Office of the Chief of Engineers
Value Engineering Study Team

VEST

US Army Corps
of Engineers

VALUE ENGINEERING TEAM STUDY REPORT

NEW BEDFORD HARBOR DREDGING

EPA SUPERFUND PROJECT

New Bedford, Massachusetts

Sponsored By:
U.S. Army Engineer District, New England

JUNE 2000

VALUE ENGINEERING TEAM STUDY

DOD SERVICE: USACE
CONTROL NO: CEMVN-VE-00-05
VALUE ENGINEERING OFFICER: Bill Herland

Value Engineering Study on the

NEW BEDFORD HARBOR DREDGING CDF "D"

EPA SUPERFUND PROJECT

NEW BEDFORD, MASSACHUSETTS

JUNE 2000
U.S. Army Engineer District, New England

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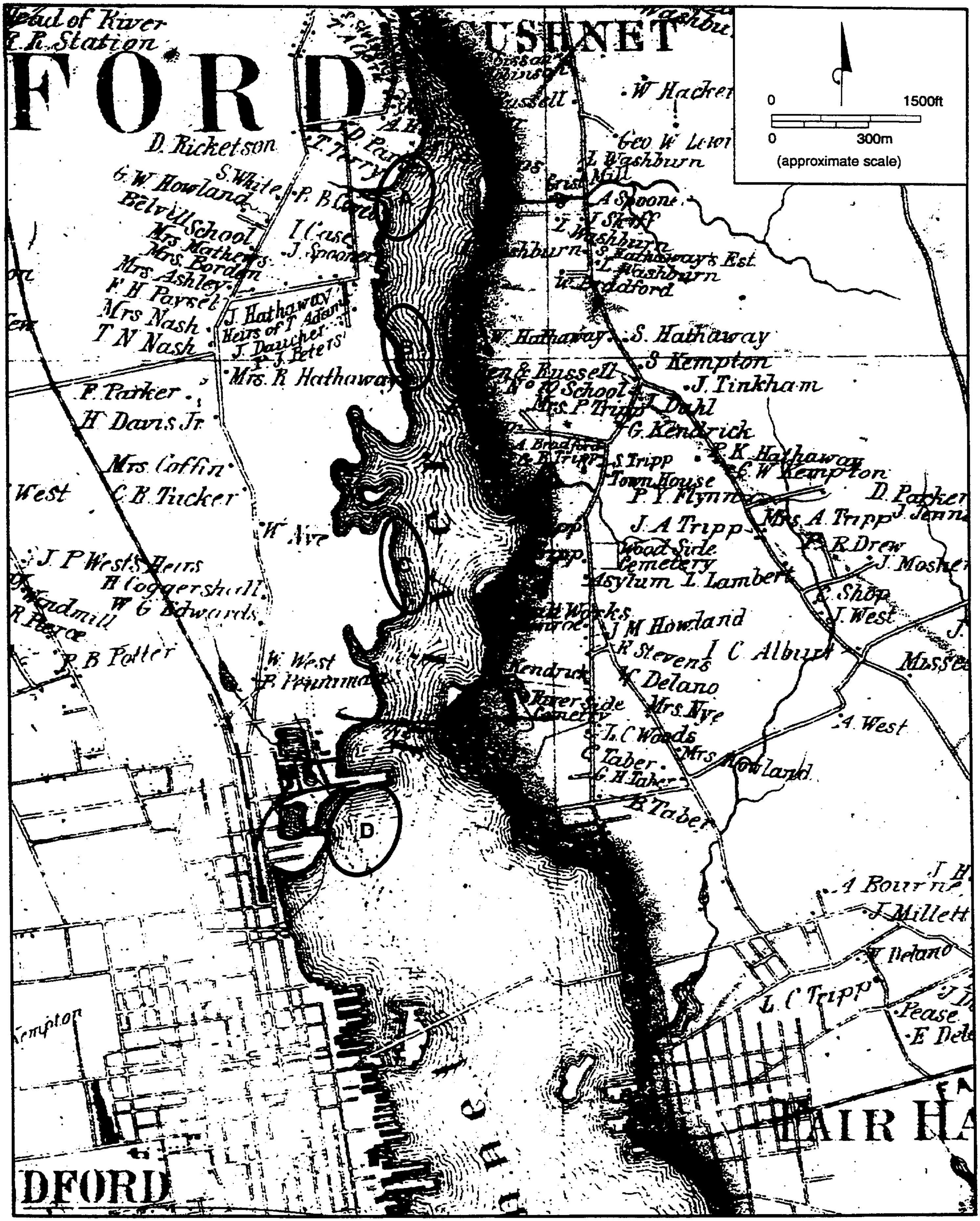

Figure 5-1. Detail, *Map of the City of New Bedford and the Village of Fairhaven* (Walling 1858), showing locations of proposed CDF's.

VALUE ENGINEERING TEAM STUDY

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PROJECT DESCRIPTION AND BACKGROUND

PROJECT TITLE: New Bedford Harbor Dredging
PROJECT LOCATION: New Bedford, MA

The New Bedford Harbor Superfund Site is located in Bristol County, MA. The site extends from the shallow northern reaches of the Acushnet River Estuary south through the commercial port of New Bedford Harbor and adjacent areas of Buzzards Bay. The sediments in the harbor are contaminated with high concentrations of many pollutants including PCBs and heavy metals from the industrial and urban development surrounding the harbor.

From the 1940s until approximately the 1970's, two electrical capacitor manufacturing plants in the New Bedford area discharged PCB waste either directly into the harbor or indirectly through discharges to the city's sewerage system. In the mid 1970s, as a result of EPA sampling, PCBs were identified in the sediments and the seafood in the New Bedford Harbor area. These previous releases of PCBs into the harbor pose an imminent threat and substantial endangerment to the public health and welfare and the environment. In 1979, the Massachusetts Department of Public Health issued regulations prohibiting Fishing and lobstering throughout the site due to high levels of PCB contamination ranging from below detection limits to higher than 100,000 parts per million (ppm) in various parts of the harbor. The site was included on the Superfund National Priorities List (NPL) in September 1983. EPA's site-specific investigations were initiated in 1983-1984, and included engineering feasibility studies of alternative dredging methods and disposal of contaminated sediments, pilot dredging and disposal studies to field test different dredging and disposal technologies of the contaminated sediments, and extensive physical and chemical computer modeling of the site.

The selected cleanup remedy as described in the ROD requires the dredging and excavation of approximately 450,000 cubic yards (CY) of PCB contaminated sediments spread over 170 acres of the upper, lower and outer areas of the New Bedford Harbor. The goals of the remedy are to minimize health risks due to the consumption of PCB contaminated seafood and contact with the shoreline sediments and improve the quality of the upper and lower harbor marine ecosystem for the City of New Bedford and the Towns of Acushnet and Fairhaven, Massachusetts.

The project site encompasses the entire upper and lower harbor areas of the New Bedford Harbor. The upper harbor is defined as all intertidal, subtidal, beach combing, wetland/salt marsh and upland areas north of Coggeshall Street and the lower harbor is defined as all areas south of Coggeshall Street Bridge to the New Bedford Hurricane Barrier. This project involves the dredging and excavation of all intertidal, subtidal, upland and wetland/marsh areas of the upper and lower New Bedford Harbor which have PCB contaminated sediments that exceed the cleanup levels established by EPA's September

PROJECT TITLE: New Bedford Harbor Dredging
PROJECT LOCATION: New Bedford, MA

1998 Record of Decision (ROD). A few areas outside of the New Bedford Hurricane barrier will also be dredged since they exceed the cleanup levels for this project. As stated in the ROD, contaminated sediments will be disposed of in four Confined Disposal Facilities, identified as CDF's, A, B, C, and D, along the New Bedford Harbor shoreline that will be designed and constructed.

