ft.)	7	12	20
Empty (open, ft.)	3	6	9
Empty (closed, ft.)	2	3	4

While the selection of the barges ultimately to be used in the project are depth limited, the choice is also dictated by the availability of equipment at the time of dredging.

Johanson et al., (1976) discusses several other methods which may be potential improvements for ocean disposal: pump-down from barges and scows, dredged material modifications, and improvements in navigational techniques. At the present time, the barge pump-down technique is utilized extensively in Europe where it is used to unload dredge barges and pump the dredged material ashore via a pipeline. For use in an ocean disposal program, the dredge barge could be moved and the material piped down to the disposal site. Johanson et al., (1976) presents various schematic and working diagrams which illustrate the use of such a technique. They estimate the present cost of a pump-down barge 150x30 feet to be $3.5 million. The expertise exists now to construct such vessels which would also be useful in transferring dredged materials to land disposal sites. However, none have been built as yet in the United States.

6.3 Alternative Disposal Sites

6.3.1 Land Disposal Sites

In coordination with the Massachusetts Department of Environmental Quality Engineering, Executive Office of Environmental Affairs, Coastal Zone Management Program, the Environmental Protection Agency, and the Planning Offices of the cities of New Bedford and Fairhaven; alternative land disposal sites were considered. Land (waterfront) sites considered suitable have been discussed in Section 2.6. Sites which were also considered but for various reasons were not found suitable include the New Bedford landfill, the Fairhaven landfill, local quarries, a waterfront site along Sycamore Street in Fairhaven, side dressing and/or fill for roadways, and transportation to a proposed fill area on Spar Island in Mount Hope Bay. The Massachusetts Audubon Society has suggested that an island be built over the boulder reefs west of Sconticut Neck or the low islands north and east of West Island. The building of any land mass from the dredged material will require containment structures of some type, and the chemical nature of the dredged material from this project makes such an alternative questionable. Were the materials cleaner, the approach could meet with more favor.

6.3.2 Ocean Disposal

Alternative disposal sites for the New Bedford project have been considered in view of current State and Federal directives and legislation concerning ocean disposal of dredged materials. All potential open water sites have been discussed in Section 2.6. Of the sites considered, two which are authorized for disposal of clean material are also within the Massachusetts Cape and Islands Marine Sanctuary. The site used for past dredged material disposal from New Bedford is not authorized and also lies within the boundaries for the Marine Sanctuary. A number of alternate sites in Rhode Island Sound have been discussed, but none of these have been approved for disposal of any dredged material.

The munitions disposal site south of Nomans Land has also been suggested as an alternate dredge materials disposal site. There is no information available on the sediment quality, however, some fisheries information has been found. Mr. Weld of the National Coalition For Marine Conservation, Inc. reports that lobstering of a medium intensity is conducted in the general area to depths of 22 fathoms. Fin fishing is also conducted by American and foreign fishermen for yellowtail flounder, scup, butterfish and other groundfish. An intensive foreign fishery for squid and mackerel and an intensive summer recreational fishery for broadbill swordfish are also reported. Data is not available on the macrobenthos populations of the region.

6.4 Alternative Uses of Dredged Material

Alternative uses for dredged material include such things as beach nourishment, construction aggregate, and fill for abandoned strip mines. The New England Division, U.S. Army Corps of Engineers suggests that for beach nourishment, medium grain size of the sediments be between 0.4mm and 2.0mm. Because none of the materials to be removed from the project area have suitable grain sizes, and because of chemical contaminants beach nourishment is not feasible.

It has also been suggested by various authorities that abandoned strip mines could serve as disposal sites for dredged material. At this time it is unlikely that such an alternative would be economically feasible, due primarily to transportation costs. It is likely that material from New Bedford Harbor would cause water quality problems, due to salinity and heavy metal and PCB levels, in ground and surface water at the disposal sites.

7.0 RELATIONSHIP BETWEEN SHORT TERM USES AND LONG TERM PRODUCTIVITY

The short term dredging of sediments from New Bedford Harbor will produce variable impacts to the natural environment. Most obviously, organisms will be killed at the dredge and disposal sites. Concentrations of turbidity, suspended solids, nitrogen compounds, petroleum residuals, trace metals, PCB compounds, and oxygen demands will be increased in the harbor during dredging and disposal. Some of these impacts, such as the oxygen demands and suspended solids, are expected to be of short duration. However, the nature of the project area sediments suggests the possibility of long term impacts to the natural environment from trace metals and PCB's. Ocean disposal can be expected to spread the PCB's. Spanning a number of maintenance dredging projects in this harbor, there will be an additional long term impact on the biological communities, particularly the benthos. The net effect will be a continued biological diversity less than it would be if nothing had been done because the community is never allowed enough time to reach equilibrium. Due to the repetitive nature of maintenance projects, biological productivity cannot be enhanced even if polluted sediment is removed.

At the disposal site, similar impacts will also be found. Regardless of the quality of the sediment being disposed of, the benthos will not be able to reach equilibrium as a result of the routine projects. While bioassays for such short periods as 10 days may or may not indicate chronic or acute toxicity, cumulative effects or appearance of threshold limits are not likely to be identified through these tests. It is fair to say that the character of any ocean disposal site chosen and its environs would be altered and a return to steady or natural state conditions would not likely occur within the foreseeable future.

Economically, the maintenance of the authorized depths is considered a long term benefit even though there will be some hinderence to marine traffic during the dredging. Without the dredging, New Bedford and the region will not realize the anticipated economic goals associated with increasing marine commerce.

8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IF THE ACTION IS IMPLEMENTED

Implementation of the maintenance dredging will require the irretrievable loss of capital, energy, and labor. Section 4.3 indicates that there will be losses to biologic communities at dredge and disposal sites. In all likelihood, these losses will not be irreversible. However, if maintenance dredging continues in the future at an interval less than that necessary for recolonization, it will prolong or even prevent recovery of biologic resources to pre-dredging levels. It is conceivable that continued use of the oceans for disposal could irretrievably affect the productivity of an area for spawning, nursing, growth, etc.

If land disposal is chosen, the filling of certain areas of the waterfront will constitute essentially an irreversible loss of a potentially productive area for a gain in economic values.

9.0 COORDINATION

During the preparation of this draft environmental assessment, numerous government and private agencies were contacted. In many cases, contacts were initially made to collect relevant information; however, at the same time, opinions of various officials as to dredging and disposal related impacts were also solicited. Many of the replies were utilized in the preparation of this report. Background data for this report were compiled by Jason M. Cortell and Associates Inc., Waltham, Massachusetts. Fay, Spofford, and Thorndike Engineers provided preliminary cost and design data for proposed in-harbor disposal sites. The following listing contains the names of the agencies and organizations contacted to data.

Federal

U.S. Geological Survey, Woods Hole (10/77, M. Bothner)
U.S. Fish and Wildlife Service, Concord, NH (11/77, L. Morse)
U.S. Environmental Protection Agency (9/77, K. Silverman, A. Ikalanian; 10/77, E. Wong, B. Higgins, T. Landry, R.J. Wilder, M.P. Holmes)
National Marine Fisheries Service (9/77,D. Kolek)
U.S. Food and Drug Administration (9/77, M. Lynch)

State

Massachusetts Historical Commission (10/77, E. Amadou)
Mass. Department of Environmental Quality Engineering (10/77, T. McLoughlin, P. Mallard)
Mass. Division of Water Pollution Control (10/77, W. Slagle)
Mass. Division of Waterways (10/77, J. Hannon)
Mass Executive Office of Environmental Affairs (Environmental Review) (10/77, M. Kolb)
Mass. Executive Office of environmental Affairs (Coastal Zone Management Program) (9/77, L. Smith, S. Alexander)
Mass. Department of Environmental Management (11/77, H. Bacon)
Underwater Archaeological Resources Commission (10/77, R. Cahil)
Mass. Division of Marine Fisheries (9/77, A. Chesmore, R. Beals, A. Carr)

Local

Southeastern Regional Planning and Economic Development District (10/77, W. D. Toole, J.J. Pobst)

New Bedford Planning Department (12/77, R.A. Walega, R.B. Davis)
Fairhaven Planning Department (12/77, N. Tangney)
New Bedford Harbor Development Commission (12/77, P. Saunders)
Harbormaster (12/77, L. Chongarhids)

Private Organizations/Universities

Woods Hole Oceanographic Institute (11/77, J. Ellis, J. Milliman)

Questions of comments relevant to this report should be directed to the Environmental Analysis Branch, New England Division, U.S. Army Corps of Engineers.

Prior to the commencement of any work, a public notice will be issued describing the proposed action plan. Comments by all interested persons and agencies may be submitted to the Corps for a thirty day period following release of this notice.

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APPENDIX A

RESULTS OF NEW BEDFORD HARBOR SEDIMENT CORE ANALYSIS

SAMPLE	USC[1]	MEDIAN[2]	Q_1[3]	Q_3[4]	LL[5]	PL[6]	PI[7]
KE-1	OH	.0095	.027	.003	94	47	47
KE-2	OH	.014	.073	.004	97	43	54
KE-3	OH	.012	.028	.0059	116	45	71
KE-4	OH	.011	.016	.0072	-	-	-
KE-5	OH	.01	.02	.0049	78	35	43
KE-6	S	.12	.31	.014	52	30	22
KE-7	OH	.029	.090	.0075	69	37	32
KE-8	OH	.015	.058	.005	93	42	51
KE-9	OH	.01	.018	.005	114	50	64
KE-10	S	.15	.42	.01	36	22	14
KE-11	OH	.014	.04	.0036	77	38	39
KE-12	OH	.015	.038	.0041	84	38	46
KE-13	OH	.013	.032	.0038	80	39	41
KE-14	OH	.009	.016	.0051	124	54	70
KE-15	S	.30	.39	.25	-	-	-

1 USC = United Soil Classification
2 Median = From grain size curve - size of grain of which 50% of sample is finer.
3 Q^1 = From grain size curve - size of grain of which 75% of sample is finer.
4 Q_3 = From grain size curve - size of grain of which 25% of sample is finer.
5 LL = Liquid Limit
6 PL = Plastic Limit From Atterberg Limit Tests
7 PI = Plastic Index

APPENDIX B

New Bedford Harbor Species List

Sipunculid
Oligochaeta

Polychaeta *Odostomia seminuda*
- Ampharetidae
- Capitellidae
- Cirratulidae
- Dorvallidae
- Flabelligeridae
  - *Pherusa affinis*
- Glyceridae
  - Glycera americana
- Hessionidae
- Lumbnneridae
  - *Lumbrinereis tenuis*
- Nereidae
- Orbiniidae
- Paranidae
- Phyllodocidae
- Spionidae
- Syllidae
- Terebellidae
- Trichobranchidae
- Nephtydae
  - *Nepthys incisa*

Mollusca
- Gastropoda (snails)
  - *Acteon punctostriatus*
  - *Anadara transversa* - transverse ark
  - *Busycon canaliculatum* - channeled whelk
  - *Crepidula plana* - Slipper limpet
  - *Crepidula convexa* - Slipper limpet
  - *Crepidula fornicata* - Slipper limpet
  - *Haminoea solitaria*
  - *Littorina* sp. - Periwinkle
  - *Mercenaria* sp. - Quahaug
  - *Mitrella Lunata*
  - *Nactica pusilla*
  - *Nassarius trivatattus* - Nassa
  - *Retusa* sp.