The United States Environmental Protection Agency (EPA) has selected a remedial action plan for the upper and lower areas of the New Bedford Harbor (NBH). The plan includes removal of approximately 450,000 cubic yards of PCB-contaminated sediment; containment of the sediments in four shoreline confined disposal facilities (CDFs), treatment of water decanted from the sediments, and interim and final capping of the CDFs once filled. Section X of the ROD provides a more complete discussion of the remedy. Subsequently, the EPA and U.S. Army Corps of Engineers, New England District (USACE-NAE) entered into an Inter-Agency Agreement in February 1998 which gives NAE responsibility of providing technical assistance to the EPA on this project. In October of 1998, the EPA authorized NAE to perform remedial investigation and design activities associated with the upper and lower New Bedford Harbor cleanup.

In order to perform a number of pre-design and design activities requested by EPA, a team approach between Foster Wheeler Environmental Corporation and NAE was determined to be the most advantageous means of accomplishing the work. Foster Wheeler has been awarded a task order under NAE's Total Environmental Restoration Contract (TERC) with the intent of establishing a collaborative effort and allowing the project to take advantage of the most qualified individuals and specialists in both organizations to prepare and implement the designs. In addition, NAE has acquired the services of Haley & Aldrich, Inc. (H&A) for their geotechnical expertise in the design of CDF "D".