Bivalvia (bivalves)
- *Astarte castanea*
- *Astarte* sp.
- *Anomia simplex* - Mermaid's toenail
- *Cardita borealis*
- *Ensis directus* - Razor clam
- *Nucula proxima*
- Mercenaria mercenaria - Quahoug
- *Mulinia lateralis*
- *Pandora gouldiana*
- *Pitar morrhuana*
- *Tellina agilis* - Tellin shell
- *Yoldia limatula*

Decapoda
- *Neopanope texana*
- *Pagurus longicarpus* - Hermit crab

Echinodermata (starfish)
- *Asterias* sp.

Souce: Massachusetts Division of Water Pollution Control 1972
Kelley, 1977

Appendix C
NEW BEDFORD LANDINGS

SPECIES	1976 pounds	1976 dollars	1975 pounds	1975 dollars	1974 pounds	1974 dollars	1973 pounds	1973 dollars
Anglerfish	239,475	71,249	103,373	19,716	3,730	536	3,985	459
Bluefish	7,017	693	4,033	875	3,416	280	5,892	393
Butterfish, Large	1,701	378	625	125	---	---	---	---
Butterfish, Medium	10,304	2,555	7,305	1,263	12,780	2,044	8,190	1,730
Butterfish, Small	4,408	765	2,516	393	1,470	160	---	---
Butterfish, Unclass.	---	---	---	---	125	25	---	---
Cod, Whale	43,316	12,131	72,427	18,121	6,084	1,248	6,464	1,417
Cod, Large	3,643,150	1,033,063	2,198,775	554,205	1,957,165	421,576	1,402,786	277,532
Cod, Market	7,520,948	2,225,286	9,793,558	2,532,026	10,469,725	2,159,293	4,795,692	972,141
Cod, Scrod	2,594,371	583,303	876,566	200,416	1,804,163	311,545	4,202,649	629,321
Cod	9,750	1,176	---	---	1,140	115	12,540	1,101
Croaker, Small	107	21	---	---	---	---	---	---
Cusk	10,145	1,424	2,526	188	---	---	4,559	440
Eels, Common	---	---	---	---	27,390	547	---	---
Flounders, Blackback, Large	3,616,112	1,528,864	5,009,907	1,980,633	3,447,471	947,466	4,321,533	1,024,061
Flounders, Blackback, Small	2,329,595	699,388	2,700,617	740,244	1,979,055	382,646	1,679,747	301,532
Flounders, Dab, Sea, Large	384,117	161,380	382,424	132,608	435,839	113,758	---	---
Flounders, Dab, Sea, Small	391,949	120,203	425,664	102,607	574,811	105,107	---	---
Flounders, Dab, Sea, Unclass.	---	---	---	---	---	---	887,140	188,316
Flounders, Fluke, Large	432,096	273,092	242,477	125,350	81,107	26,502	44,290	17,399
Flounders, Fluke, Medium	608,956	321,996	402,374	170,210	172,358	41,542	49,740	12,230
Flounders, Fluke, Small	1,240,314	487,633	145,678	46,088	158,975	26,927	27,430	4,846
Flounders, Gray, Sole, Large	266,926	118,531	435,878	175,228	346,794	99,676	---	---
Flounders, Gray, Sole, Small	359,517	117,159	673,676	185,961	493,122	105,456	---	---
Flounders, Gray, Sole, Unclass.	---	---	---	---	---	---	---	---
Flounders, Lemon Sole	845,967	433,750	1,236,422	565,406	918,235	345,666	1,096,530	374,914
Flounders, Sand	3,381,641	887,572	3,320,877	670,874	---	---	---	---
Flounders, Yellowtail, Large	12,413,979	6,080,675	17,289,354	7,048,020	23,535,258	6,506,121	---	---
Flounders, Yellowtail, Small	9,272,140	3,064,466	10,116,892	2,820,760	7,280,268	1,651,057	---	---
Flounders, Yellowtail, Unclass.	---	---	775	108	17,625	5,865	30,762,280	7,021,021
Flounders, Unclass.	21,525	6,035	1,085	326	6,625	513	---	---
Haddock, Large	2,019,707	802,209	1,762,352	622,336	967,439	398,155	1,104,706	456,931
Haddock, Scrod	556,609	162,465	2,160,472	461,840	688,416	131,640	337,747	74,793
Haddock, Snapper	2,992	508	2,851	334	57,563	6,134	13,575	1,886
Hake, Red	---	---	500	50	1,750	175	695	32
Hake, White, Large	---	---	---	---	---	---	1,227	68
Hake, White, Medium	---	---	---	---	---	---	1,374	80
Hake, White, Unclass.	12,415	2,062	20,817	1,600	11,469	599	6,850	379

Appendix C

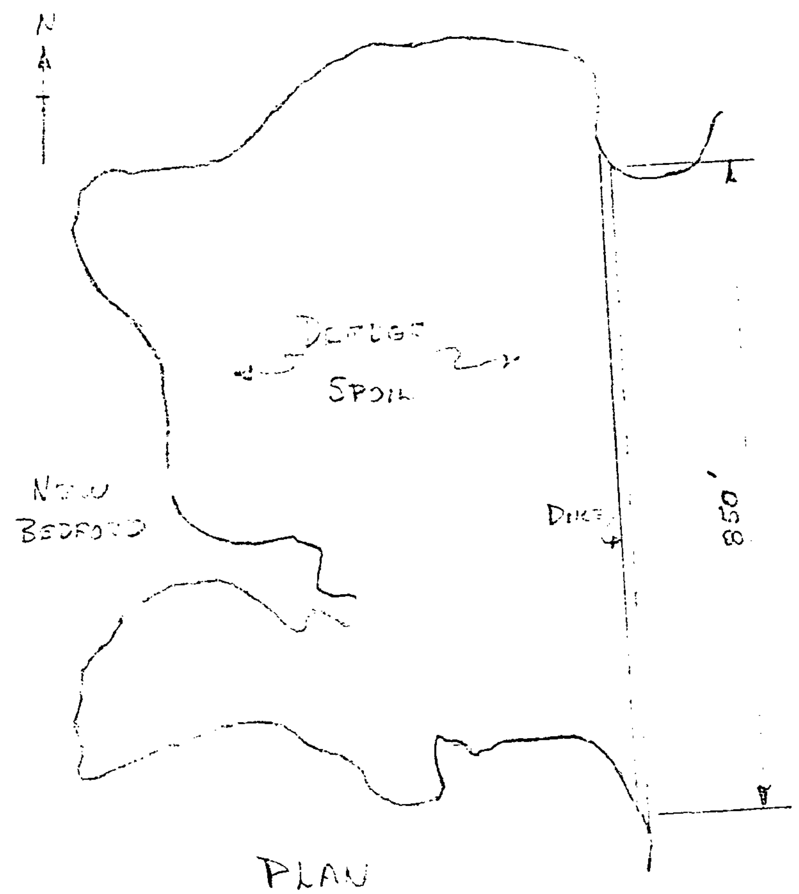
NEW BEDFORD LANDINGS

SPECIES	1976		1975		1974		1973	
	pounds	dollars	pounds	dollars	pounds	dollars	pounds	dollars
Halibut	1,737	1,814	---	---	1,634	1,114	932	467
Herring, Sea	---	---	590,000	17,110	225,670	6,769	---	---
Mackerel, Atlantic	125	25	---	---	280	42	---	---
Menhaden	---	---	370,934	5,378	3,621,890	45,273	1,153,000	19,648
Ocean Perch, Atlantic	11,375	1,909	7,800	1,216	---	---	436,450	40,212
Ocean Pout	19,500	1,850	---	---	---	---	---	---
Pollock	922,509	119,251	570,937	67,488	432,569	47,589	182,830	15,105
Scup or Porgy, Large	142,680	37,989	16,400	4,942	4,000	1,520	3,100	1,064
Scup or Porgy, Medium	129,025	29,428	17,641	2,835	55,075	11,294	30,520	6,484
Scup or Porgy, Small	20,375	5,848	8,295	1,481	---	---	2,025	264
Scup or Porgy, Unclass.	---	---	---	---	6,000	2,280	---	---
Sea Bass, Large	12,238	5,685	5,809	2,758	3,560	2,017	525	236
Sea Bass, Medium	5,543	3,144	2,830	1,496	1,540	616	135	54
Sea Bass, Small	---	---	---	---	---	---	65	24
Sea Bass, Unclass.	---	---	---	---	1,975	889	---	---
Sea Trout, Grey	3,618	448	693	73	430	41	839	103
Sharks	3,462	721	256	43	1,057	176	---	---
Skates	150	10	270	22	---	---	---	---
Striped Bass	122	37	---	---	530	212	125	38
Sturgeon	236	35	319	40	234	20	---	---
Swordfish	1,274,723	1,770,878	1,350,695	1,614,471	928,024	864,374	297,462	355,328
Tautog	3,875	536	180	18	---	---	2,225	111
Tilefish	73,115	13,967	3,401	1,117	5,041	953	---	---
Tuna, Bluefin	983	486	412,039	100,194	476,779	133,785	356,571	85,646
Tuna, Skipsack	---	---	---	---	---	---	207,000	49,680
Tuna, Unclass.	---	---	---	---	293	119	70	35
Whiting	2,354	168	---	---	1,393	88	1,559	141
Wolffish	66,808	5,060	34,254	2,793	55,278	4,032	9,876	448
Unclass. for Food	153,050	51,328	437,360	111,228	16,855	1,349	4,225	521
Unclass. for Spawn	---	---	---	---	---	---	---	---
Unclass. for Industrial	---	---	---	---	1,808,850	27,970	5,669,410	100,382
TOTAL FISH	55,088,852	21,250,649	63,222,859	21,112,614	63,110,325	14,944,896	59,986,800	12,254,432

Appendix C
NEW BEDFORD LANDINGS

SPECIES	1976 pounds	1976 dollars	1975 pounds	1975 dollars	1974 pounds	1974 dollars	1973 pounds	1973 dollars
Shellfish								
Crabs, Jonah	2,417	726	3,582	977	11,000	3,300	---	---
Crabs, Red	---	---	---	---	68,857	20,657	56,278	17,483
Lobsters, American, Unclass.	212,378	385,627	221,508	379,640	153,960	247,960	27,275	46,180
Lobsters, American, Small	---	---	---	---	---	---	4,000	6,480
Lobsters, American, Select	4,339	9,848	1,193	1,968	3,999	7,202	---	---
Lobsters, American, Large	6,419	10,771	6,298	9,590	11,189	18,642	14,925	21,708
Shrimp, Saltwater (Heads on)	---	---	---	---	---	---	6,429	7,918
Conchs (Meats)	7,870	604	3,771	303	---	---	---	---
Scallops, Sea (Meats)	9,525,691	17,523,163	5,179,526	9,778,169	3,958,052	6,108,216	2,800,877	4,974,156
Squid	796,849	160,053	1,485	243	239,970	38,614	188,310	28,822
TOTAL SHELLFISH	10,555,963	18,090,792	5,417,363	10,170,890	4,447,027	6,443,871	3,100,094	5,102,747
GRAND TOTAL	65,644,815	39,341,441	68,640,222	31,283,504	67,557,352	21,388,767	63,086,894	17,357,179