VALUE ENGINEERING TEAM STUDY
PROJECT DESCRIPTION AND BACKGROUND

PROJECT TITLE: New Bedford Harbor Dredging
PROJECT LOCATION: New Bedford, MA

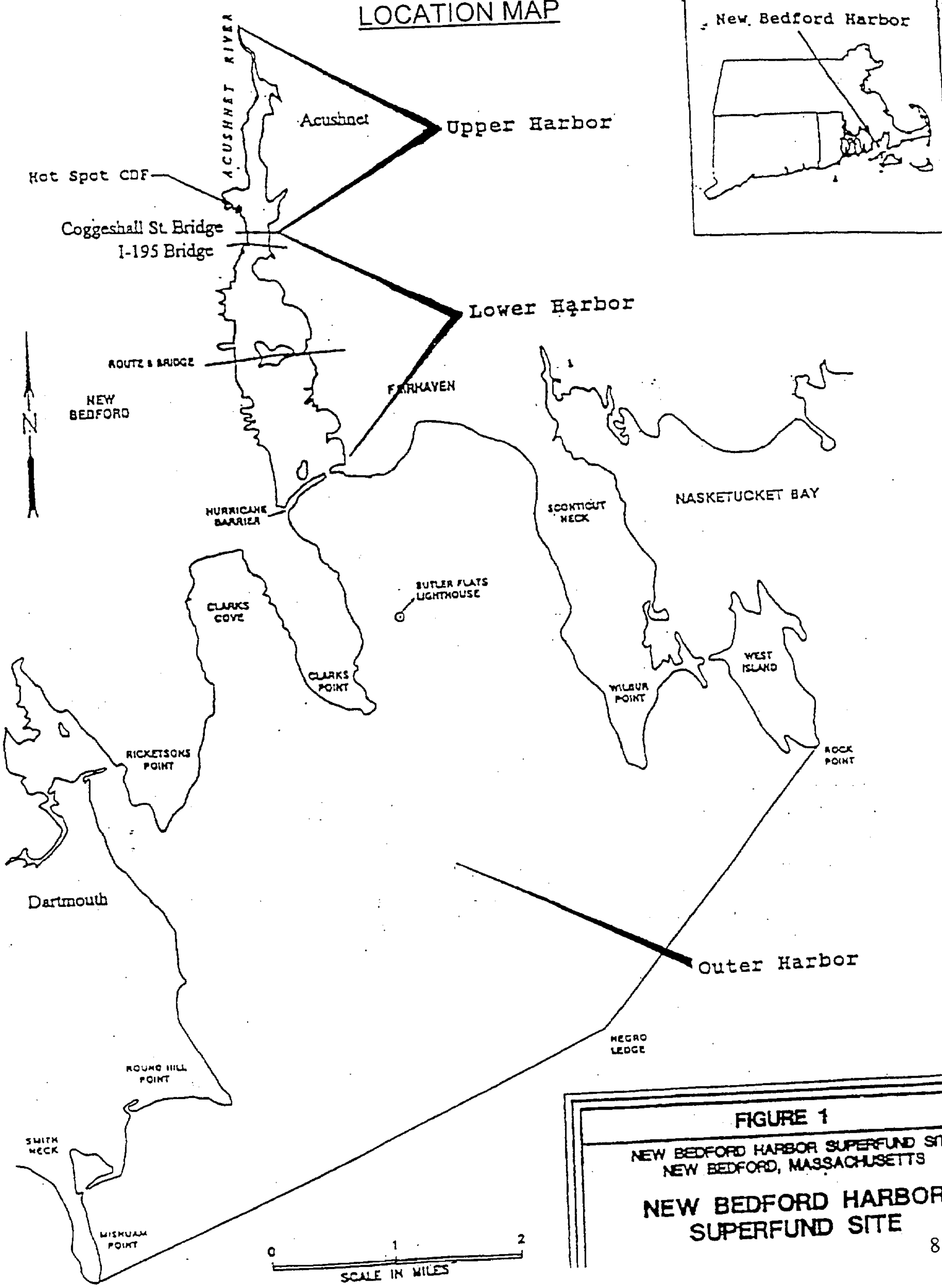


FIGURE 1

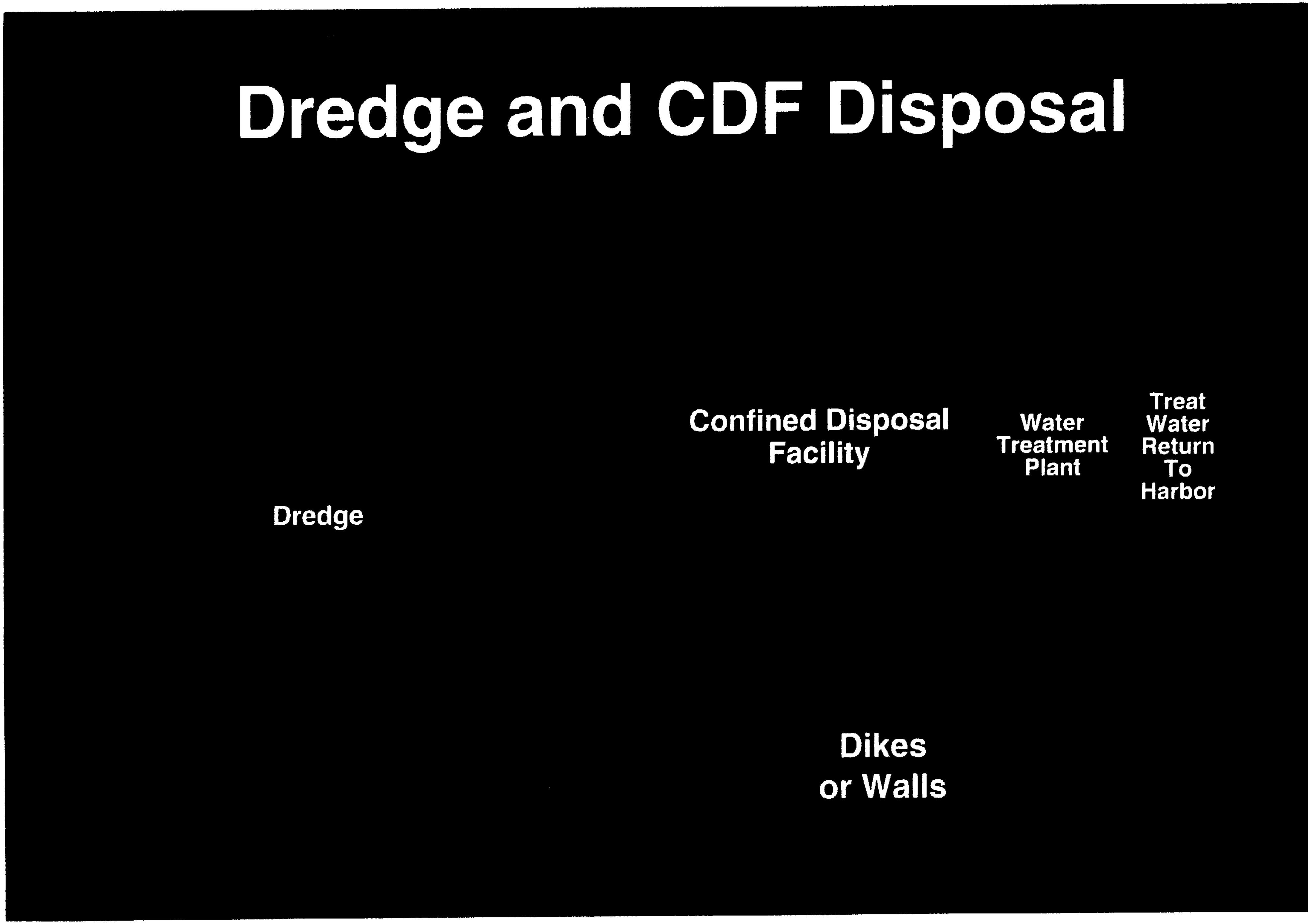
NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

NEW BEDFORD HARBOR SUPERFUND SITE

PROJECT TITLE: New Bedford Harbor Dredging
PROJECT LOCATION: New Bedford, MA

SITE PLAN

Originals in color.



Originals in color.

VALUE ENGINEERING TEAM STUDY

EXECUTIVE SUMMARY

Value Engineering is a process used to study the functions a project is to provide. As a result, it takes a critical look at how these functions are met and develops alternative ways to achieve the same function while increasing the value of the project. In the end, it is hoped that the project will realize a reduction in cost, but adding value over reducing cost is the focus of VE.

The Value Engineering Study was initiated during the week of 18 – 23 June 2000 at the New England District Office. A site tour of the project was conducted on 18 June 2000 for the VE Team, and the basis of the study was the Draft Feasibility Study and Technical Information Report dated 9 June 2000.

The project was studied using the Corps of Engineers standard Value Engineering (VE) methodology, consisting of five phases:

Information Phase: The Team studied drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved. Cost Models (see Appendix C) were compared to determine areas of relative high cost to ensure that the team focused on those parts of the project which offered the most potential for cost savings.

Speculation Phase: The Team speculated by conducting brainstorming sessions to generate ideas for alternative designs. All team members contributed ideas and critical analysis of the ideas was discouraged (see Appendix B).

Analysis Phase: Evaluation, testing and critical analysis of all ideas generated during speculation was performed to determine potential for savings and possibilities for risk. Ideas were ranked by priority for development. Ideas which did not survive critical analysis were deleted.

Development Phase: The priority ideas were developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches, technical support documentation, and cost estimates were prepared to support implementation of ideas. Additional VE Team Comments were included for items of interest which were not developed as proposals, and these comments follow the study proposals.

Presentation Phase: Presentation is a two-step process. An outbriefing on preliminary study results was given on 22 June 2000. The published VE Study Report will then be distributed for review by project supporters and decision-makers. A briefing will be conducted later to decide which proposals merit implementation into project design. The Summary of Proposals follows on the next page.

SUMMARY OF PROPOSALS

During the Speculation Phase of this study, 148 ideas for ways to improve the project or reduce costs were generated. The Analysis Phase of the study reduced the number of ideas to 47 for development, of which 22 ideas were designated as design comments and are included in this report.

The remaining 25 ideas from the Analysis and Development Phases were combined or developed individually to become 22 proposals which, when accepted, can result in maximum possible cumulative savings of ***$113,614,000*** for this project .

PROPOSAL NO.	DESCRIPTION	*POTENTIAL SAVINGS
(CIVIL):		
C-01	Construct CDF "D" Dike Using Sand from Other Navigation Dredging	$ 45,717,000
C-02	Construct Earth Berm/Cut-Off wall at CDF, Construct Earth Dike, No Cut-Off, Use Rock-Filled Dike with Interior Liner/Cut-Off, Construct Hybrid Rock/Sand Berm	$ 22,263,000
C-03	Provide a Land-Side Earth/Stone Berm to the Sheetpile Bulkhead Wall	$ 1,230,000
C-04	Install Curtain around Site, Rollover Pre-Dredge and Contaminant	31,184,000
C-05	Build Interior Containment Dike within CDF "D", Rollover Pre-Dredge and Contaminant Layer into Containment Area	$ 25,374,000
C-06	Use 3 or 4 CDF's to Store Dredged Harbor and Foundation Materials, No Lobe Excavation, No Upland Storage	$ 43,059,000
C-07	Use CDF "D" with "New" Alignment to Avoid Channel Relocation, Delete "A", "B", and "C", De-water Harbor Sediments, Delete Upland Storage Sites	$ 13,863,000
C-08	Add Horizontal Drains (Underdrains) – CDF "D2"	$ 24,144,000
C-09	Construct Contaminated Side Slope Next to Cell Wall, Install Geotextile Cutoff	$ 7,831,000

PROPOSAL NO.	DESCRIPTION	POTENTIAL SAVINGS
C-10	Eliminate Liners and Cutoffs	$ 15,704,000
C-11	Vinyl Sheet Pile Cut-Off Wall in lieu of Steel on Land Side of CDF	$ 911,000
C-12	Use Geomembrane on Landside of CDF	$ 292,000
C-13	Define Cap Area to be Paved (Plan A1)	$ 844,000
	(Plan A3)	$2,665,000
C-14	Eliminate Pre-Dredge of Inorganic Material along CDF "D" Bulkhead Footprint	$ 341,000
C-15	Half Dike	$ 9,359,000
C-16	Transport to Dispose, Reduce Volume of CDF "D"	($ 9,879,200)
C-17	Construct CDF "C", Reduce Volume of CDF "D"	($ 11,829,000)
C-18	Build CDFs "A", "B", "C" . Delete CDF "D" and Delete All Upland Storage	($ 38,586,000)
C-19	Dispose Clean Pre-Dredging Material at Subtitle D Facility	($ 70,023,000)
(STRUCTURAL):		
S-01	Use Free and/or Recycled Sheet Pile	$ 1,371,000
S-02	Weld Interlocks, Plans A-1 and D-2	$ 5,835,000
S-03	Grout Cells, Use Concrete Cells	($ 2,688,000)

**** TOTAL POTENTIAL CUMULATIVE SAVINGS Rounded to $1,000**
$ 113,614,000.

** (Total Potential Cumulative Savings are based on the sum of Proposals C-01, C-05, C-08, C-10, C-13). The other proposals compete with these and therefore their savings are not additive.

NOTE: ( ) denotes cost increase

* Rounded to $1,000

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-01 PAGE NO: 1 OF 11

DESCRIPTION: Construct CDF "D" Dike Using Sand from Other Navigation Dredging

ORIGINAL DESIGN:

The current design constructs the CDF "D" dike using steel pile cells (See Drawing No. 1 and Appendix E).

PROPOSED DESIGN:

Construct the CDF "D" dike using sand made available from dredging and other nearby projects. A sand containment dike would have either a vertical cutoff wall or place a geomembrane on the inside slope of the disposal area (See Drawing No. 2). Excavation of unsuitable materials under the dike would still be required. Fill would be compacted with terra-probe (or similar device).

ADVANTAGES:

1. Fill material comes from another dredging project and is essentially free.
2. Eliminates construction of sheet pile cells.
3. Extends the life of the disposal area where dredged material would have gone.

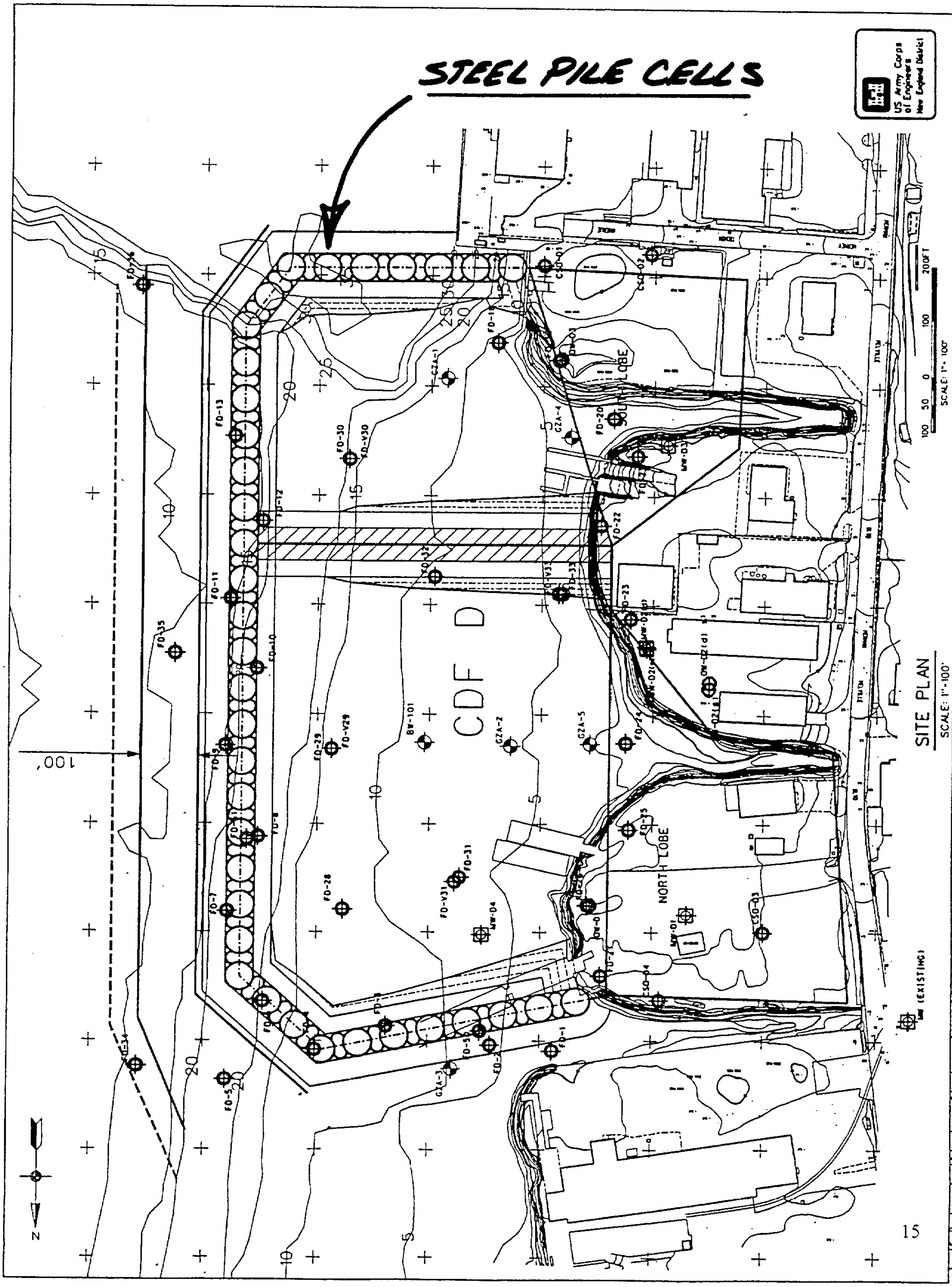
DISADVANTAGES:

1. May be difficult to install the geomembrane and costs are therefore uncertain.
2. Requires close coordination to obtain a sufficient quantity of "free" fill, if even possible.
3. Timing delays probable.
4. Suitability of material questionable.