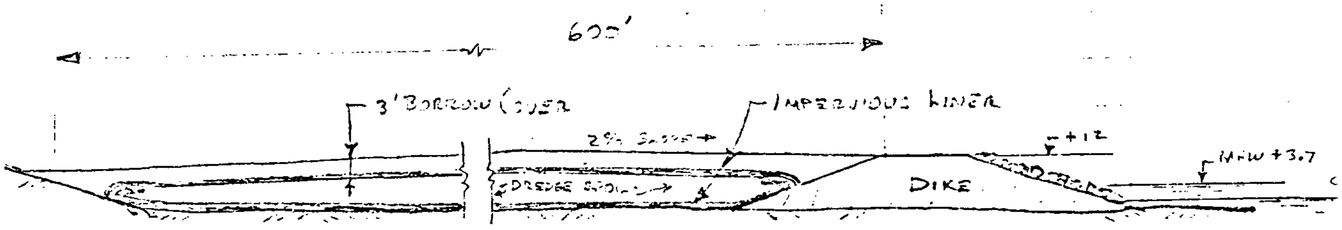
SUBJECT DISPOSAL OF DREDGE SPOIL
SITE C N. OF RTE. 195 BRIDGE



PLAN

VOLUME INSIDE DIKE (FOR SPOIL

$900(600)\,8\left(\frac{1}{27}\right) = 160{,}000$ c



SECTION

NOTE: BORROW COVER SHOULD BE INCREASED UP TO 5' WHERE UTILITIES REQD

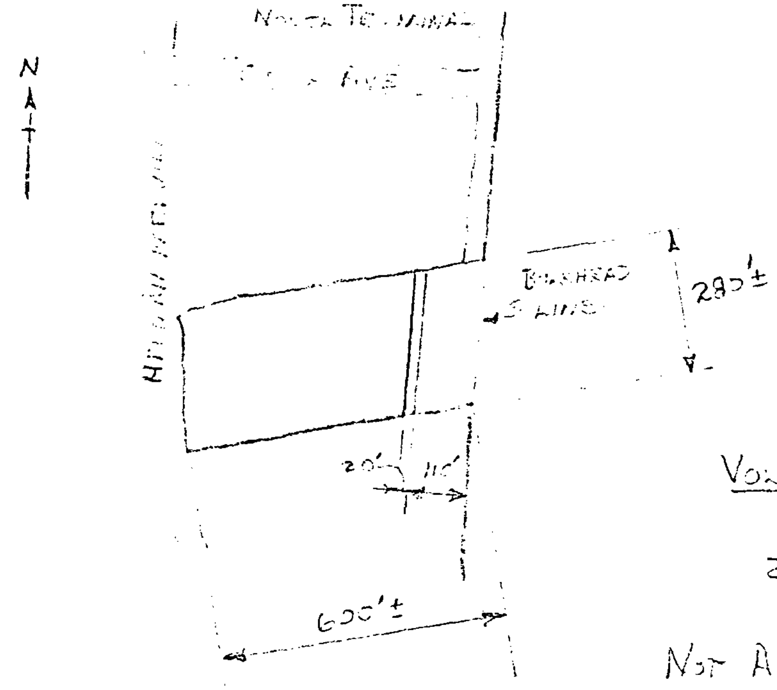
DISPOSAL SITE COSTS

DIKE	850 (28.5 cy/LF)	=	24,000± cy @	$8 =	$192,000
RIPRAP			850 LF @	$240 =	204,000
LINER	900 (650) 2 ($\frac{1}{27}$)	=	137,000± cy @	$19 =	2,470,000
BORROW	900 (650) 3 ($\frac{1}{27}$)	=	65,000 cy @	5 =	325,000
					$3,191,000

$\frac{\$3{,}191{,}000}{[illegible]} = \$20/cy \pm$

SUBJECT: Disposal Of Dredge Mat'l
Site D North Terminal

DATE: 10/26/..
COMPUTED BY: ...
CHECKED BY: ...

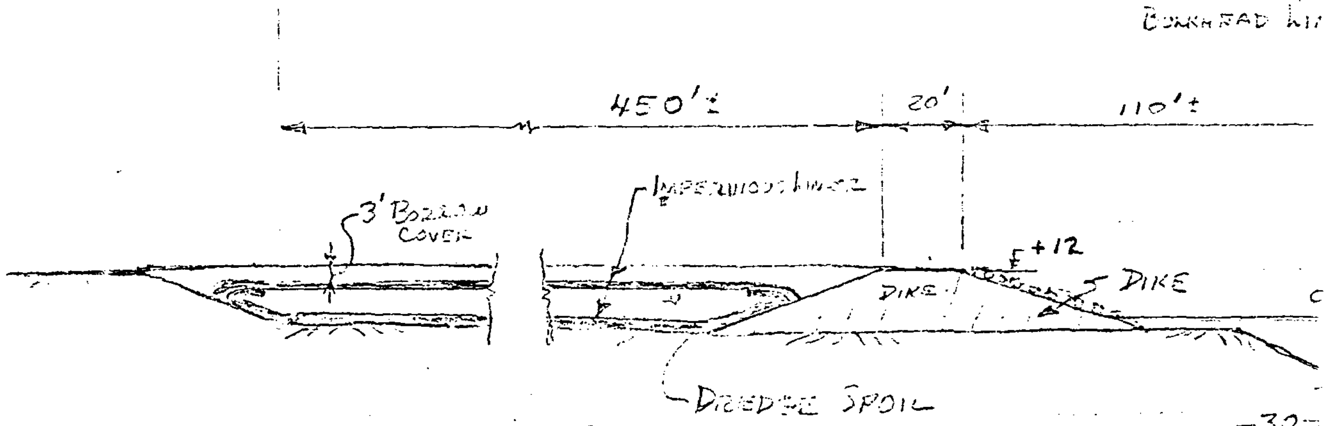


PLAN

Volume Inside Dike (For Spoil)

$280(450)\,9\left(\frac{1}{27}\right) = 42{,}000\ CY\pm$

Not Adequate
Dredge Spoil Volume = 150,000 C



SECTION (1" = 50')

Disposal Site Costs

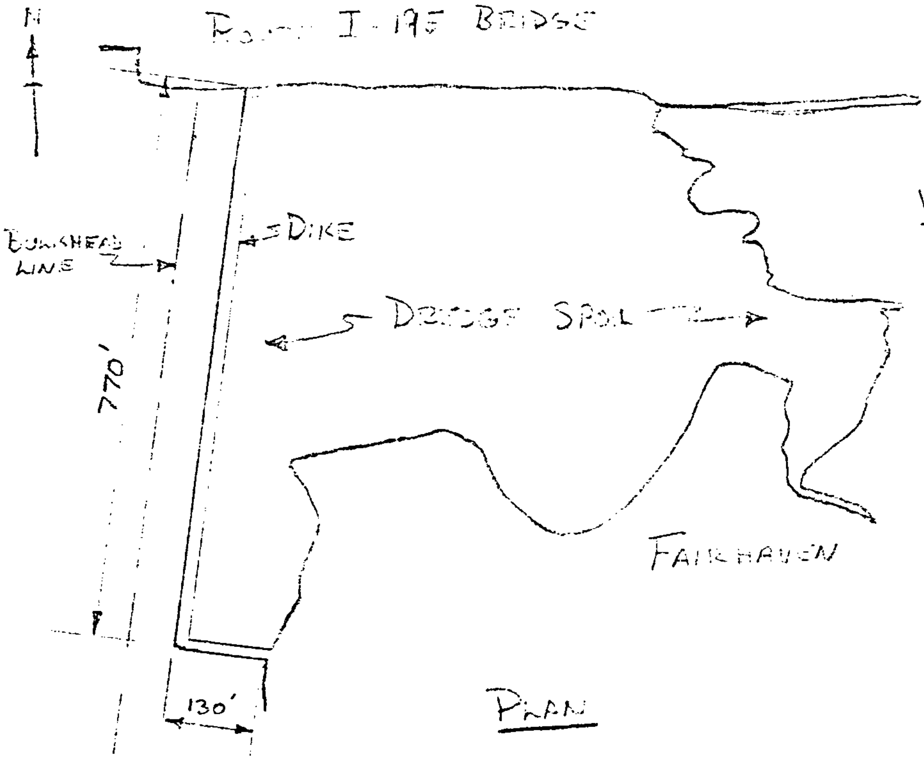
Dike	280 (36 cy/LF)	=	10,000 cy @ \$8 =	\$80,000
Riprap			280 LF @ \$240 =	67,000 ±
Liner	$500(350)\,2\left(\frac{1}{9}\right)$	=	39,000 SY @ \$18 =	702,000 ±
Borrow	$450(300)\,3\left(\frac{1}{27}\right)$	=	15,000 cy @ 5 =	75,000
				\$924,000

$\frac{\$924{,}000}{42{,}000\ cy} = \$22^{-}/cy$

BOSTON

SUBJECT: Disposal of Dredge Spoils
Site (B) South of I-195 Bridge

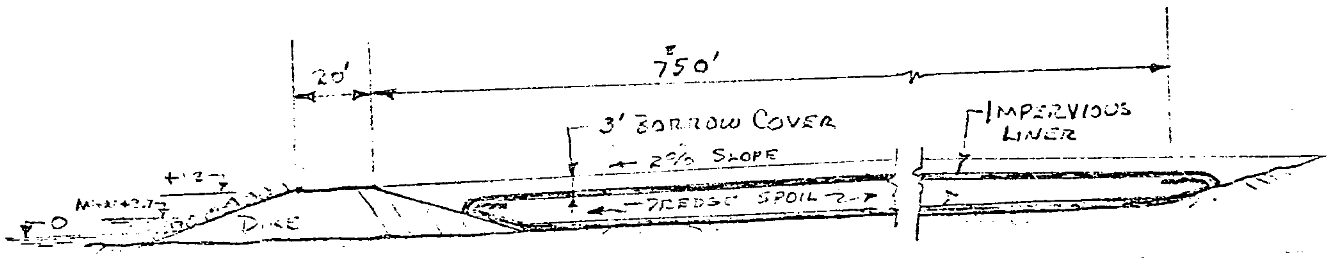
DATE: 12/27/77
COMPUTED BY: [illegible]
CHECKED BY: C?C