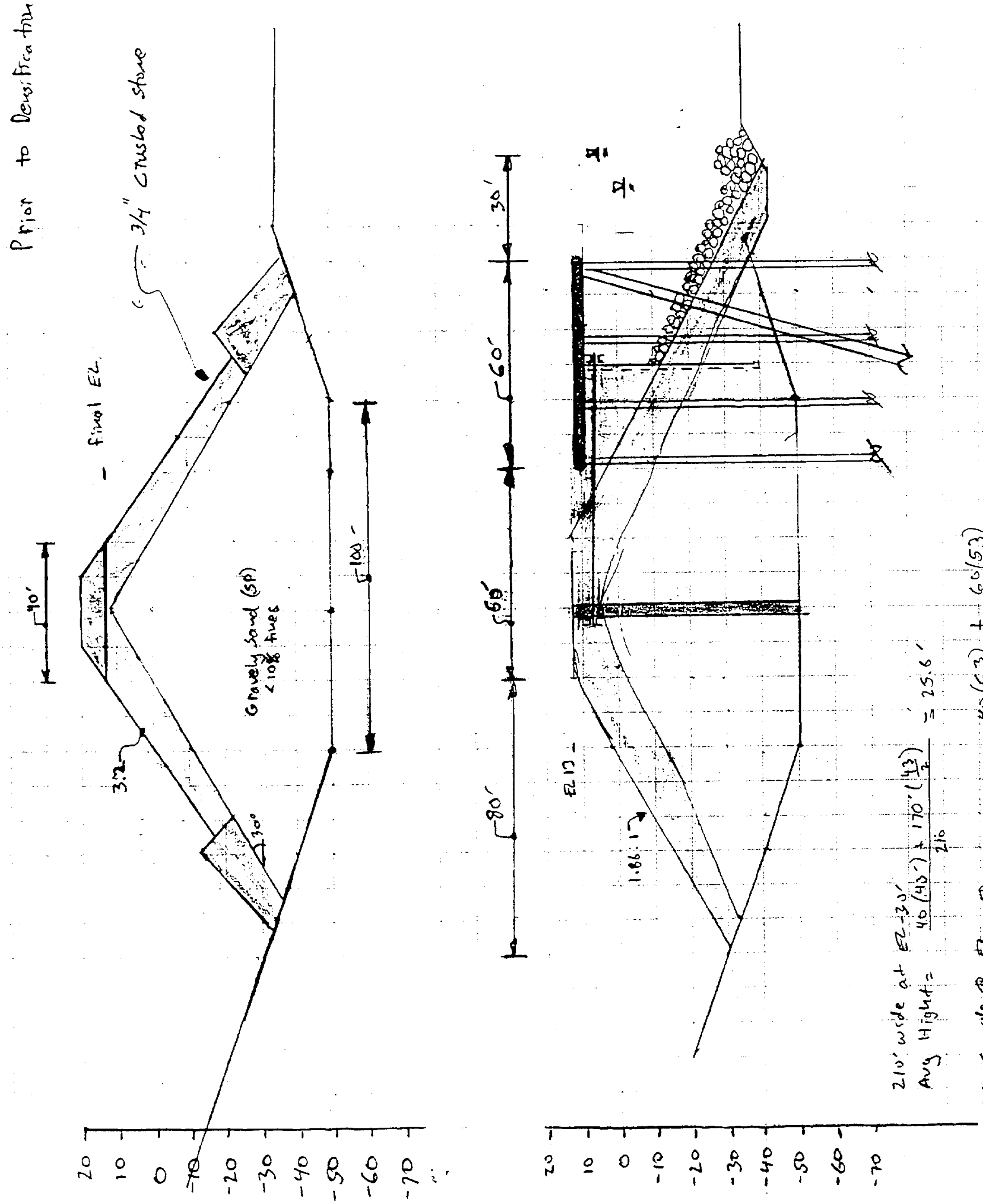
JUSTIFICATION:

This proposal will save construction funding. It requires low maintenance. Ease of construction of port facility.

DRAWING NO. 1

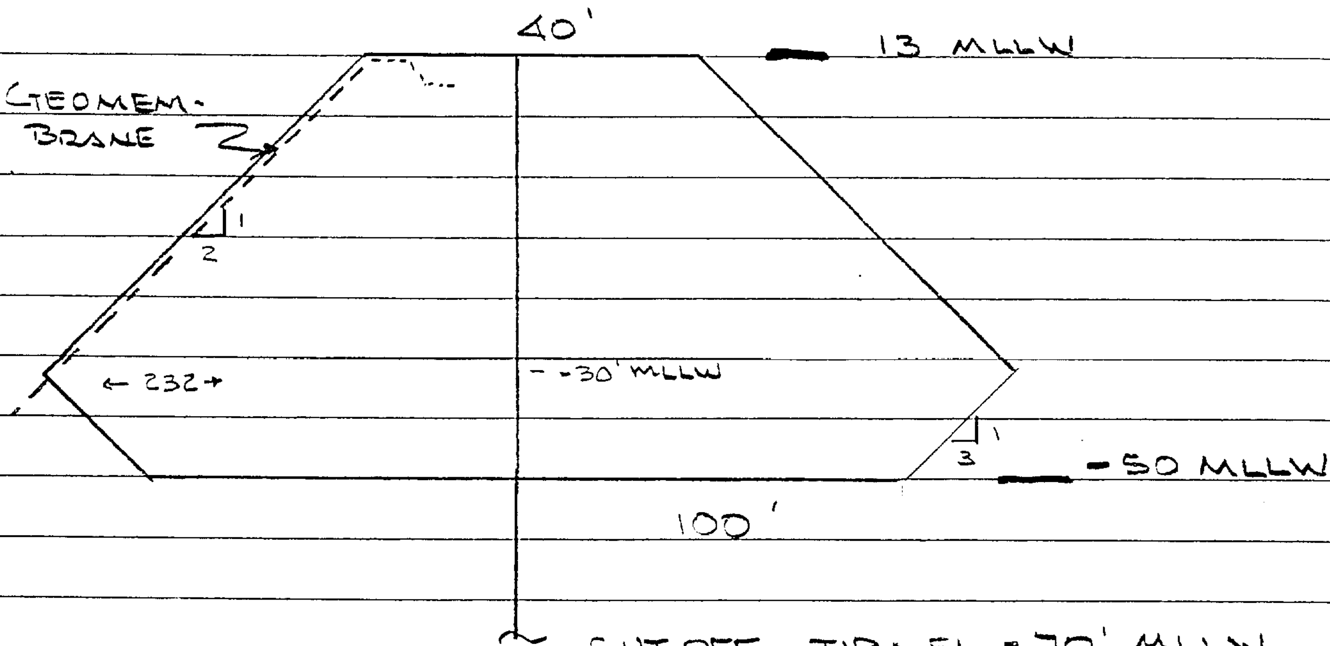

STEEL PILE CELLS
US Army Corps of Engineers New England District
CDF D
NORTH LOBE
SITE PLAN
SCALE: 1"=100'
100'
...\cdf d\plans\cdfd-plana2b.dgn Jun. 16, 2000 14:47:19

DRAWING NO. 2


Prior to Densification
3/4" crushed stone
Final EL
Gravely sand (SP) <10% fines
210' wide at EL-30'
Avg Hight = 40(43') + 170'(43/2) / 210 = 25.6'
100' wide @ EL -50 Avg Hight = 40(63) + 60(53) / 110 = 51.8'

CALCULATIONS

QUANTITY OF FILL - ASSUME THAT ENTIRE DIKE BOTTOM ELEVATION IS -50 FT MLLW. TOP WIDTH IS 40' W/ 1V 3 SIDE SLOPES



$$AREA = \frac{40+232}{2}(43) + \frac{100+232}{2}(20)$$

$$= 9168 \text{ SF}$$

LENGTH OF SHEET PILE WALL = 83 LF

CDF DIKE LENGTH - A1 = 2430 LF

A2 = 2430 LF

A3 = 2110 LF

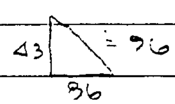
CALCULATIONS

VOLUMES

	FILL	SHEET PILE
Δ1	2430 x 9168/27 = 825,120 CY	2430 x 83 = 201,690 SF
Δ3	2430 x 9168/27 = 825,120 CY	2430 x 83 = 201,690 SF
D2	2110 x 9168/27 = 716,460 CY	2110 x 83 = 175,130 SF

GEOMEMBRANE -

LENGTH = 10 + 5 + 96 = 111 LF



Δ1 : 111 x 2430 = 269,730 SF

Δ3 : 111 x 2430 = 269,730 SF

D2 : 111 x 2110 = 234,210 SF

CRUSHED STONE COVER - 2' THICK

$\frac{((96 \times 2) + 40)\,2}{27} = 17$ CY/LF

Δ1 = 2430 x 17 = 41,310 CY

Δ3 = 2430 x 17 = 41,310 CY

D2 = 2110 x 17 = 35,870 CY

COST ESTIMATE WORKSHEET

CDF A1 - Vinyl Sheetpile Cutoff

PROPOSAL NO.: C-01

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Backfill/compact foundation walls	CY	52,000	$18.00	$936,000
Backfill/compact foundation walls	CY	261,000	$30.00	$7,830,000
Steel sheetpile for cells & arcs, installed	Cell	37	$461,500.00	$17,075,500
Backfill bulkhead wall cells	CY	115,000	$22.50	$2,587,500
Install cutoff wall within bulkhead cell	SF	150,000	$47.00	$7,050,000
		Total Deletions		$35,479,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
**	Earth fill	CY	825,120	$10.00	$8,251,200
	Vinyl sheet pile	SF	210,690	$9.00	$1,896,210
	Crushed stone	CY	41,310	$25.00	$1,032,750
			Total Additions		$11,180,160
			Net Savings		$24,298,840
		*	Markups	84.00%	$20,411,026
			Total Savings		$44,709,866

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available from a nearby project, cost shown for placement and compaction only.