PLAN

Volume Inside Dike (For S…

750(500) 10 (1/27) = 139…
200(140) 11 (1/27) = 14…
153…



SECTION

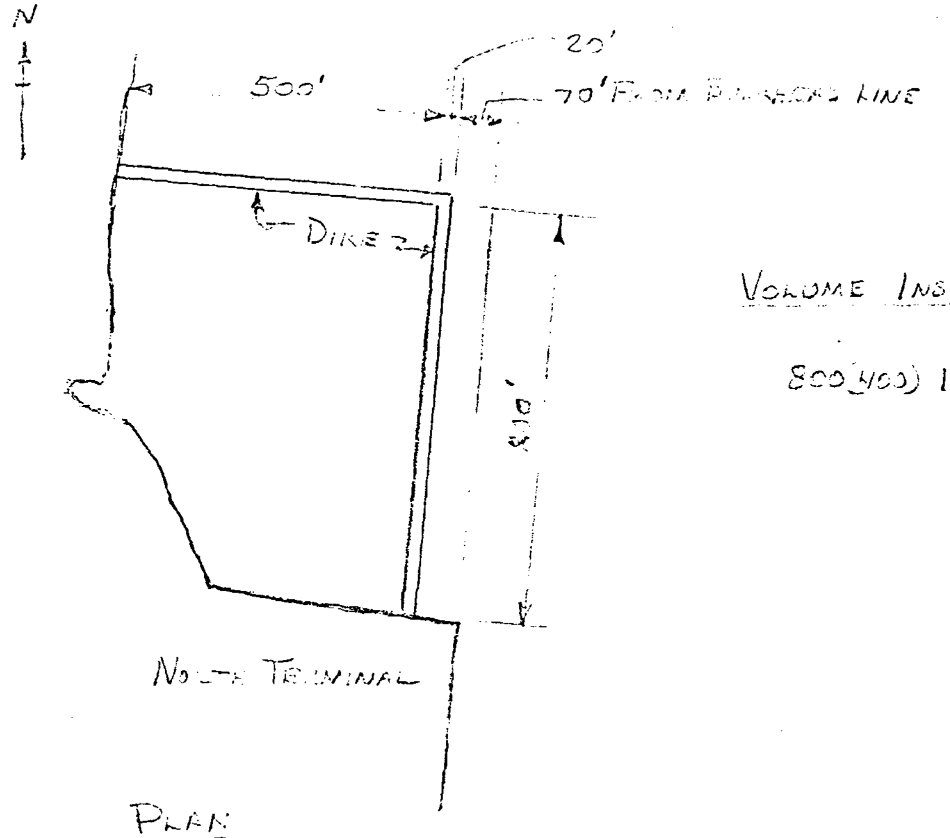
Note: Borrow Cover Should Be Increased Up To 5' Where Utilities Reqd.

Disposal Site Cost

Dike 900 (32.2 CY/LF) = 29,000 CY @ $8 = $23…
Riprap 900 LF @ $240 = 21…
Liner [800(500) + 300(200)] 2/9 = 111,000 SY @ $18 = 2,00…
Borrow [800(500) + 300(200)] 3/27 = 56,000 CY @ $5 = 28…
$2,72…

$2,723,000 / 153,000 CY = $17.80/CY

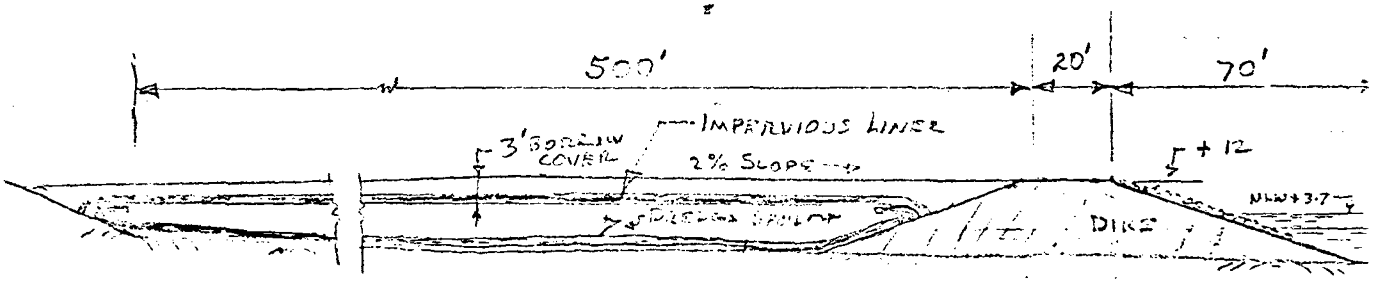
SUBJECT Disposal of Dredge Spoils
Site © North Terminal



Plan
No Scale

Volume Inside Dike (For Spoil)

800 (400) 13 (1/27) = 154,000 cy



Section
1" = 50'

Disposal Site Costs

Dike	800 (59.2 cy/LF) + 500 (40.3 cy/LF) =	63,000 cy @	$8 =	$54.
Riprap		1,300 LF @	$240 =	31.
Liner	550 (550) 2 (1/9) =	104,000 SY @	$18 =	1,87
Borrow	550 (800) 3 (1/27) =	49,000 cy @	$5 =	24.
				$2,97