COST ESTIMATE WORKSHEET

CDF A1 - Geomembrane Liner

PROPOSAL NO.: C-01

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Backfill/compact foundation walls	CY	52,000	$18.00	$936,000
Backfill/compact foundation walls	CY	261,000	$30.00	$7,830,000
Steel sheetpile for cells & arcs, installed	Cell	37	$461,500.00	$17,075,500
Backfill bulkhead wall cells	CY	115,000	$22.50	$2,587,500
Install cutoff wall within bulkhead cell	SF	150,000	$47.00	$7,050,000
		Total Deletions		$35,479,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
**	Earth fill	CY	825,120	$10.00	$8,251,200
***	Geomembrane liner	SF	269,730	$5.00	$1,348,650
	Crushed stone	CY	41,310	$25.00	$1,032,750
			Total Additions		$10,632,600
			Net Savings		$24,846,400
		*	Markups	84.00%	$20,870,976
			Total Savings		$45,717,376

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available from a nearby dredging project, cost shown for placement & compaction only.

*** $5/SF cost for geomembrane liner assumes 3 times regular material and installation cost due to underwater placement, water bourne operation, etc.

COST ESTIMATE WORKSHEET

CDF A3 - Vinyl Sheet Pile Cutoff

PROPOSAL NO.: C-01

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Backfill/compact foundation walls	CY	237,000	$18.00	$4,266,000
Backfill/compact foundation walls	CY	76,000	$30.00	$2,280,000
Steel sheetpile for cells & arcs, installed	Cell	37	$487,500.00	$18,037,500
Backfill bulkhead cell walls	CY	125,000	$22.50	$2,812,500
Install cutoff wall within bulkhead cell	SF	156,000	$47.00	$7,332,000
		Total Deletions		$34,728,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
**	Earth fill	CY	825,120	$10.00	$8,251,200
	Vinyl sheet pile	SF	201,690	$9.00	$1,815,210
	Crushed stone	CY	41,310	$25.00	$1,032,750
			Total Additions		$11,099,160
			Net Savings		$23,628,840
		*	Markups	84.00%	$19,848,226
			Total Savings		$43,477,066

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available from a nearby project, cost shown for placement and compaction only.

COST ESTIMATE WORKSHEET

CDF A3 - Geomembrane Liner

PROPOSAL NO.: C-01

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Backfill/compact foundation wall	CY	237,000	$18.00	$4,266,000
Backfill/compact foundation wall	CY	76,000	$30.00	$2,280,000
Steel sheetpile for cells & arcs, installed	Cell	37	$487,500.00	$18,037,500
Backfill bulkhead wall cells	CY	125,000	$22.50	$2,812,500
Install cutoff wall within bulkhead cell	SF	156,000	$47.00	$7,332,000
		Total Deletions		$34,728,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
**	Earth fill	CY	825,120	$10.00	$8,251,200
***	Geomembrane Liner	SF	269,730	$5.00	$1,348,650
	Crushed stone	CY	41,310	$25.00	$1,032,750
			Total Additions		$10,632,600
			Net Savings		$24,095,400
		*	Markups	84.00%	$20,240,136
			Total Savings		$44,335,536

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available from a nearby project, cost shown for placement and compaction only.

*** $5/SF cost for geomembrane liner assumes 3 times regular material and installation cost due to underwater installation, water bourne operation, etc.

COST ESTIMATE WORKSHEET				
CDF D2 - Vinyl Sheetpile Cutoff				
PROPOSAL NO.: C-01				PAGE 10 OF 11

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
Backfill/compact foundation walls	CY	23,000	$18.00	$414,000
Backfill/compact foundation walls	CY	299,000	$30.00	$8,970,000
Steel sheetpile for cells & arcs, installed	Cell	32	$487,500.00	$15,600,000
Backfill bulkhead wall cells	CY	110,000	$22.50	$2,475,000
Install cutoff wall within bulkhead cell	SF	131,000	$47.00	$6,157,000
		Total Deletions		$33,616,000

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
** Earth fill	CY	716,460	$10.00	$7,164,600
Vinyl sheet pile	SF	175,130	$9.00	$1,576,170
Crushed stone	CY	35,870	$25.00	$896,750
		Total Additions		$9,637,520
		Net Savings		$23,978,480
	*	Markups	84.00%	$20,141,923
		Total Savings		$44,120,403

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available form a nearby project, cost shown for placement and compaction only.

COST ESTIMATE WORKSHEET

CDF D2 - Geomembrane Liner

PROPOSAL NO.: C-01

DELETIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	Backfill/compact foundation walls	CY	23,000	$18.00	$414,000
	Backfill/compact foundation walls	CY	299,000	$30.00	$8,970,000
	Steel sheetpile for cells & arcs, installed	Cell	32	$487,500.00	$15,600,000
	Backfill bulkhead wall cells	CY	110,000	$22.50	$2,475,000
	Install cutoff wall within bulkhead cell	SF	131,000	$47.00	$6,157,000
			Total Deletions		$33,616,000

ADDITIONS

	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
**	Earth fill	CY	716,460	$10.00	$7,164,600
***	Geomembrane liner	SF	234,210	$5.00	$1,171,050
	Crushed stone	CY	35,870	$25.00	$896,750
			Total Additions		$9,232,400
			Net Savings		$24,383,600
		*	Markups	84.00%	$20,482,224
			Total Savings		$44,865,824

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

** Material available from a nearby project, cost shown for placement and compaction only.

*** SF cost for geomembrane liner assumes 3 times regular material and installation cost due to underwater placement, etc.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-02 PAGE NO: 1 OF 5

DESCRIPTION: Construct Earth Berm/Cut-Off wall at CDF, Construct Earth Dike, No Cut-Off, Use Rock-Filled Dike with Interior Liner/Cut-Off, Construct Hybrid Rock/Sand Berm

ORIGINAL DESIGN:

Cellular sheet-pile bulkhead with berms and cutoff wall (See Drawing No 1 and Appendix E).

- Pre-dredge to remove unsuitable soils
- Back fill with granular fill
- Densify existing sand and fill using Terra Probe or Vibro-compaction
- Drive steel sheeting
- Backfill and compact cells working from completed cells
- Install cutoff wall
- Construct wharf on berm

PROPOSED DESIGN:

Rock fill/sand embankment with liner on inside berm (See Drawing Nos. 2 and 3).