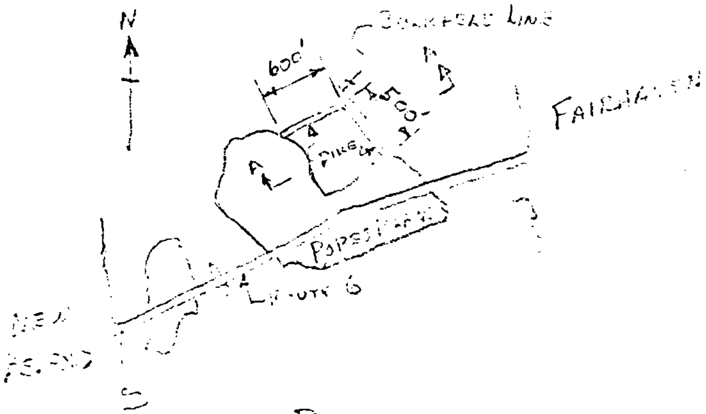
$2,971,000 / 154,000 cy = $19.32/cy

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT New Bedford

FILE NUMBER 1M-55
SHEET NUMBER 7-15
DATE 12/23/77
COMPUTED BY WHF
CHECKED BY CWC

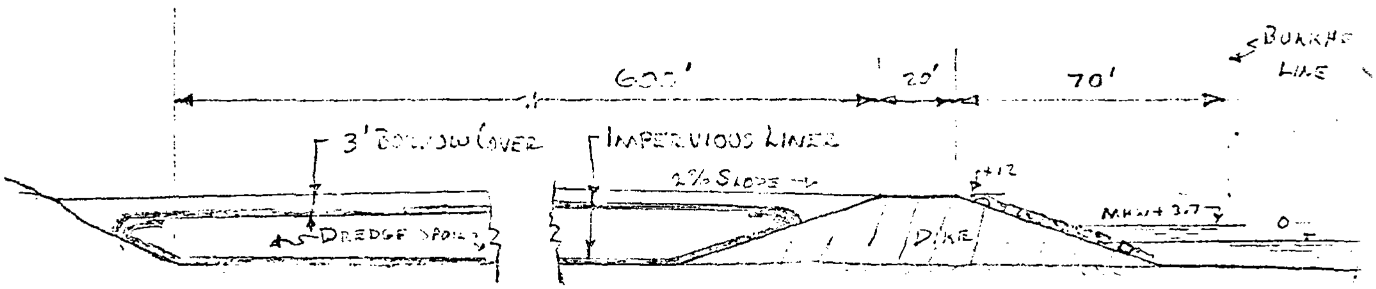
SUBJECT Disposal of Dredge Spoils
Site (E) Popes Island



PLAN

Volume Inside Dike (for Spoil)

$600(550)\,12\left(\frac{1}{27}\right) = 147{,}000$ CY



SECTION A-A

Note: Borrow Cover Should Be Increased Up To 5' Where Utilities Req.

Disposal Site Costs

Dike	(500 + 600) 49.3 cy/LF =	54,000 cy ±	@ $8	=	$432,000
Riprap		1,100 LF	@ $240	=	264,000
Liner	$650(600)\,2\left(\frac{1}{9}\right)$ =	87,000 SY ±	@ $18	=	1,570,000
Borrow	$600(550)\,3\left(\frac{1}{27}\right)$ =	37,000 cy ±	@ $5	=	185,000
					$2,451,000

$$\frac{\$2{,}451{,}000}{147{,}000\ cy} = \$16^{70}/cy \pm$$

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT New Bedford

FILE NUMBER TN-35
SHEET NUMBER 9-15
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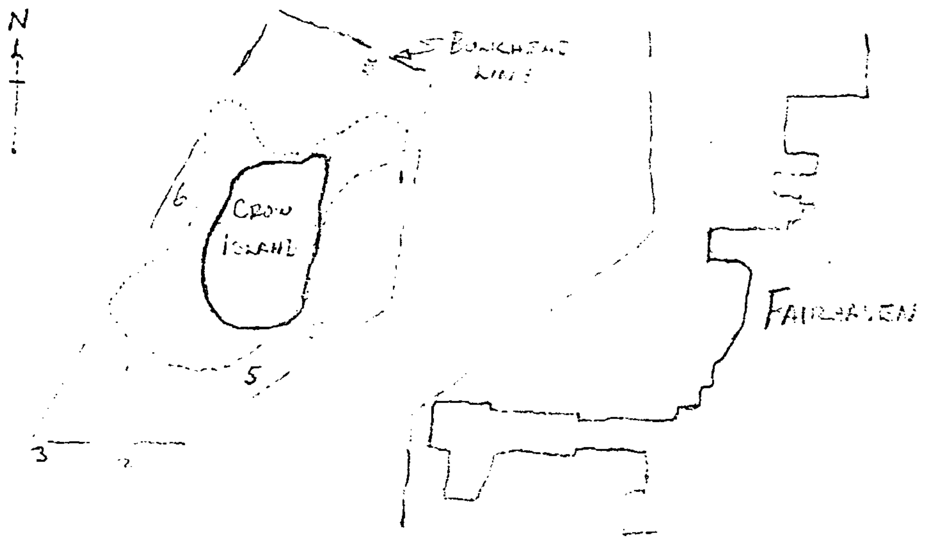
CHECKED BY

SUBJECT Disposal of Dredge Spoil
Site (F) Crow Island



PLAN
1" = 400' ±

Volume Inside Bulkhead Line (For Spoil)

$$[1,000(400) - 200(400)]\ \frac{11}{27} = 130,000\ cy \pm$$

$$400(200)\ \frac{2}{27} = 6,000$$

$$136,000\ cy$$

Site Does Not Have Enough Area To Dispose Of The 150,000 cy Of Dredge Spoil Even If Filled Out To The Bulkhead Line. If Dikes Are Used The Area Will Be Even Less.