- Pre-dredge to remove unsuitables – drive wharf piles
- Working from land, end-dump rock fill to construct embankment
- Compact rock fill in lifts above the water table
- Working from top of embankment place gravel filter and sand layers with clam shell
- Install geomembrane liner – cover with sand
- Build wharf and retaining wall (concrete logging behind deck pier)
- Place Class I armor at toe

ADVANTAGES:

1. Eliminate cost of steel sheeting and cutoff wall
2. Faster construction
3. Low maintenance – no corrosion
4. Low seizure risk

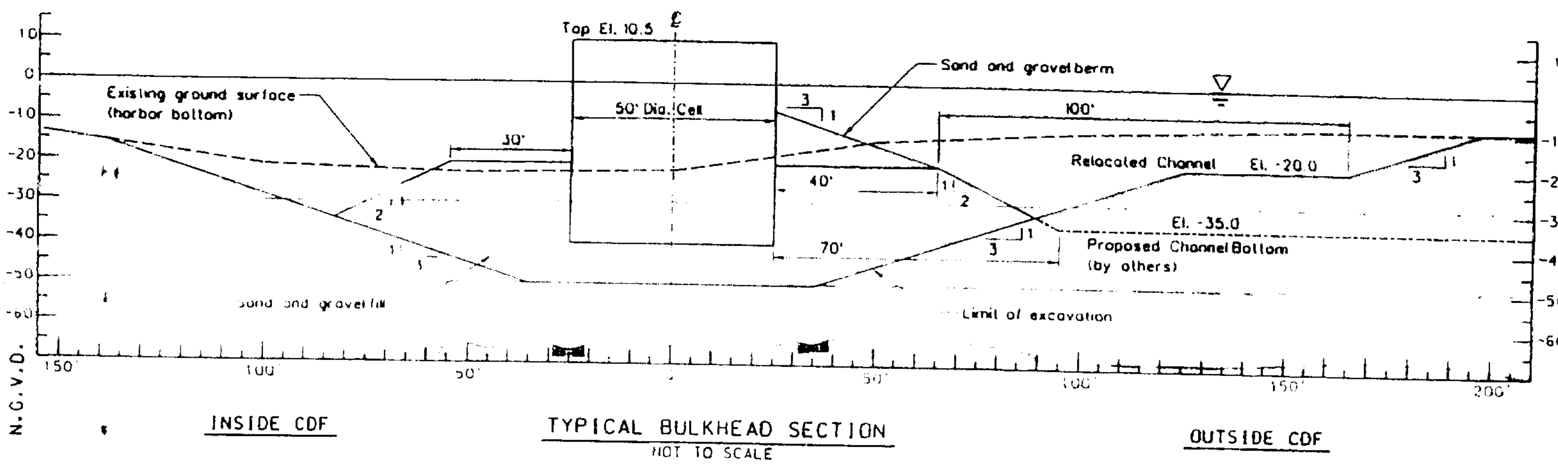
DISADVANTAGES:

1. Loss of storage volume/channel space
2. More risk of leakage
3. Can not de-water CDF initially, may restrict initial filling rate

JUSTIFICATION:

Saves money. Similar embankment has been constructed without significant settlement. Liner placement is new and therefore uncertain as to how well it will work and how much it will cost.

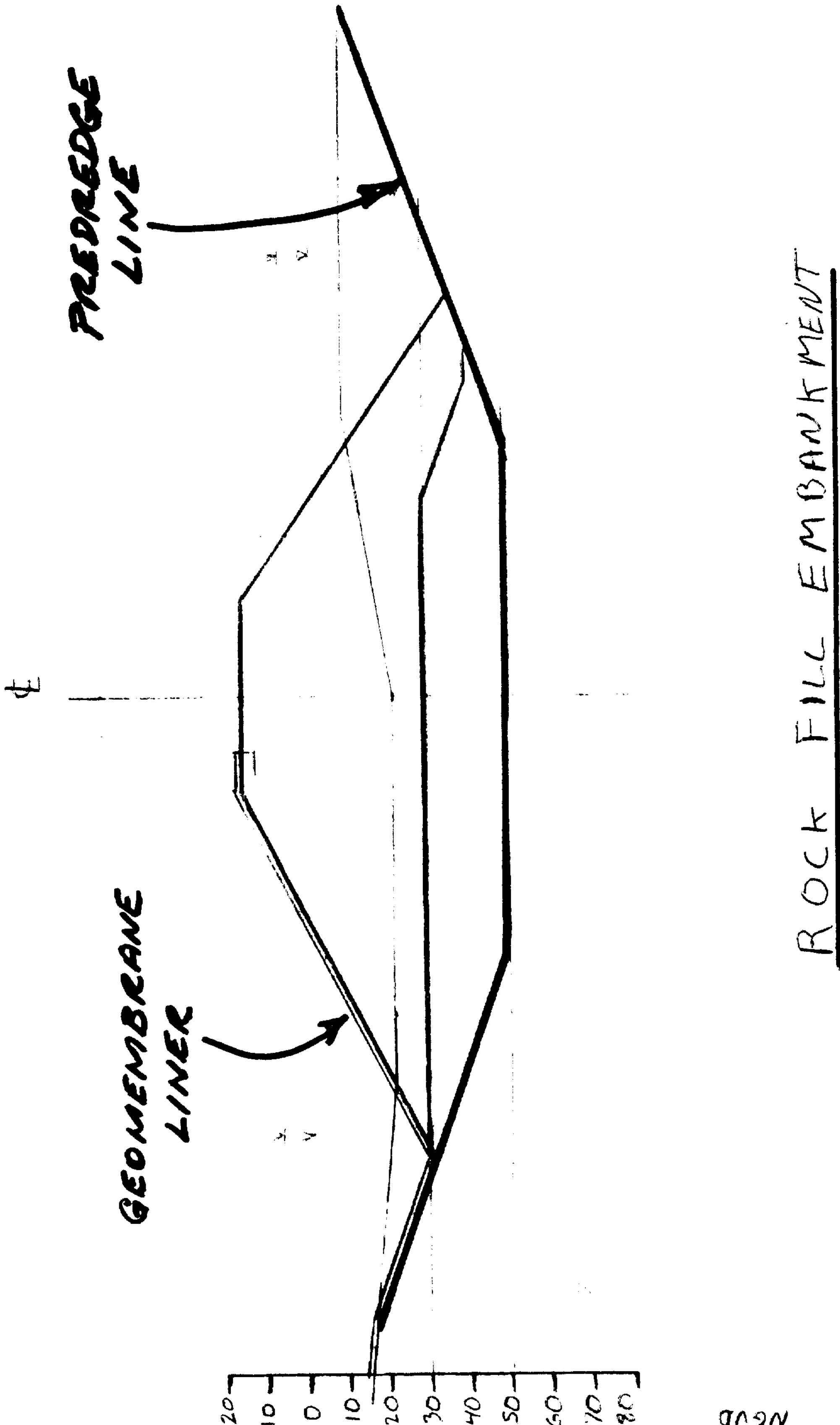
DRAWING NO. 1



CDF D
ALTERNATIVE A-1
TYPICAL BULKHEAD SECTION

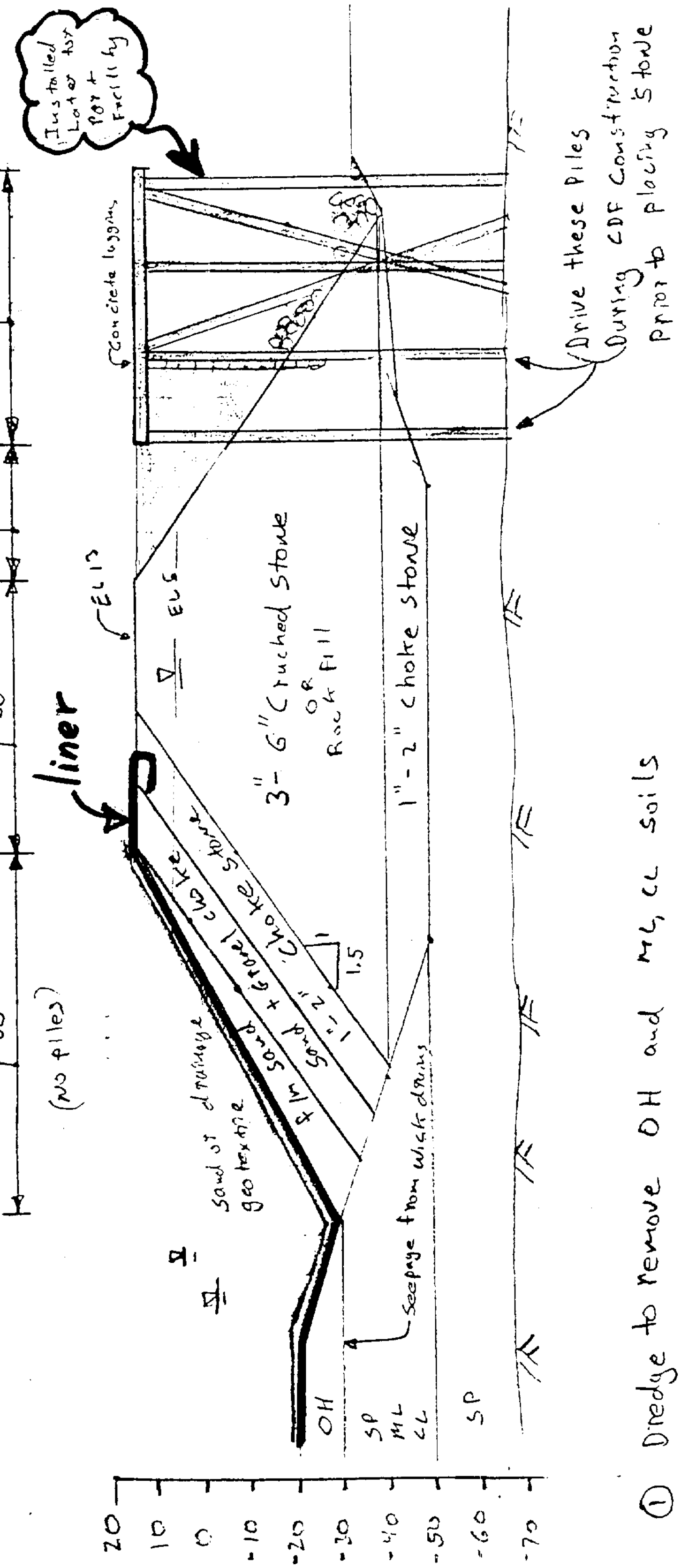
Originals in color.

DRAWING NO. 2



Originals in color.

DRAWING NO. 3



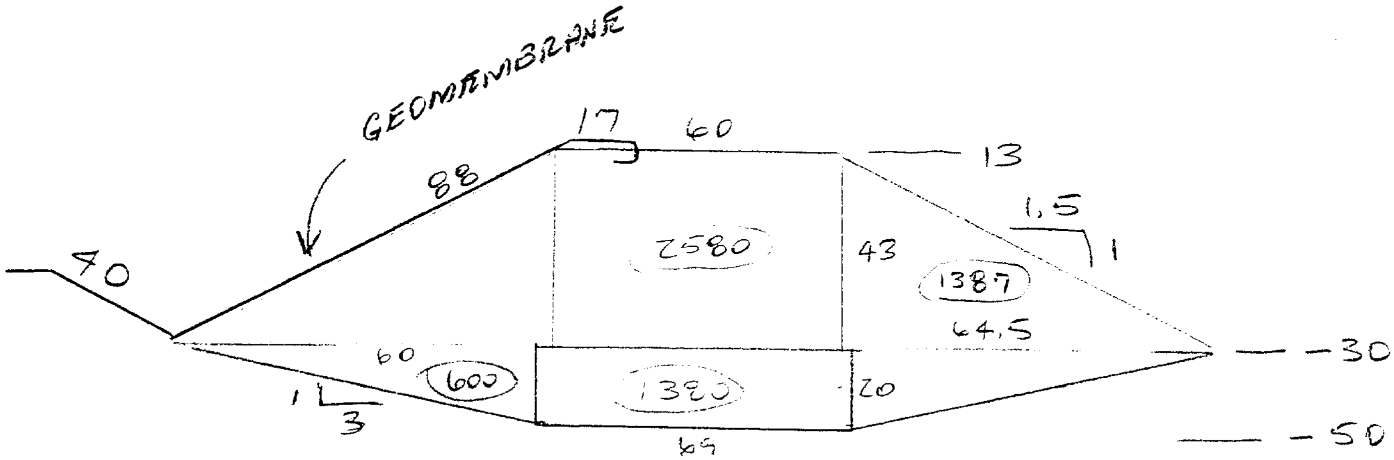
① Dredge to remove OH and ML, CL soils

② If necessary vibro compact lower sand

③ Install piles indicated working from a barge

④ Place 3"-6" crushed stone for embankment by end dumping from land. Place choke stone layers by clamshell from land and work into place

⑤ Install Geomembrane. Clamshell place sand over geomembrane to hold in place and to provide drainage layer.



ROCKFILL

AREA = 2580
1387
1387
1380
600
600

7,934 FT²

LENGTH = 2,430 FT

VOLUME = 7934 × 2430 / 27 ≅ 714,060 CY

GEOTEXTILE LENGTH 40 + 88 + 17 = 145 FT

AREA 2,430 × 145 ≅ 352,400 SF

COST ESTIMATE WORKSHEET

** PROPOSAL NO.: C-02 | PAGE 5 OF 5

(Plan A-1 used as basis for cost comparison)

DELETIONS

ITEM	UNITS	UANTIT	UNIT COST	TOTAL
Steel sheetpile for cells & arcs, installed	LS	1	17,075,500	$17,075,500
Cut-off wall within bulkhead cell	LS	1	7,050,000	$7,050,000
Backfill and compact foundation (reused material)	LS	1	936,000	$936,000
Backfill and compact foundation (additional offsite fill imported)	LS	1	7,830,000	$7,830,000
Backfill and compact interior of cells	LS	1	2,587,500	$2,587,500
		Total Deletions		$35,479,000

***

ADDITIONS

ITEM	UNITS	UANTIT	UNIT COST	TOTAL
Crush stone	CY	714,060	25.00	$17,851,500
Geomembrane	SF	352,400	5.00	$1,762,000
Compaction and shaping	CY	714,060	5.00	$3,570,300
		Total Additions		$23,183,800
		Net Savings		$12,295,200
		Markups	84.00%	$10,327,968
		Total Savings		$22,623,168

* Markups include:25% contingency, plus 40% (OH,fee,S&A,SS&H, QC, etc.) plus 5% escalation

*** NOTE: Cost (Value) of loss of storage volume and cost of channel improvements not included in estimate.

Click here to go to next section